CODE	COURSE NAME	CATEGORY	L	T	P	CREDIT
EET381	SOLID STATE POWER CONVERSION	VAC	3	1	0	4

Preamble: To impart knowledge about the power semiconductor devices, operation and performance of different power converters and its applications.

Prerequisite: Basic knowledge of electric circuits, and basic electronics.

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

CO 1	Explain the operation of various power semiconductor devices and its characteristics
CO 2	Select appropriate triggering circuit for thyristor
CO 3	Analyse the working of various power converters
CO 4	Describe the principle of operation and voltage control of inverters
CO 5	Compare the features and performance of different dc-dc Converters.

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	3	1	-	1	-	-	-	-	-	-	-	-
CO 2	3	2	1	2	1	-	-	-	-	-	-	-
CO 3	3	3	-	1	-	-	-	-	-	-	-	-
CO 4	3	3	-	-	-	-	-	-	-	-	-	-
CO 5	3	2	1	2	-	-	-	-	-	-	-	-

Assessment Pattern

Bloom's Category	Continuous Assessment Tests		End Semester Examination
	1	2	
Remember	10	10	20
Understand	20	20	40
Apply	20	20	40
Analyse			
Evaluate			
Create			

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 anyone. Each question can have maximum 2 sub-divisions and carry 14 marks.

Course Level Assessment Questions

Course Outcome 1 (CO1):

1. Explain the Working of SCR, power diode, MOSFET, IGBT, TRIAC.
2. Draw the VI characteristics of different power devices
3. Draw and explain the switching characteristics of SCR.
4. Discuss the protection circuits for SCR.
5. Understand the requirements in series & Parallel operation of SCR

Course Outcome 2 (CO2)

1. With waveforms explain R and RC triggering circuits.
2. Explain the need and methods of electrical isolation in triggering circuits for Power Electronics

Course Outcome 3 (CO3):

1. Explain the working of halfwave controlled rectifier.
2. Explain the principle of operation, characteristics and performance of fully controlled and half controlled bridge converters.
3. Problems in finding the average output voltage of rectifier
4. Describe the operation of AC voltage controllers

Course Outcome 4 (CO4):

1. Explain the working of various inverter circuits.
2. Problems in finding the output voltage of inverter.
3. How the output voltage of an inverter can be varied
4. Explain single PWM & multiple PWM technique
5. Explain sinusoidal PWM technique.

Course Outcome 5 (CO5):

1. Explain the working of step down and step up choppers
2. Differentiate between first quadrant, two quadrant and four quadrant operation of choppers.
3. Describe pulse width modulation & current limit control in dc-dc converters
4. Design the value of filter inductor & capacitance in regulators

Model Question paper

Pages: 2

Reg. No:_____

Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIFTH SEMESTER B.TECH DEGREE EXAMINATION,

MONTH & YEAR

Course Code: EET381

Course Name: **SOLID STATE POWER CONVERSION**

Max. Marks: 100 Duration: 3 Hrs

PART A

Answer all questions. Each question carries 3 marks.

1. Draw the circuit for two transistor analogy of silicon controlled rectifier and briefly describe the working.
2. Define holding current and latching current of SCR. Show these currents on the static VI characteristics of SCR.
3. Draw the circuit of an R-Triggering circuit for controlling the thyristor in a half wave-controlled rectifier.
4. Derive the expression for the output voltage of a single phase fully controlled bridge converter with RL load.
5. A three phase half wave converter is operated from 3–phase, 230 V, 50Hz supply with load resistance R= 10Ω. An average output voltage of 50% of the maximum possible output voltage is required. Determine the firing angle.
6. What are the two types of voltage control adopted in ac voltage controllers?
7. With the help of circuit diagram explain the working of current source inverter.
8. What is pulse width modulation? List the various PWM techniques.
9. Draw the circuit of step up chopper and explain its working.
10. A type A chopper has input voltage of 200 V. The current through a load of R=10Ω in series with L=80 mH, varies between 12 A and 16 A. Find the form factor of the output voltage waveform

PART B

Answer any one full question from each module. Each question carries 14 marks.

Module 1

11. a) Discuss the condition which must be satisfied for turning on the SCR with agate signal. **(7)**

b) Explain the significance of dv/dt protection in thyristors and describe the method employed for improving the same. **(7)**

12. a) What are the steps to be employed to prevent the difficulties of parallel operation of thyristors? **(6)**

b) Drew the structure of TRIAC and explain its principle of operation. **(8)**

Module 2

13. a) Design an R-triggering circuit for a half wave controlled rectifier circuit for 24 V ac supply. The SCR to be used has the following data.

I_{gmin} = 0.1 mA, I_{gmax} = 12 mA, V_{gmin} = 0.6V, V_{gmax} = 1.5 V **(7)**

b) With the help of circuit diagram explain the operation of single phase semi converter with RL load. Draw the waveform of input voltage, output voltage, load current and voltage across the thyristor. **(7)**

14. a) Draw RC triggering circuit for SCR and explain with relevant wave forms. **(7)**

b) With the help of circuit diagram explain the working of single phase fully controlled converter with RL load. Draw the waveform of output voltage and output current. **(7)**

Module 3

15. a) Sketch the waveform of input voltage, output voltage and output current of a three phase half wave controlled rectifier with R load operating at $\alpha = 30°$. **(7)**

b) A three phase half wave converter is operated from 3–phase, 400 V, 50Hz supply with load resistance R = 50 Ω. An average output voltage of 50% of the maximum possible output voltage is required. Determine the firing angle. **(7)**

