Indra Ganesan
COLLEGE OF ENGINEERING

Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai
Accredited by NAAC with 'B+' Grade, 2(f) & 12B Status Institution by UGC
IG Valley, Madurai Main Road, Manikandam, Tiruchirappalli - 620012

NAAC DOCUMENTS

QUALITY INDICATOR FRAME WORK

CRITERION – 1

CURRICULAR ASPECTS

SUBMITTED BY

IQAC

INTERNAL QUALITY ASSURANCE CELL

INDRA GANESAN COLLEGE OF ENGINEERING

Criteria 1	Curricular Aspects	100

1.1 Curricular Planning and Implementation (20)

1.1.1 The Institution ensures effective curriculum planning and delivery through a well-planned and documented process including Academic calendar and conduct of continuous internal Assessment

Table of Content

INDRA GANESAN COLLEGE OF ENGINEERING

IG Valley, Manikandam, Tiruchirappalli, Tamil Nadu – 620 012, India
(Approved by AICTE, New Delhi, Affiliated to Anna University, Chennai-25)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

PREFACE OF THE COURSE FILE

Batch	: **2017-2021**
Academic Year	: **2019-2020 / ODD**
Program	: **ELECTRICAL AND ELECTRONICS ENGINEERING**
Year & Semester	: **3nd Year / 5th Semester**
Course Code	: **EE8552** NBA Course Code:
Name of the Course	: **POWER ELECTRONICS**
Faculty in-charge	: D.PRAVEEN SANGEETH KUMAR, AP / EEE

D.Praveen

G. Malathi

Signature of the Faculty in-charge

HoD / EEE

Dr. G. Balakrishnan, M.E., Ph.D.,
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INDRA GANESAN COLLEGE OF ENGINEERING

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

SYLLABUS

EE8552 **POWER ELECTRONICS** **L T P C**
3 0 0 3

COURSE OBJECTIVES:

- Different types of power semiconductor devices and their switching
- Operation, characteristics and performance parameters of controlled rectifiers
- Operation, switching techniques and basics topologies of DC-DC switching regulators.
- Different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
- Operation of AC voltage controller and various configurations

UNIT I

POWER SEMI-CONDUCTOR DEVICES **9**

Study of switching devices, SCR, TRIAC, GTO, BJT, MOSFET, IGBT and IGCT- Static characteristics: SCR, MOSFET and IGBT - Triggering and commutation circuit for SCRIntroduction to Driver and snubber circuits..

UNIT II

PHASE-CONTROLLED CONVERTERS **9**

2-pulse, 3-pulse and 6-pulseconverters– performance parameters –Effect of source inductance— Firing Schemes for converter–Dual converters, Applications-light dimmer,Excitation system, Solar PV systems.

UNIT III

DC TO DC CONVERTERS **9**

Step-down and step-up chopper-control strategy– Introduction to types of choppers-A, B, C, D and E -Switched mode regulators- Buck, Boost, Buck- Boost regulator, Introduction to Resonant Converters, Applications-Battery operated vehicles

UNIT IV

INVERTERS **9**

Single phase and three phase voltage source inverters (both1200 mode and 1800 mode) – Voltage& harmonic control--PWM techniques: Multiple PWM, Sinusoidal PWM, modified sinusoidal PWM – Introduction to space vector modulation –Current source inverter, Applications-Induction heating, UPS.

UNIT V

AC TO AC CONVERTERS **9**

Single phase and Three phase AC voltage controllers–Control strategy- Power Factor Control – Multistage sequence control -single phase and three phase cyclo converters – Introduction to Matrix converters, Applications –welding

TOTAL: 45 PERIODS

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TEXT BOOKS:

1. M.H. Rashid, 'Power Electronics: Circuits, Devices and Applications', Pearson Education, Third Edition, New Delhi, 2004.
2. P.S.Bimbra "Power Electronics" Khanna Publishers, third Edition, 2003.
3. Ashfaq Ahmed 'Power Electronics for Technology', Pearson Education, Indian reprint, 2003.

REFERENCE BOOKS:

1. Joseph Vithayathil,' Power Electronics, Principles and Applications', McGraw Hill Series, 6th Reprint, 2013.
2. Philip T. Krein, "Elements of Power Electronics" Oxford University Press, 2004 Edition.
3. L. Umanand, "Power Electronics Essentials and Applications", Wiley, 2010.
4. Ned Mohan Tore. M. Undel and, William. P. Robbins, 'Power Electronics: Converters, Applications and Design', John Wiley and sons, third edition, 2003.
5. S.Rama Reddy, 'Fundamentals of Power Electronics', Narosa Publications, 2014.
6. M.D. Singh and K.B. Khanchandani, "Power Electronics," Mc Graw Hill India, 2013.
7. JP Agarwal," Power Electronic Systems: Theory and Design" 1e, Pearson Education, 2002.

