NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

COURSE PLAN – PART I			
Name of the programme and specialization	**M.Tech POWER ELECTRONICS**		
Course Title	**PWM Converters and Applications**		
Course Code	**EE693**	**No. of Credits**	**03**
Course Code of Pre-requisite subject(s)	**-**	**-**	**-**
Session	**January 2019**	**Section (if, applicable)**	**------**
Name of Faculty	**G. Saravana Ilango**	**Department**	**EEE**
Official Email	**gsilango@nitt.edu**	**Telephone No.**	**0431-2503259**
Name of Course Coordinator(s) (if, applicable)	**----------**		
Official E-mail		**Telephone No.**	
Course Type (please tick appropriately)	**Elective course**		

Syllabus (approved in BoS)

AC/DC and DC/AC power conversion - Overview of applications of voltage source converters - Pulse modulation techniques for bridge converters.

Bus clamping PWM - Space vector based PWM - Advanced PWM techniques - Practical devices in converter - Calculation of switching and conduction losses.

Compensation for dead time and DC voltage regulation - Dynamic model of a PWM converter - Multilevel converters - Constant V/F induction motor drives.

Estimation of current ripple and torque ripple in inverter fed drives - Line–side converters with power factor compensation.

Active power filtering - Reactive power compensation - Harmonic current compensation

Reference Books:

1. Mohan, Undeland and Robbins, 'Power Electronics; Converters, Applications and Design', John Wiley and Sons, 1989.

2. Erickson R W, 'Fundamentals of Power Electronics', Chapman and Hall, 1997.

3. Vithyathil J, 'Power Electronics: Principles and Applications, McGraw Hill, 1995.

COURSE OBJECTIVES

To understand the concepts and basic operation of PWM converters, including basic circuit operation and design.

To understand the steady-state and dynamic analysis of PWM converters along with the applications like solid state drives and power quality.

MAPPING OF COs with POs

Course Outcomes	**Programme Outcomes (PO)**
At the end of the course students will be able to	
1. Understand the need and operation of various multilevel inverters	
2. Understand the basic operations of various PWM techniques for Power Converters.	
3. Steady-State and transient modelling and analysis of power converters with various PWM techniques.	
4. Analysis and Design of Control Loops for PWM power converters along with the applications like solid state drives and power quality.	

COs / POs		Course outcomes(COs) 1	2	3	4
Programme Outcomes (POs)	1	H	H	H	H
	2	M	M	M	H
	3	M	H	H	L
	4	H	H	H	H
	5	H	H	H	H
	6	M	M	H	H
	7	H	H	L	M
	8	H	H	M	H
	9	H	H	L	L
	10	H	H	H	H
	11	H	H	H	H
	12	H	H	H	H
	13	M	M	M	H
	14	H	H	H	H

COURSE PLAN – PART II

COURSE OVERVIEW

The main objective of the PWM is to control the inverter output voltage and to reduce the harmonic content in the output voltage. These techniques are most efficient, and extensively used in the speed control of drives.

Aim of this course is to give the exposure to the students on Converter topologies for AC/DC and DC/AC power conversion, overview of applications of voltage source converters; pulse width modulation techniques for 1-phase and 3-phase bridge converters, sine-triangle PWM, bus clamping PWM, space vector based PWM, advanced PWM techniques; calculation of switching and conduction losses; compensation for dead time and DC voltage regulation; estimation of current ripple and torque ripple in inverter fed drives; over modulation; extension of modulation methods to multilevel inverters.

