Flipped IN-CLASS Lesson Plan Template

Topic or concept:
Design and Simulation of a DC/DC Buck Converter

Basic objectives for preparatory work:	Advanced objectives for classwork & after class work:
Define buck converter uses and applications Explain the theory of operation of buck converters Derive the formula for buck converter voltage ratio Design the passive elements of a buck converter	Choose the buck converter active and passive components Simulate the buck converter operation. Generate the simulation plots and analyze them in comparison with the theory. Design a buck converter for a given application and simulate its performance.

	Time planned	Activity and rationale	Resources needed
Beginning of class period	10 mins + 10 mins	Instructor summarizes the key points of the pre-class content and answer students questions + Quiz on the pre-class material	Whiteboard instructing + Quiz sheets distributed to the students
Middle of period	40 mins	Two Group Exercises to achieve some of the classwork and after class work objectives The group members will be limited to 2-4 members. Every group will have two exercises to solve within the allocated 40 mins. The group members can design their workload accordingly.	Laptops, internet, Simulation software (PLEXIM) and exercise sheets

	Time planned	Activity and rationale	Resources needed
		The first activity will be assigned to every group to find appropriate passive and active elements for their design. Every group will work on this task in parallel with the second group activity. After finishing this activity, the instructor will ask the group specific questions about the components they selected and the reasons behind their selections. The group will not be graded unless all the group members fully understand their answers. The websites the students should use are digikey, coilcraft, and mouser to find their passive and active elements. To earn the full grade, all the selected components should be adequate for the particular exercise. Extra credit will be awarded to the best 3 groups with the most efficient design. The second activity will be assigned to every group to simulate a buck converter for some given specifications. The students will watch a video for 5 minutes during the class time to learn how to simulate the converter. Following the video, every group will build their own circuit model and generate the simulation plots that will be checked by the instructor.	
End of period	10 mins	Review the key points of the exercises and answer student questions. Introduce students to post class assignments.	Instructor laptop + projector

Flipped AFTER CLASS Work Plan Template

Advanced learning objective	Activity and rationale	Instructions to students
Design a buck converter for a given application and simulate its performance.	Fully Design a Buck Converter for two Different Applications *This activity will be assigned to students individually. Every student will be fully responsible to design a buck converter for a specific application. Student will have to use the right formulas, choose the right components and simulate the converter performance.* *If successfully implemented, this activity will help students to engage with the material in an untraditional practical way that closely aligns with the industry needs.*	*Students are encouraged to collaborate but the final design and the simulation plot should be generated from the student own design and simulation files.* *Students will have access to industry application notes after the class to aid them in their design and simulation tasks.*

GUIDED PRACTICE

Class: EE-136
Date assigned:
Date due:
Time estimate to complete this assignment: 15 mins

Overview/Introduction

The pre-class material will introduce students to the following:

1- Necessary revision over some circuit concepts that are needed for this class.

2- The applications of a buck converter.

3- The basic performance and operation of Buck converters.

4- The need to design and simulate buck converters.

Learning Objectives

Basic objectives

- Define the buck converter uses and applications.
- Explain the theory of operation of buck converters.
- Derive the buck converter voltage ratio.
- Identify the necessity to simulate and design buck converters.

Advanced objectives

- Recognizing the performance plots of buck converters.
- Applying circuit formulas to conclude the passive elements design.
- Analyzing the impact of different factors (switching frequency, inductor size, etc…) on the performance of the converter.

Preparatory Activities and Resources:

1. Give detailed, action-oriented instructions for completing the Guided Practice assignment. Keep in mind that the activities should be minimal, simple, engaging, productive, and failure tolerant (see Talbert, 2017, pg. 135)

- Watch the posted videos and solve the interactive quiz questions in each one of them.
- The videos are titled as follows:
  1- Intro into Buck Converters.
  2- Buck Converter Applications.
  3- Basic Buck Converter Performance and Plots

2. Give a "playlist" of resources such as readings, videos, audio, or other content delivery methods that provide students the content to work with.

- The three posted videos
- Sections 6.1-6.4 in "Power Electronics" by Daniel Hart.

Exercises: Please complete before the class time.

- The quiz questions will be asked during the video and should be answered for the video to resume.

Questions?

For any questions, please use the discussion board for this class. Students are encourage to respond to one another on the discussion board. The instructor will review the board every day to respond to new unanswered questions.

ADVANCED PRACTICE

This is given for students to complete after the class meeting in which they work together.

Class: EE-136
Date assigned:
Date due:
Time estimate to complete this assignment: 90 mins

Learning Objectives

Advanced objectives

1- Choose the buck converter active and passive components

2- Simulate the buck converter operation.

3- Generate the simulation plots and analyze them in comparison with the theory.

4- Design a buck converter for a given application and simulate its performance.

Activities & deliverables

Activity:

- Design a buck converter for a given application and simulate its performance.

Deliverables:

1. List the buck converter equations and formulas needed for the design.
2. Choose the passive elements to achieve 40% inductor current ripple and 10% capacitor voltage ripple at 20 kHz switching frequency.
3. Choose the active components in the converter to increase the system efficiency at a given power flow.
4. Simulate the converter performance for the given application.
5. Show the simulation plots and compare them to the theoretical performance of the converter.
6. Comment on the results.

Resources:

- Texas Instruments “Synchronous Buck Converter” application notes.
- Infineon “DC/DC buck converter” application notes.

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