**EEE 148 Buck Converter in Simulink**

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| **Collaborated with:** | | |

**GENERAL INSTRUCTIONS:** Provide the required information in the spaces provided. If you run out of room for your answer, feel free to adjust the template as necessary.

**Learning Activity: Open-Loop Buck Converter**

1. **Open-loop Buck Converter.** Implement the open-loop buck converter in Figures 4 and 5.

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| 1. waveform. at steady - state = 6V      1. waveform. |

1. **Buck Converter with Resistances.** Modify the buck converter in Fig. 4 using the following values: L = 5µH, RL = 80mΩ, C = 390µF, Resr = 2mΩ.

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| 1. Block Diagram of the buck converter itself (similar to Fig 4; not the overall diagram). |

1. **PWM.** Set d=0.4

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| 1. waveform. at steady - state = 4.45V      1. waveform. at steady - state = 4.45V |

1. **Varying the duty cycle.**  Change the duty cycle iteratively to get the desired output of .

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| 1. What is the duty cycle needed to get ? 2. waveform. at steady - state =      1. waveform.      1. What is your process for varying the duty cycle? How does the output of the buck converter affect your decision whether to increase or decrease the duty cycle?  * Increasing the duty cycle also increases the steady – state output voltage. I increase or decrease accordingly. |

1. **Changing the load resistance**

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| 1. Show the new block diagram of the open-loop system.      1. What is the value of and at steady state? 4.77V, 0.47A      1. How does the load affect and ? Explain.  * The load scales * This follows Ohm’s law. With the same changes depending on the load resistance.  1. How can you get back a desired value for when using a different load?  * Since the duty cycle and * This k holds for every value of |

**Learning Activity: Closed-Loop Buck Converter**

1. **Closed-loop Buck Converter.** Implement the open-loop buck converter in Figures 7.

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| 1. waveform. at steady - state = 5V      1. waveform. |

1. **Changing the output .** Modify the closed-loop buck converter such that

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| 1. Block Diagram of the closed-loop buck converter      1. What variable must be changed? What should be its value? Voltage divider gain = 0.25      1. Explain how this works. Include both equations and explanations.  * With ,  1. Probe the value of the duty cycle . What is the value at steady - state? 0.72   Compare this with the duty cycle value that you got in the open-loop exercise to also get . Explain.     * This is the same as the d value for the open loop setup. |

1. How can you implement without using another voltage source? Note that we only have a single input  
   voltage source available to us.

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| * We can always use the and a gain block. The gain will have a value: |

1. **Changing the load resistance.** Replace the load with

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| 1. Show the new block diagram of the closed-loop system.      1. Show the waveforms. What is the value of and at steady state?   8.0V, 0.8A     1. How does the load affect and ? Explain.  * The load current and voltage is governed by Ohm’s law. Here, with the same  1. Probe the value of the duty cycle d. What is the value at steady - state? Did the value change when compared to when ? Why or why not?      * The value of d decreased. * I think this has something to do with the load resistance having an effect to the current. |

1. Explain how an open-loop system would get a desired , and how it differs from a closed-loop system.

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| * For an open loop system, the * With this, we can obtain any * For a closed loop system, * The duty cycle is not manually set in a closed loop system. It can vary since it has a feedback path. |

1. Explain the advantages and disadvantages of using an open-loop vs. using a closed-loop system.

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| * The gain may be high on the open-loop system but is it not as stable when compared to the closed-loop system * A closed-loop system is generally harder to design since the system also needs to use controllers. |