Minor 1: ELL 302 Power Electronics

Date: 9th November 2020, Time: 8:30 AM to 9:30 AM

Answer all questions, total marks – 20

Please write your name and entry number at the top of the answer sheet

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1. In a certain application, an unregulated dc input voltage can vary between 18 and 36 V. It is desired to produce a regulated output of 24 V at 2 A load current.
   a) Which converter is suitable for such application?
   b) Derive expressions for the dc components of each capacitor voltage(s), inductor current(s), and switch currents as functions of the duty cycle D, the input voltage V_{in}, and the load resistance R.
   c) A control circuit automatically adjusts the converter duty cycle D, to maintain a constant output voltage of $V = 24$ V. The input voltage slowly varies over the range $18\text{ V} \le V_{in} \le 36\text{ V}$. The load current is constant and equal to 2 A. Over what range will the duty cycle D vary? Over what range will the input inductor current dc component I_{in} vary? (2+4+4)

2. You are given the following –
   a) one current-bidirectional two quadrant switch and
   b) many single quadrant SPST switches having negative voltage blocking capability and positive current carrying capability.

   Develop a four quadrant switch using these switches. (2)

3. For the following converter, find the expression for the average output capacitor voltage and the inductor current. State how each switch can be realized using transistors and/or diodes, and whether the realization requires single-quadrant, current-bidirectional two-quadrant, voltage-bidirectional two-quadrant, or four-quadrant switches when the duty ratio is $0 \le D < 0.5$. (2+6)