ECT322	POWER ELECTRONICS	CATEGORY	L	T	P	CREDIT
		PEC	2	1	0	3

Preamble: This course aims to develop the skill of the design of various power electronic circuits.

Prerequisite: ECT201 Solid State Devices, ECT202 Analog Circuits

Course Outcomes: After the completion of the course the student will be able to

CO 1 K2	Understand the characteristics of important power semiconductor switches
CO 2 K3	Apply the principle of drive circuits and snubber circuits for power semiconductor switches
CO 3 K3	Build diode bridge rectifiers and Controlled rectifiers
CO 4 K3	Develop DC – DC Switch-Mode Converter
CO 5 K2	Illustrate the principle of DC – AC Switch-Mode Inverter
CO 6 K3	Apply the principle of power electronics for various applications

Mapping of course outcomes with program outcomes

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
CO 1		2			2							
CO 2		3			2							
CO 3		3			2							
CO 4		3			2							
CO 5		2			2							
CO 6		3			2							

Assessment Pattern

Bloom's Category		Continuous Assessment Tests		End Semester Examination
		1	2	
Remember	K1	10	10	10
Understand	K2	30	30	60
Apply	K3	10	10	30
Analyse				
Evaluate				
Create				

Mark distribution

Total Marks	CIE	ESE	ESE Duration
150	50	100	3 hours

Continuous Internal Evaluation Pattern:
Attendance : 10 marks
Continuous Assessment Test (2 numbers) : 25 marks
Assignment/Quiz/Course project : 15 marks

End Semester Examination Pattern: There will be two parts; Part A and Part B. Part A contain 10 questions with 2 questions from each module, having 3 marks for each question. Students should answer all questions. Part B contains 2 questions from each module of which student should answer any one. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1): Understand the characteristics of important power semiconductor switches.

1. Illustrate the static and dynamic characteristics, Power BJT, Power MOSFET and IGBT.
2. Illustrate the construction and characteristics of SCR and GTO
3. Model and simulate power semiconductor switches.

Course Outcome 2 (CO2): Apply the principle of drive circuits and snubber circuits for power semiconductor switches.

1. Design the base drive circuits for Power BJT.
2. Design the gate drive circuits for Power MOSFET.
3. Outline the principle of snubber circuits for power switches.
4. Model and simulate above circuits.

Course Outcome 3 (CO3): Build diode bridge rectifiers and Controlled Rectifiers.

1. Explain the operation of three phase diode rectifier and the effect of various loads on the rectifier function
2. Explain the operation of controlled rectifiers and the effect of various loads on the rectifier function
3. Model and simulate diode rectifiers and controlled rectifiers for various loads

Course Outcome 4 (CO4): Develop the principle of DC – DC Switch-Mode Converter

1. Illustrate the principle of DC-DC converters under steady state conditions.
2. Design non-isolated and isolated DC-DC converters for given specifications.
3. Model and simulate non-isolated and isolated DC-DC Switch-Mode converters

Course Outcome 5 (CO5): Illustrate the principle of DC – AC Switch-Mode Inverter.

1. Understand the different types of inverters
2. Construct Driven Inverters for given specifications.
3. Model and simulate Driven Inverters

Course Outcome 6 (CO6): Apply the principle of power electronics for various applications.

1. Illustrate the principle of Adjustable-speed DC drive.
2. Explain the principle of Variable frequency PWM-VSI Induction Motor drives
3. Give at least two applications of power electronic circuits for residential applications.
4. Explain at least two applications of power electronic circuits for industrial applications

SYLLABUS

Module 1 : Power Semiconductor Switches

Power diodes, Power BJT, Power MOSFET and IGBT - static and dynamic characteristics, SCR and GTO

Module 2 : Protection circuits and Rectifiers

BJT and MOSFET drive circuits, Snubber circuits, Three phase diode bridge rectifiers, Single phase and three phase controlled rectifiers.

