Problem 9 (a) A buck converter is to be designed to deliver power from a DC input with voltage 12 V to an output of 5 V. The switching frequency is chosen to be $f = 25$ kHz. The specifications call for a 20 mV peak-to-peak output-voltage ripple, and a 0.8 A peak-to-peak inductor-current ripple. Assume all switching and filter components are ideal. 2 points

(i) What is the duty cycle that the converter should operate at?

(ii) What value of filter inductance would meet the specifications?

(iii) What value of filter capacitance would meet the specifications?

(iv) Assuming a load resistance, $R = 500\,\Omega$, what is the critical filter inductance for the converter? (Recall, the converter operates at the boundary of continuous- and discontinuous-current conduction modes when the inductance is chosen to be the *critical filter inductance*.)

Problem 9 (b) Consider a power system composed of two buses. Bus#1 is connected to a generator, and bus#2 is a load bus. The load consumes 1 p.u. active and 0.5 p.u. reactive power, and it is connected to the generator through a transmission line with impedance $Z_{\text{line}} = 0.02 + \text{j}0.06\,\text{pu}$. Also, there is a capacitor for power factor correction connected to the load bus with admittance $Y_{\text{cap}} = \text{j}0.25\,\text{pu}$. The terminal voltage of the generator is $V_1\angle\theta_1 = 1\angle 0\,\text{pu}$. 2 points

(i) Draw a one-line diagram of the power system described above and write out the admittance matrix of the network.

(ii) Write the power flow equations that you would have to solve numerically to compute the load-bus voltage magnitude and angle, i.e., $V_2\angle\theta_2$. [**YOU DO NOT HAVE TO SOLVE THESE EQUATIONS**]