Question:

Consider a buck converter where the only parasitic element to be included in the following analysis is the ESR of the inductance, ESR $= 3m\Omega, L = 0.5mH,$ $C = 100\mu F, V_g = 100V, V_o = 40, I_{load} = 4 - 40A.$ The converter is enclosed in a single feedback loop, which functions to regulate the output voltage, of the type discussed in class ($V_M = 4V, Vref = 4V$).

a) Derive expressions for the following converter transfer functions:
   i. Duty ratio control to output
   ii. Audiosusceptibility
   iii. Output impedance

b) Draw a complete block diagram representation of the system, which incorporated the above transfer function blocks, and which features a cascade lead compensator (one zero and one pole).

c) Determine the expression for the loop gain and sketch its magnitude using straight line asymptotes.

d) Under the above sketch for the loop gain, sketch the magnitude response of the return difference expression and hence determine a factored zero/pole approximation of this expression.

e) Under the above sketches, sketch the magnitude response of the output impedance and hence determine the range of frequencies for which the open loop output impedance is greater than 0.1Ω.

f) Design the compensator so that closed loop output impedance is less than 0.1Ω over the full bandwidth and where the phase margin is greater than 45 degrees and the unity gain frequency is *10,000 Hz.*

g) Sketch the magnitude response of the closed loop output impedance and from it determine an approximate factored zero/pole expression.

Question:
The expression of the closed loop output impedance of a voltage regulator system which features single loop feedback control is given by

$$Z_{of} = \frac{Z_o}{1+T}$$

where Z_{of}, Z_o and T are the closed loop output impedance, open loop output impedance and loop gain, respectively.

Show how this expression can be derived.

Question:

Consider the ideal buck-boost converter.

a) Using the state space averaging modeling method, determine an expression for the input admittance of the converter as seen by the input voltage source.
b) Present your expression from part (a), in standard form and sketch the asymptotic magnitude and phase responses.