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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

Lecture Schedule

Degree/Program: **B.E / EEE**
Duration: **2019 - 2020**

Course code &Name: EE8552 –Power Electronics
Semester: **III** Faculty: **Mr. D. PRAVEEN SANGEETH KUMAR**

AIM:

To impart knowledge about the Different types of power semiconductor devices and their switching.

OBJECTIVES:

To impart knowledge on the following Topics

- Different types of power semiconductor devices and their switching
- Operation, characteristics and performance parameters of controlled rectifiers
- Operation, switching techniques and basics topologies of DC-DC switching regulators.
- Different modulation techniques of pulse width modulated inverters and to understand harmonic reduction methods.
- Operation of AC voltage controller and various configurations.
- Circuit theory, Electromagnetic theory

PREREQUISITES:

COURSE OUTCOMES:

After the course, the student should be able to:

CO	Course Outcomes	POs	PSOs
C303.1	Understand different types of power semiconductor devices, their switching characteristics and driver circuits	1,2,3,4	1,2
C303.2	Classify the various performance parameters in controlled rectifiers with different load conditions	1,2,3,4	1,2
C303.3	Analyze DC –DC switching regulators with its Commutation Techniques and apply it for real time applications like SMPS	1,2,3,4	1,2
C303.4	Explain the various pulse width modulated inverters for different loads and infer the effect of power quality disturbances over the system.	1,2,3,4	1,2
C303.5	Analyze AC voltage controllers, Matrix Converters & Cyclo converters with various loads and infer its various configurations.	1,2,3,4	1,2

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S.No	Date	Period	Topics to be Covered	Book & Page. No.
			UNIT -I - TRANSMISSION LINE PARAMETERS	**Target periods :9**
1	01/07/19	7	Study of switching devices, SCR, TRIAC	T1,R1
2	02/07/19	1	Study of switching devices GTO, BJT, MOSFET	T1,R1
3	04/07/19	3	Study of switching devices IGBT and IGCT	T1,R1
4	05/07/19	2	Static characteristics: SCR, MOSFET	T1,R1
5	08/07/19	7	Static characteristics: IGBT	T1,R1
6	09/07/19	1	Triggering and commutation circuit SCR	T1,R1
7	11/07/19	3	Introduction to Driver circuits	T1,R1
8	12/07/19	2	Introduction to snubber circuits	T1,R1
9	13/07/19	1	Switching Application	T1,R1
10	13/07/19	7	Revision	T1,R1
			UNIT II - MODELLING AND PERFORMANCE OF TRANSMISSION LINES	**Target periods :9**
11	19/07/19	7	2-pulse, 3-puls converters	T1,R1
12	20/07/19	1	6-pulse converters	T1,R1
13	22/07/19	3	Performance Parameters	T1,R1
14	23/07/19	2	Effect of Source Inductance	T1,R1
15	25/07/19	7	Firing Schemes For Converter	T1,R1
16	26/07/19	1	Dual Converters, Applications-	T1,R1
17	29/07/19	3	Light Dimmer	T1,R1
18	29/07/19	2	Excitation System	T1,R1
19	30/07/19	7	Solar PV System	T1,R1
			UNIT III - SAG CALCULATION AND LINE SUPPORTS	**Target Periods :9**
20	06/08/19	7	Step-down and step-up chopper	T1,R1
21	08/08/19	1	control strategy	T1,R1
22	09/08/19	3	Introduction to types of choppers-A, B, C	
23	12/08/19	2	Introduction to types of choppers D and E	T1,R1
24	13/08/19	7	Switched mode regulators-	T1,R1
25	15/08/19	1	Buck, Boost, Buck- Boost regulator	T1,R1
26	16/08/19	3	Introduction to Resonant Converters	T1,R1
27	19/08/19	2	Applications	T1,R1
28	20/08/19	7	Battery operated vehicles	T1,R1
			UNIT IV - UNDERGROUND CABLES Target Periods :9	
29	29/08/19	2	Single phase and three phase voltage source inverters (both1200 mode and 1800 mode)	T1,R1
30	30/08/19	7	Voltage& harmonic control	