16. a) Explain the basic working of a single phase dual converter. **(6)**

b) Draw the circuit of a three phase fully controlled bridge converter and draw the waveforms of input voltage, output voltage, output current and input current in any one phase. Assume resistive load and firing angle is 30 degrees. **(8)**

Module 4

17. a) Describe the working of a three phase voltage source inverter with an appropriate circuit diagram. **(7)**

b) Explain with suitable diagram, the principle of voltage control in inverters with single pulse width modulation. **(7)**

18. Explain the 120 degree conduction mode of a three-phase bridge inverter with output voltage waveforms (phase and line), indicating the devices conducting in each state. **(14)**

Module 5

19. a) With the help of circuit diagram and waveform explain the operation of buck converter and derive the equation of output voltage. **(7)**

b) Differentiate between PWM control and current limit control in choppers. **(7)**

20. a) Explain the working of two quadrant (class C) chopper, with relevant waveform. **(8)**

b) A step-up chopper is used to generate 220 V from 100 V dc source. The OFF period of switch is 80μs. Compute the required pulse width. **(6)**

Syllabus

Module 1

Power semiconductor devices, their symbols and static characteristics, specifications of switches, steady state characteristics of Power MOSFET and IGBT.

SCR – Operation, V-I characteristics, steady state and switching characteristics, two transistor model, methods of turn-on, power diodes, operation of TRIAC, series and parallel connection of SCRs.

Module 2

Gate triggering circuits – R and RC triggering circuits – isolation circuits using opto-isolators and pulse transformers.

Controlled rectifiers – half-wave controlled rectifier with R load – single phase fully controlled bridge rectifier with R, RL and RLE loads (continuous conduction) – output voltage equation – single phase half controlled bridge rectifier with R, RL and RLE loads.

Module 3

Three phase half-wave-controlled rectifier with R load – three phase fully controlled & half-controlled converter with RLE load (continuous conduction) – output voltage equation-waveforms for various triggering angles (analysis not required) – single phase and three phase dual converter.

AC voltage controllers (ACVC) – 1-phase full-wave ACVC with R, & RL loads – waveforms – RMS output voltage, sequence control (two stage) with R load.

Module 4

Inverters – voltage source inverters – single phase half-bridge & full bridge inverter with R & RL loads – 3-phase bridge inverter with R load – 120° & 180° conduction mode, current source inverters.

Voltage control in inverters – Pulse Width Modulation – single pulse width, multiple pulse width & sine PWM – modulation index & frequency modulation ratio.

Module 5

DC-DC converters – step down and step up choppers – single-quadrant, two-quadrant & four quadrant chopper – pulse width modulation & current limit control in dc-dc converters. Switching regulators – buck, boost & buck-boost – operation in continuous conduction mode – steady state waveforms – selection of components.

Text Books

1. Muhammad H. Rashid, Power Electronics Circuits, Devices and Applications, Pearson Education
2. P.S. Bimbhra, Power Electronics, Khanna Publishers, New Delhi

Reference Books

1. Mohan N., T. M. Undeland and W. P. Robbins., Power Electronics, Converters, Applications & Design, Wiley-India
2. Krein P. T., Elements of Power Electronics, Oxford University Press, 1998
3. L. Umanand, Power Electronics – Essentials & Applications, Wiley-India
4. Alok Jain, Power Electronics and its Applications, Penram International Publishing (I) Ltd, 2016
5. Singh M. D. and K. B. Khanchandani, Power Electronics, Tata McGraw Hill, New Delhi, 2008.

Course Contents and Lecture Schedule

No	Topic	No. of Lectures
1	**Power semiconductor devices (9 hours)**	
1.1	Symbols, static characteristics and specifications of semiconductor switches.	2
1.2	Power diodes, power MOSFET and IGBT	3
1.3	SCR - VI Characteristics, Turn on methods	1
1.4	Structure and principle of operation of TRIAC	1
1.5	Series and parallel operation of SCRs	2
2	**Gate triggering circuits & single-phase controlled converters (9 hours)**	
2.1	R and RC triggering circuits	3
2.2	Isolation circuits using opto-isolators and pulse transformers	1
2.3	Half-wave controlled rectifier with R load	1
2.4	Single phase fully controlled bridge rectifier with R, RL and RLE loads	2
2.5	Single phase half controlled bridge rectifier with R, RL and RLE loads	2
3	**Three phase controlled converters & AC voltage regulator (9 hours)**	
3.1	Three phase half-wave-controlled rectifier with R load	1
3.2	Three phase fully controlled & half-controlled converter with RLE load	4
3.3	Single phase and three phase dual converter	2
3.4	AC voltage controllers (ACVC)	1
3.5	Sequence control (two stage) with R load	1
4	**Inverters (9 hours)**	
4.1	Single phase half-bridge & full bridge inverter with R & RL loads	3
4.2	Three phase bridge inverter with R load – 120° & 180° conduction mode	2
4.3	Current source inverters.	1

4.4	Pulse Width Modulation – single pulse width, multiple pulse width & sine PWM	3
5	**DC-DC Converters (9 hours)**	
5.1	Principle of step down and step up choppers	2
5.2	Description of single-quadrant, two-quadrant & four quadrant choppers	1
5.3	Pulse width modulation & current limit control in dc-dc converters	3
5.4	Switching regulators – buck, boost & buck-boost - continuous conduction mode only	2
5.5	Design of filter inductance & capacitance	1