Module 3 : DC – DC Switch Mode Converters

Buck, Boost and Buck-boost DC-DC converters

Waveforms and expression of DC-DC converters for output voltage, voltage and current ripple under continuous conduction mode. (No derivation required)

Isolated converters: Flyback, Forward, Push Pull, Half bridge and Full bridge converters – Waveforms and governing equations (No derivation required)

Module 4 : DC-AC Switch Mode Inverters

Inverter topologies, Driven Inverters : Push-Pull, Half bridge and Full bridge configurations, Three phase inverter, Pulse width modulation

Module 5 : Applications

DC Motor Drives, Induction Motor Drives, Residential and Industrial applications.

Text Books

1. Umanand L, "Power Electronics: Essentials & Applications", Wiley India, 2015
2. Ned Mohan, Tore M Undeland, William P Robbins., "Power Electronics: Converters, Applications, and Design"., Wiley India Pvt. Ltd, 3/e, 2015

Reference Books

1. Muhammad H. Rashid., "Power Electronics : Circuits, Devices, and Applications", Pearson Education India, 4/e, 2014.
2. Daniel W. Hart, Power Electronics, McGraw Hill, 2011.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Power Semiconductor Switches**	
1.1	Power diodes and Bipolar power transistors – structure, static and dynamic characteristics	2
1.2	Power MOSFET and IGBT – structure, static and dynamic characteristics	3
1.3	SCR and GTO – construction and characteristics	2
2	**Protection circuits and Rectifiers**	
2.1	BJT and MOSFET driver circuits (at least two circuits each)	2
2.2	Snubber circuits – ON and OFF snubbers	1
2.3	Three phase diode bridge rectifiers – basic principles only	1
2.4	Single phase and three phase Controlled rectifiers (with R, RL & RLE loads) – basic principles only	3
3	**DC – DC Switch Mode Converters**	
3.1	Buck, Boost and Buck-Boost DC-DC converters	2
3.2	Waveforms and expression of DC-DC converters for output voltage, voltage and current ripple under continuous conduction mode (No derivation required)	3
3.3	Isolated converters: Flyback, Forward, Push Pull, Half bridge and Full bridge converters – Waveforms and governing equations (No derivation required)	3
4	**DC-AC Switch Mode Inverters**	
4.1	Inverter topologies	2
4.2	Driven Inverters: Push-Pull, Half bridge and Full bridge	2

	configurations	
4.3	Three phase inverter	1
4.4	Sinusoidal and Space vector modulation PWM in three phase inverters	2
5	**Applications**	
5.1	DC Motor Drives – Adjustable-speed DC drive	2
5.2	Induction Motor Drives – Variable frequency PWM-VSI drives	2
5.3	Residential and Industrial applications	2

Assignment:

At least one assignment should be simulation of power electronic circuits using any circuit simulation software.

Simulation Assignments (ECT 322)

The following simulations can be done in LTspice or any other circuit simulation software.

1. Model and simulate BJT test circuit Fig. 1.50 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.48.
2. Model and simulate MOSFET test circuit Fig. 1.51 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.49.
3. Model and simulate IGBT test circuit Fig. 1.52 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.50.
4. Model and simulate BJT drive test circuit Fig. 2.33 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.86.
5. Model and simulate MOSFET drive test circuit Fig. 2.36 of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.88.
6. Model and simulate MOSFET shunt snubber test circuit Fig. 2.37of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.89.
7. Model and simulate MOSFET seriessnubber test circuit Fig. 2.39of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.90.
8. Model and simulate diode rectifiers and controlled rectifiers for various loads.
9. Model and simulate Buck converter circuit Fig. 5.68of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.277.
10. Model and simulate Boost converter circuit Fig. 5.70of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.278.
11. Model and simulate Buck-boost converter circuit Fig. 5.71of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.279.

