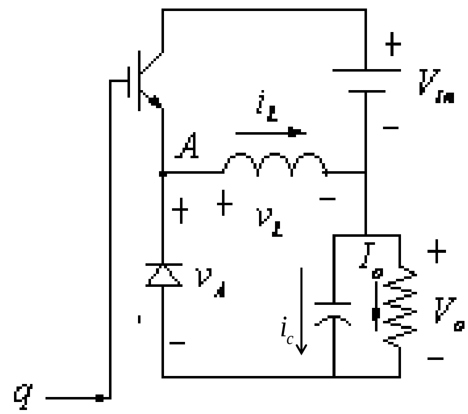
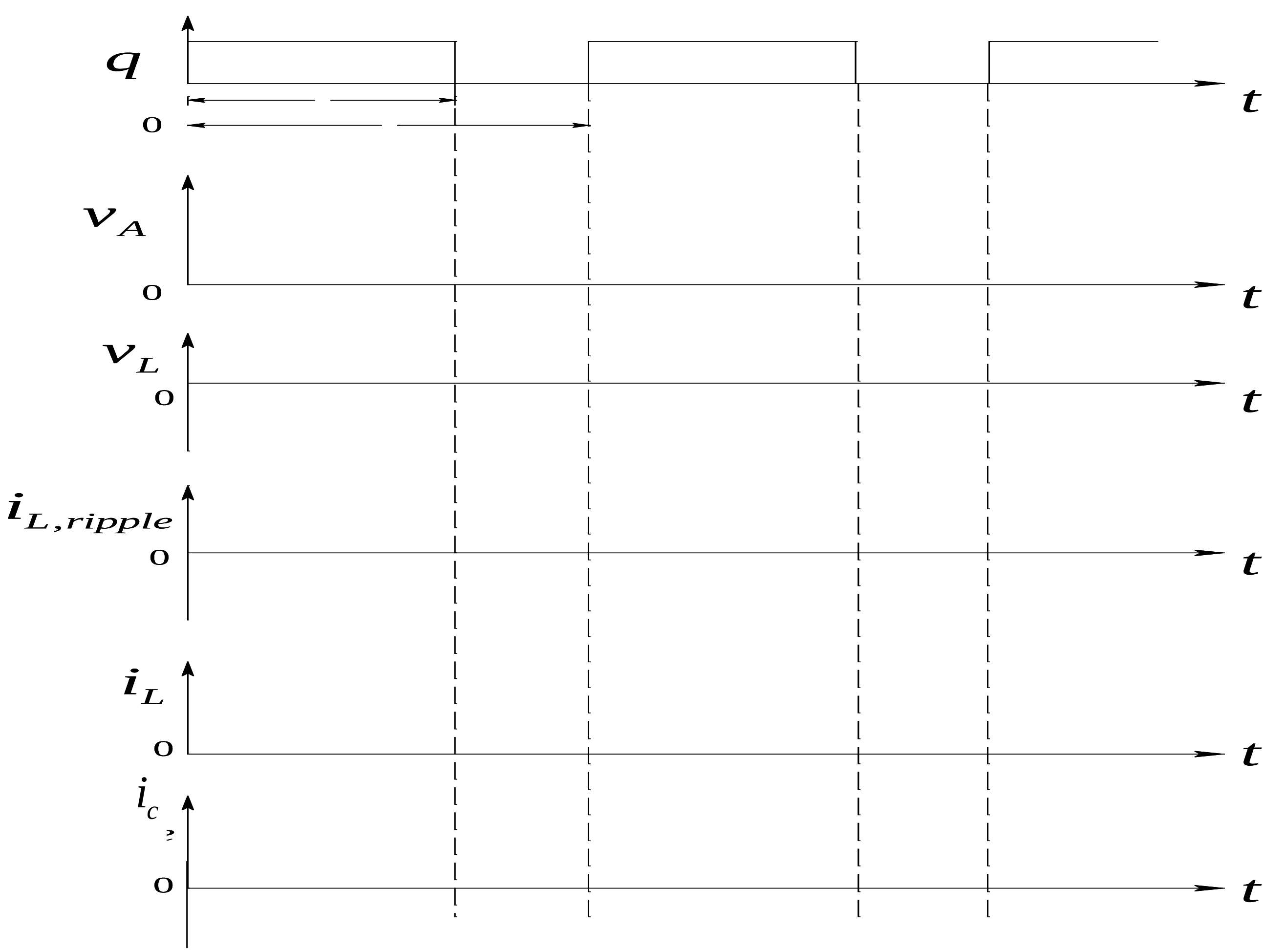
Problem 9A) Power Electronics (2 pts)

A Buck-Boost converter shown below is designed to operate with $V_{in} = 30V$, $V_o = 60V$ and $f_s = 200\,kHz$. The maximum output power level of this converter is $P_{o,\max} = 180W$. Assume ideal components. Neglect the ripple in the capacitor voltage.



