Final Exam **Name (Print):** _____
Spring 2015
EE513-Power Electronics
06/23/15
Time Limit: 120 Minutes Advisor Name _____

This exam contains 12 pages (including this cover page) and 4 problems. Check to see if any pages are missing. Enter all requested information on the top of this page, and put your initials on the top of every page, in case the pages become separated.

You are required to show your work on each problem in this exam. The following rules apply:

- **Mysterious or unsupported answers will not receive full credit**. A correct answer, unsupported by calculations, explanation, or algebraic work will receive no credit; an incorrect answer supported by substantially correct calculations and explanations might still receive partial credit.
- **Mobile devices must be turned off**. Calculator, pen, pencil ,and eraser are allowed. Scratch paper will be provided. Mobile electronics devices must be turned off during the exam.

Do not write in the table to the right.

Problem	Points	Score
1	40	
2	20	
3	28	
4	12	
Total:	100	

1. (40 points) The buck-boost converter in Fig. 1 has an input voltage $V_g = 12V$. The duty cycle $D = 0.6$, and the switching frequency is $25kHz$. For the inductance, $L = 250\mu H$ and for filter capacitance $C = 220\mu F$. For the average load current $I_a = 1.2A$. Determine:

   (a) (8 points) The average output voltage V?

   (b) (8 points) The peak-to-peak output ripple voltage ΔV?

   (c) (8 points) The peak-to-peak output ripple current of inductor ΔI_L?

   (d) (8 points) The peak current of the transistor $I_{s,p}$?

   (e) (8 points) The critical values of L and C.

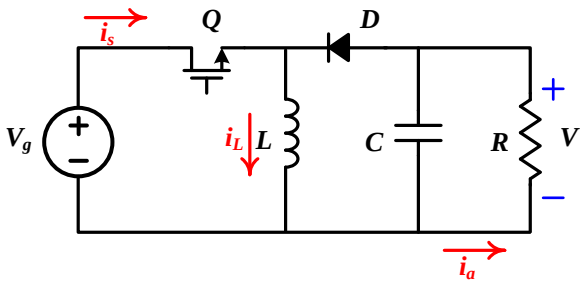

Figure 1: Buck-boost converter.

2. (20 points) The steady-state duty cycle of the boost converter is $D = 40\%$, and the output power is $150W$ at an average output voltage of $V = 20V$. If the duty cycle is changed by a small amount of $\Delta d = \pm 5\%$, use the small-signal model in Fig. 2 to determine:
   (a) (10 points) The percentage change in the input voltage V_g.
   (b) (10 points) The percentage change in the output current I_2.

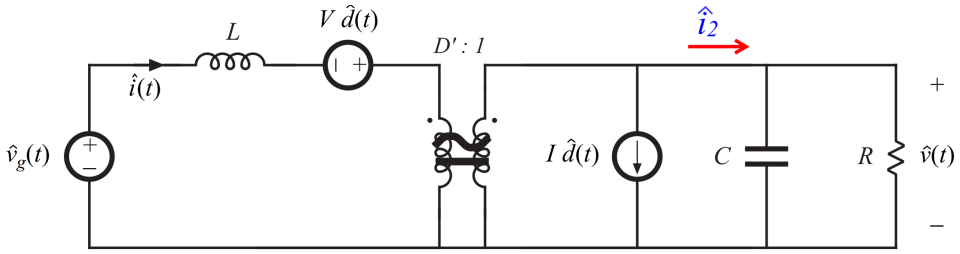

Figure 2: Small signal ac model of the boost converter.

3. (28 points) In the boost converter of Fig. 3, $V_g = 48V$, $L = 100\mu H$, $C = 33\mu F$, $R = 12\Omega$. Switching frequency is $f_s = 200kHz$. The converter operates in the continuous conduction mode, with quiescent duty cycle $D = 0.6$. Derive the expression and construct the magnitude and phase Bode plots of:

   (a) (8 points) The control-to-output transfer function $G_{vd}(s)$.

   (b) (8 points) The line-to-output transfer function $G_{vg}(s)$.

   (c) (6 points) The output impedance $Z_{out}(s)$.

   (d) (6 points) The input impedance $Z_{in}(s)$.

   The Bode plots should be plotted in semi-log axes. On each plot, label the corner frequencies and the asymptotes (渐近线).

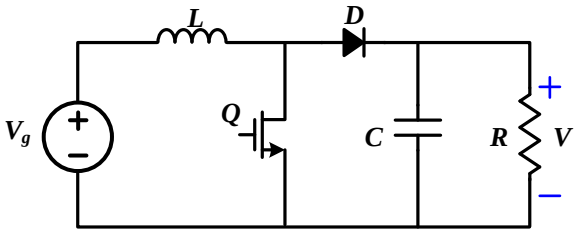

Figure 3: Boost converter

4. (12 points) Use block diagram to plot a typical negative feedback system. Explain the effect of negative feedback on the system.