12. Model and simulate Forward converter circuit Fig. 5.72of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.280.
13. Model and simulate Flyback converter circuit Fig. 5.73of Umanand L., Power Electronics Essentials and Applications, Wiley India, 2015, page no.281.
14. Model and simulate Driven Inverters
15. Model and simulate Pulse Width Modulator

Model Question paper

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SIXTH SEMESTER B.TECH DEGREE EXAMINATION, (**Model Question Paper)**

Course Code: ECT 322

Program: Electronics and Communication Engineering
Course Name: Power Electronics

Max.Marks: 100 Duration: 3Hours

PART A

Answer ALL Questions. Each Carries 3 mark.

1	What is meant by reverse recovery time for a diode	K2	CO1
2	What is the tail current in IGBT ?	K2	CO1
3	What is the purpose of snubber circuits ?	K2	CO2
4	Obtain the expression for average load voltage in three phase full wave bridge rectifier	K3	CO3
5	What is volt-second balancing?	K2	CO4
6	What is the flux walking problem in push-pull converter ?	K2	CO4
7	What is the distinction between chopper, oscillators and inverters ?	K3	CO5
8	Distinguish between driven and self-driven inverters.	K2	CO5
9	How converters are used in induction heating ?	K2	CO6
10	What is regenerative breaking in PWM-VSI drive?	K2	CO6

PART – B

Answer one question from each module; each question carries 14 marks.

	Module – I			
11(a)	Compare and contrast power BJT, MOSFET and IGBT for switching applications	7	CO 1	K2
11(b)	A diode and a 10 Ω resistor are connected in series to a square wave voltage source of 50V peak. The reverse recovery time for the diode is 200nsec. Find the switching loss of the diode when the input frequency is 100 KHz.	7	CO 1	K3
	OR			
12(a)	With the two-transistor model of SCR, explain the working principle of SCR	7	CO 1	K2
12(b)	Illustrate the dynamic characteristics of GTO	7	CO 1	K2
	Module – II			
13(a)	Illustrate the base current requirement of power BJT	7	CO 2	K2
13(b)	Explain the operation of any one type of the power BJT base drive circuit	7	CO 2	K2
	OR			
14(a)	Illustrate the principle of operation of a single-phase, 2 pulse, fully controlled rectifier for RL load with circuit diagram and waveforms.	10	CO 3	K2
14(b)	Deduce the expression for average load voltage in the circuit.	4	CO 3	K2
	Module – III			
15(a)	Explain the operation of Buck-Boost converter and illustrate the operation with the inductor current and switching waveforms.	8	CO 4	K2
15(b)	A Buck-Boost converter that switching at 50 KHz is supplied with an input voltage that varies between 5V to 10V. The output is required to be regulated at 15V. A load resistor of 15Ω is connected across the output. If the maximum allowable inductor current ripple is 10% of the average inductor current, estimate the value of the inductance to be used in the Buck-Boost converter.	6	CO 4	K3
	OR			

16(a)	Describe the principle of operation of the full-bridge converter with circuit diagram and waveforms.	8	CO 4	K2
16(b)	How is the flux walking problem solved in full-bridge converter ?	6	CO 4	K2
	Module – IV			
17(a)	Explain the operation of push-pull inverter	8	CO 5	K2
17(b)	Illustrate the PWM switching scheme for sine wave output of the inverter	6	CO 5	K2
	OR			
18(a)	Enumerate the principle of operation of three phase inverters	8	CO 5	K2
18(b)	What is Space vector modulation in three phase inverters	6	CO 5	K2
	Module – V			
19(a)	Explain the principle of adjustable speed DC drive using switched mode DC-DC converter.	8	CO 6	K2
19(b)	Compare adjustable speed DC drives using switched mode DC-DC converter and line frequency-controlled converter.	6	CO 6	K2
	OR			
20 (a)	Illustrate the principle of operation of Variable frequency PWM-VSI Induction Motor drive.	9	CO 6	K2
20(b)	Explain dissipative braking scheme in Induction Motor drive.	5	CO 6	K2