COURSE TEACHING AND LEARNING ACTIVITIES			
S.No.	**Week/Contact Hours**	**Topic**	**Mode of Delivery**
1	2nd week of January 19 (7 to 11) **(3 Contact Hours)**	Review of Fourier series, fundamental and harmonic voltages, Introduction to Power conversion-DC/AC, AC/DC converters, Single, Two and Four quadrant switches	Lecture C&T / Document viewer / PPT or any suitable mode
2	3rd week of January 19 (14 to 18) **(3 Contact Hours)**	Electronic realization of SPDT in buck, boost converter, VSI and CSI.	Lecture C&T / Document viewer / PPT or any suitable mode
3	4th week of January 19 (21 to 25) **(3 Contact Hours)**	Single pulse, Multiple pulse, Sinusoidal PWM, third harmonic injection PWM, selective harmonic elimination, THD optimized PWM.	
4	5th week of January 19 to 1st week of Feb. 19 (28.01.2019 to 01.02.2019) **(3 Contact Hours)**	Concept of space vector PWM, continuous PWM, Bus clamping or discontinuous PWM, split clamp PWM, properties of common mode signal.	
5	2nd week of Feb. 19 (04 to 08) **(3 Contact Hours)**	Practical devices in converter, Simplifying assumptions in evaluation of inverter loss, dependence of inverter loss on line power factor, influence of PWM techniques on switching loss.	
6	3rd week of Feb. 19 (11 to 15) **(2 Contact Hours+1-hour Cycle test)**	Requirement of dead-time, Effect of dead-time with discontinuous or bus-clamping PWM, compensation of dead-time, Dynamic model of a PWM converter **Assessment – 1**	Lecture C&T / Document viewer / PPT or any suitable mode **I Cycle Test**
7	4th week of Feb. 19 (18 to 22) **(3 Contact Hours)**	Diode clamped, Flying capacitor and Cascaded H-bridge inverter.	Lecture C&T / Document viewer / PPT or any suitable mode
8	5th week of Feb. 19 to 1st week of March 19 (25.02.2019 and 01.03.2019) **(3 Contact Hours)**	Torque Speed characteristics of Variable speed IM, Variable voltage, variable frequency and Constant V/f drives	
9	2nd week of March 19 (4 to 8) **(3 Contact Hours)**	Synchronously revolving reference frame; Volt-second balance and instantaneous error voltage, Estimation of Current ripple and Torque ripple in the inverter fed drives	

10	3rd week of March 19 (11 to 15) **(2 Contact Hours + 1-hour Cycle test)**	Line side converters with power factor compensation, Applications based on power factor control **Assessment – 2**	Lecture C&T / Document viewer / PPT or any suitable mode
11	4th week of March 19 (18 to 22) **(3 Contact Hours)**	Non-linear loads, Harmonic injection to avoid mains voltage distortion, Harmonic current compensation	
12	5th week of March 19 to 1st week of April 19 (25.03.2019 to 05.04.2019) **(3 Contact Hours)**	Need for series compensation, active front-end converters, Active power filtering, Reactive power compensation	Lecture C&T / Document viewer / PPT or any suitable mode
13	2nd week of April 19 (08 to 012) **(3 Contact Hours)**	Applications of voltage source converters	
14	4th week of April 19 (22 to 26) - **CPA**	**Compensation Assessment (CPA)**	**Written test**
15	1st week of May 19 or date decided by Class committee / Dean office **(3 Hours written test)**	**End Semester Examination**	**Written test**

COURSE ASSESSMENT METHODS (shall range from 4 to 6)

S.No.	Mode of Assessment	Week/Date	Duration	% Weightage
1	I Cycle test (Written examination)	3rd week of Feb. 2019	1 Hour	20
2	II Cycle Test (Written examination)	3rd week of March 2019	1 Hour	20
3	Seminar / case study / design examples /Projects	During the contact hours		30
CPA	Compensation Assessment	4th week of April 2019	1 Hour	Please refer course policy for more details
4	Final Assessment (End Semester Examination)	1st week of May 2019	3 Hours	30

COURSE EXIT SURVEY (mention the ways in which the feedback about the course shall be assessed)

Feedback from the students during class committee meetings
Anonymous feedback through questionnaire

COURSE POLICY

MODE OF CORRESPONDENCE (email/ phone etc)

1. All the students are advised to check their NITT WEBMAIL regularly. All the correspondence (schedule of classes/ schedule of assessment/ course material/ any other information regarding this course) will be done through their webmail.
2. Queries (if required) may be emailed to me / contact me during 4.00 pm to 5.00 pm on Monday and Friday with prior intimation for any clarifications.

COMPENSATION ASSESSMENT

1. If any student is not able to attend I and / or II Cycle test(s) due to genuine reasons, student is permitted to attend the compensation assessment (CPA) with 20% weightage (20 marks).

ATTENDANCE POLICY (A uniform attendance policy as specified below shall be followed)

- At least 75% attendance in each course is mandatory.
- A maximum of 10% shall be allowed under On Duty (OD) category.
- Students with less than 65% of attendance shall be prevented from writing the final assessment and shall be awarded 'V' grade.

ACADEMIC DISHONESTY & PLAGIARISM

- Possessing a mobile phone, carrying bits of paper, talking to other students, copying from others during an assessment will be treated as punishable dishonesty.
- Zero mark to be awarded for the offenders. For copying from another student, both students get the same penalty of zero mark.
- The departmental disciplinary committee including the course faculty member, PAC chairperson and the HoD, as members shall verify the facts of the malpractice and award the punishment if the student is found guilty. The report shall be submitted to the Academic office.
- The above policy against academic dishonesty shall be applicable for all the programmes.

ADDITIONAL INFORMATION, IF ANY

FOR APPROVAL

Course Faculty _____ **CC- Chairperson** _____ **HOD** _____