GUJARAT TECHNOLOGICAL UNIVERSITY

ELECTRICAL ENGINEERING (07)
MODELING AND ANALYSIS OF POWER CONVERTERS
SUBJECT CODE: 2730709
M.E. SEM-III

Type of course: Engineering

Prerequisite: Power Electronics (2710702)

Rationale: The courses in power electronics at undergraduate level generally introduces the preliminary circuits, their steady state analysis, operation and applications. Hence, the course is included to provide the exposure to modeling, analysis, control and design aspects of switched mode power electronic circuits.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks		Practical Marks				
L	T	P	C	ESE (E)	PA (M)	ESE (V)		PA (I)		
						ESE	OEP	PA	RP	
3	2#	2	5	70	30	20	10	10	10	150

Content:

Sr. No.	Course Content	Total Hrs	% Weightage
1	Review of the ideal switch; basic switch cell; basic topology rules; basic converter topologies; steady-state analysis; dc transformer model, construction of equivalent circuit model	03	6
2	AC Equivalent circuit Modeling Basic AC modeling approach; State-space Averaging; Circuit Averaging and Average Switched Model; The Canonical Circuit Model; Modeling of PWM Modulator; Some examples	08	20
3	Converter Transfer Functions Review of Bode Plots; Analysis of converter transfer functions; Graphical construction of impedances and transfer functions; Graphical construction of Converter transfer functions, Measurement of AC transfer functions and impedances	07	15
4	Controller Design Introduction; Effect of negative feedback on the network transfer functions; Closed loop transfer functions; Stability; Regulator Design : PI, PD and PID compensators; Measurement of loop gains	06	12
5	Input Filter Design EMI and filter design problem; Effect of input filter on converter transfer	03	8

	functions; Design of Damped input filter; Examples		
6	AC and DC equivalent circuit modeling of the discontinuous conduction mode DCM averaged switched model; Small-signal AC modeling of the DCM switch network; High frequency dynamics of converters in DCM	04	9
7	Current Programmed Control Oscillation for D > 0.5 ; A simple first order model; More accurate model; Transfer functions; Effects of current-programmed control on converter transfer functions; Discontinuous conduction mode	05	10

Reference Books:

1. Robert Ericksson and Dragan Maksimovic, "Fundamentals of Power Electronics", Springer (India) Pvt. Ltd., 2nd ed., 2005.
2. Middlebrook, R. D. (Robert David), and Slobodan Cuk, Advances in Switched-Mode Power Conversion, Volumes I and II, 2nd ed., TESLAco, 1983.
3. Daniel M. Mitchell, "DC-DC Switching Regulator Analysis", McGraw-Hill, New York, 1988.
4. Seddik Bacha, Lulian Munteanu, Antoneta Luliana Bratcu, "Power Electronic Converters Modeling and Control", Springer, 2014.
5. V. Ramanarayanan Course Material on Switched Mode Power Conversion,Department of Electrical Engineering, Indian Institute of Science, Bangalore 560012.
6. Ned Mohan, Tore M. Undeland and William P. Robbins, "Power Electronics – Converters, Applications and Design", John Willey & sons, Inc., 3rd ed., 2003.
7. Muhammad H. Rashid, "Power Electronics - Circuits, Devices and Applications", Prentice Hall of India, 3rd ed., 2009.
8. Recent Literature

Course Outcome:

After learning the course the student should be able to:

1. Analyze switched mode power electronic converters.
2. Model and simulate switched mode power electronic converters
3. Design the control scheme for switched mode power converters.

List of Experiments:

Lab experiments shall target the modeling of various switched mode power electronic converters and hence, simulation of these converters using these models to study their steady state and dynamic response. Both isolated and non-isolated converters shall be covered. Experiments related to design of filters and their effect on transfer function and response shall also be included.

Design based Problems (DP)/Open Ended Problem:

Course coordinator can assign the design based problem/open ended problem which involves the modeling and design of some converters for some specific applications.

Major Equipment:

Simulation software like MATLAB, PSIM or Scilab and Power Electronic Converters as demanded by the course.

List of Open Source Software/learning website:

1. MIT OPEN COURSEWARE by Massachusetts Institute of Technology
   - website: ocw.mit.edu
2. Material on Fundamental of Power Electronics by Robert Erickson
   - website: ecee.colorado.edu/copec/book/slides/slidedir.html
3. Courses available through NPTEL.
   - website : nptel.ac.in

Review Presentation (RP): The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.