(a) (1 pt) It is to be designed such that if the output power is equal to or higher than one-third of $P_{o,\max}$, it remains in the continuous-current conduction mode; below this output power level, it goes into the discontinuous-conduction mode. Calculate the value of the inductor L to satisfy this design condition.

(b) (1 pt) This converter is operating at $P_o = 90W$. Calculate and draw the waveforms of the following variables as a function of time in the figure below, labeling both axes as appropriate: $v_A, v_L, i_{L,ripple}, i_L$ *and* i_c. (Note: $i_{L,ripple} = i_L - I_L$).



Problem 9B) Power Systems (2 pts)

In the two bus power system below, the generator on bus 1 supplies power to a load on bus 2. Take bus 1 as the reference (swing) bus. The generator on bus 1 regulates the voltage on bus 1 to 1.0 per unit volts as long as the reactive power output of the generator on bus 1 is within limit. The generator can supply up to 200 MW and can supply reactive power as long as $-20 \le Q_{gen} \le +20$ where the figures are in MVAR.

Bus 2 has a static var compensator which simply supplies reactive power to the system at bus 2. It regulates the voltage on bus 2 to 1.0 per unit voltage. The static var compensator on bus 2 can supply up to 50 MVAR. Bus 2 also has a load of 100 MW and 0 MVAR.

Bus 1 and bus 2 are connected by two identical circuits. Data for this problem:

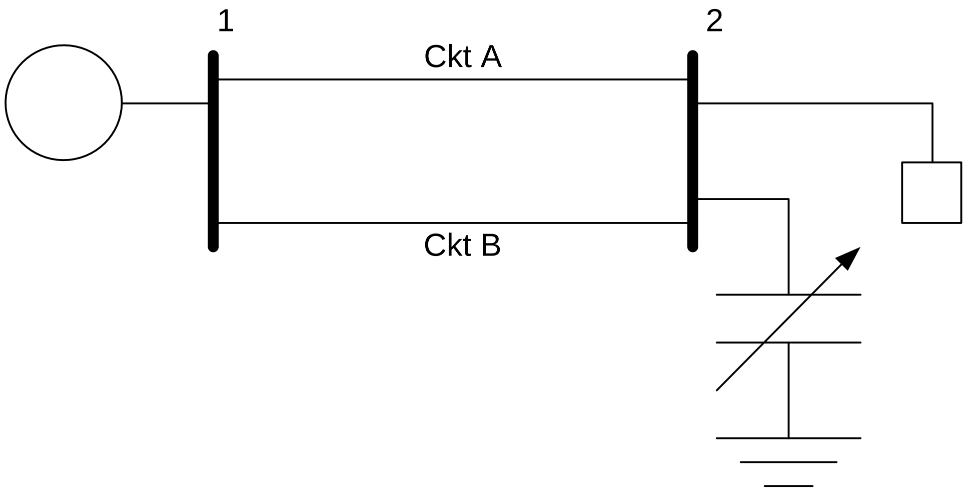
$x_{12A} = 0.5$ per unit,

$x_{12B} = 0.5$ per unit.

There is no resistance or charging capacitance for either circuit making up this line.

$|V_1| = 1.0$ per unit $\theta_1 = 0$ degrees, $|V_2| = 1.0$ per unit, $P_{2load} + jQ_{2load} = 100MW + j0MVAR$

Use a three-phase base MVA of 100 MVA, assume the line-line base voltages for both buses is 230 kV.



a) (0.25 pts) Assume both circuits A and B are in. Solve for the phase angle at bus 2 in degrees.

b) (0.25 pts) How much reactive power is being supplied from the generator? How much reactive power is supplied from the static var compensator?

c) (0.5 pt) Now assume that circuit B suffers a fault and is removed. Resolve the power flow and calculate the new phase angle at bus 2 and the reactive power output from the generator and the static var compensator. Ignore the var limits of the generator and of the static var compensator in solving this part.

d) (1.0 pts) Is everything within limit in part c above? If not, how can the system be brought to a state where all limits are met? If you can, solve for this condition. You are not allowed to reduce the load, it still must be met as in the original problem. Give a numerical answer showing the solved power flow at this new solution meeting all limits.