Name of the module: Switch-Mode Power Supplies

Number of module: 361-1-4561

BGU Credits: 3

ECTS credits:

Academic year: 2024- 2025

Semester: Fall

Hours of instruction: 3 lecture hours per week

Location of instruction: will be defined.

Website: www.pemic.org/smps

Language of instruction: Available both in Hebrew and English

Position : a module 4th year undergraduate students that take the Circuits Systems and Energy track (mandatory module), as well as to the nano , micro and VLSI track (elective module) at the School of Electrical and Computer Engineering to be taken on fall semester

Field of Education: Electrical Engineering

Responsible Department: School of Electrical and Computer Engineering

General Prerequisites: Analog circuits course

Grading Scale: the grading scale would be determined on a scale of 0 – 100 (0 would indicate failure and 100 complete success), passing grade is 56. Failure at any of the individual parts of the module will result in fail grade for the entire module.

Lecturer: Prof. Mor M. Peretz

Contact details: Room 4, Building 64

Office phone: 08-6461561

Email: morp@bgu.ac.il ;

Course Admin Dr. Michael Evzelman

Email: evzelman@bgu.ac.il

Course Description: The course will introduce the student to the basics of switch-mode power conversion. The module is divided into two sections – frontal lectures and laboratory exercises that will be conducted at the end of the module. The lectures part will focus on switch-mode converters topologies and their operation, issues of design of magnetic elements, as well as losses and efficiency of switching systems. The final part of the first section will be devoted to control and feedback construction of switching systems.

Aims of the module:(1) to provide students with a sound understanding of concept of switch-mode power conversion; and (2) to develop the necessary framework and tools to analyze and design such systems.

Objectives of the module: To provide knowledge of general control issues of switching systems and introduce the concepts of topologies, magnetics, losses and control.

Learning outcomes of the module: On successful completion of the course, the students should be able to:

(1) Evaluate and design switch-mode power conversion systems
(2) Describe the theoretical foundations of power managements systems
(3) Address practical challenges for efficient and reliable performance

Module evaluation: at the end of the semester the students will evaluate the module, in order to draw conclusions, and for the university's internal needs.

Confirmation: the syllabus was confirmed by the faculty academic advisory committee to be valid since 2013 and has been reapproved in 2018 (English version) and in 2020 (mandatory module on circuits and Energy track).

Last update: 14.11.2024

Attendance regulation: attendance in class is not mandatory. Lab experiments are mandatory.

Teaching arrangement and method of instruction: The module consists of lectures.

Assessment:

1. Final exam 75%
2. Laboratory experiments 25%

Work and assignments: No mandatory assignments.

Final exam: at the end of semester, Laboratory experiments is mandatory – last 3 weeks of the semester

To active participants in op. Iron Swords, or other issues that as a result are not able to attend labs, approval by the lecturer will be given to either adjust or replace the mandatory task. This is required to be confirmed in writing per application.

All adjustment applications should be submitted to the course admin:
Dr. Michael Evzelman : evzelman@bgu.ac.il

Time required for individual work: 3 hour per week attendance in class (or lab at the end of the semester), 1 hours per week to review the class material, 20 hours to prepare to the lab experiments, 20 hours to study to the final exam. In the case of final exam replacement by a final assignment: approx. 10 hour execution of the assignment, and 10 days will be provided to submit the assignment for evaluation.

Module Content\ schedule and outlines:

Lectures (3h):

Part 0. Introduction

- *a. Scope of course*
- *b. Linear Regulator*
- *c. Modern Power Conversion Systems Requirements*

Part 1. PWM

- *a. Inductor*

Part 2. Basic topologies: BUCK, BOOST, BUCK-BOOST, DCM operation

- *a. Buck converter*
  - *i. Operation modes*
  - *ii. Voltage transfer function*
  - *iii. Current modes (CCM, DCM)*
- *b. Capacitor current*
- *c. Boost converter*
  - *i. Operation modes*
  - *ii. Voltage transfer function*
- *d. Buck-Boost converter*
- *e. Comparison between topologies*
- *f. Average Simulation of PWM Converters*
  - *i. The Switched Inductor Model (SIM) (CCM)*
  - *ii. The Generalized Switched Inductor Model (GSIM) Model*

Part 9. Current Sensing

a. Resistor

b. Current transformer

c. Pulse Current transformer Design

i. Resistor reset

ii. Reset – Clamp

iii. Measuring DC current

d. DC Current transformer

Part 10. Power Converters Control Technique

a. The Dynamic Problem

i. Control

ii. Modulator

iii. Oscillator

b. Complete controller Voltage Mode (VM)

c. Bode Plot

i. Design problem

ii. Stability

d. Current Feedback

e. PCM & ACM

f. Parasitic effects: PCB trace resistance

i. Interfering signal injection

ii. Inductive coupling

iii. Stray inductance

Lab experiments (3h):

Buck

Boost

Flyback

Required reading

1. K. K. Sum, "Switch mode power conversion", Marcel Dekker.

2. R. W. Ericson, "Fundamentals of power electronics", Kluwer Academic, 2nd ed.

3. N. Mohan, T. M. Undeland, w. P. Robbins, "Power Electronics", Wiley, 2nd ed.

4. Website: www.pemic.org/smps

5. Website: www.pemic.org