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31	31/08/19	1	PWM techniques: Multiple PWM	T1,R1
32	03/09/19	3	Sinusoidal PWM	T1,R1
33	05/09/19	2	modified sinusoidal PWM	T1,R1
34	06/09/19	7	Introduction to space vector modulation	
35	09/09/19	1	Current source inverter	T1,R1
36	10/09/19	3	Applications	T1,R1
37	11/09/19	2	Induction heating, UPS	
UNIT V - DISTRIBUTION SYSTEMS Target Periods:9				
38	17/09/19	1	Single Phase And Three Phase Ac Voltage Controllers–	T1,R1
39	19/09/19	3	Control Strategy	T1,R1
40	20/09/19	2	Power Factor Control	T1,R1
41	21/09/19	7	Multistage Sequence Control	T1,R1
42	21/09/19	1	Single Phase Cyclo Converters	T1,R1
43	23/09/19	3	Three Phase Cyclo Converters	T1,R1
44	24/09/19	2	Introduction To Matrix Converters	T1,R1
45	26/09/19	1	Applications – Welding	T1,R1
46	26/09/19	7	Revision	T1,R1
Content Beyond the Syllabus				
47			Multilevel inverters (9level output in single voltage input)	Material

Book Reference - Text Books

Sl.	Title of the Book	Author	Publisher	Year
1.	'Power Electronics'	M.H. Rashid	Pearson Education	2004.
2.	'Power Electronics'	P.S.Bimbra.	Khanna Publishers.,	2003.
3	'Power Electronics for Technology'	Ashfaq Ahmed	Pearson Education	2003.

Book Reference – References

Sl	Title of the Book	Author	Publisher	Year
1.	Power Electronics, Principles and Applications	Joseph Vithayathil,,	McGraw Hill Series	2013.

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2.	Elements of Power Electronics	Philip T. Krein	Oxford University Press	2004
3.	"Power Electronics Essentials and Applications"	L. Umanand	Wiley	2010

Website Refere ce:
http://nptel.iitm.ac.in/courses.php?branch=Electrical
www.freebookspot.com

Signature of the Faculty in-charge

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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

Identification of Curricular Gap & Content Beyond Syllabus(CBS)

Name of the Faculty : Mr. D. PRAVEEN SANGEETH KUMAR **Course Code & Name:EE8552 PE**

Degree & Program:B.E. /EEE **Semester & Section: III** **Academic Year: 2019 -2020 /ODD**

I. Mapping of Course Outcomes with POs & PSOs.(before CBS)

Table.1 Mapping of COs, C, PSOs with POs - before CBS.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C212.1	3	2	1	1	-	-	-	-	-	2	1	1	2	2
C212.2	3	2	1	1	-	-	-	-	-	2	1	1	2	2
C212.3	3	2	1	1	-	-	-	-	-	2	1	1	2	2
C212.4	3	2	1	1	-	-	-	-	-	2	1	1	2	2
C212.5	3	2	1	1	-	-	-	-	-	2	1	1	2	2
C212.6	3	2	1	1	-	-	-	-	-	2	1	1	2	2
C212	3	2	1	1	-	-	-	-	-	2	1	1	2	2

II. Identification of content beyond syllabus.

Table.2 Identification of content beyond syllabus

Details of Content Beyond Syllabus(CBS) added	POs strengthened/ vacant filled	CO/Unit
Single phase and three phase voltage source inverters (both1200 mode and 1800 mode)	PO5(2) Vacant filled	C212.5 & C212.6/ IV & V

III. Mapping of Course Outcomes with POs & PSOs. (After CBS)

Table.3 Mapping of COs, C, PSOs with POs- after CBS.

Course	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
C212.1	3	2	1	1	-	-	-	-	-	2	1	1	2	2
C212.2	3	2	1	1	-	-	-	-	-	2	1	1	2	2
C212.3	3	2	1	1	-	-	-	-	-	2	1	1	2	2
C212.4	3	2	1	1	-	-	-	-	-	2	1	1	2	2
C212.5	3	2	1	1	*2	-	-	-	-	2	1	1	2	2
C212.6	3	2	1	1	*2	-	-	-	-	2	1	1	2	2
C212	3	2	1	1	*2	-	-	-	-	2	1	1	2	2

D Praveen

Signature of the Faculty

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DEPARTMENT OF ELECTRICAL & ELECTRONICS ENGINEERING

Identification of Curricular Gap & Content Beyond Syllabus(CBS) MATERIAL

Name of the Faculty : **Mr. D. PRAVEEN SANGEETH KUMAR, AP / EEE**

Course Code & Name: EE8552 PE

Degree & Program: B.E. /EEE **Semester & Section: III / A** **Academic Year: 2018 -2019/ODD**

TOPIC: Grid interface of renewable energy resources

A grid-connected system allows you to power your home or small business with renewable energy during those periods (daily as well as seasonally) when the sun is shining, the water is running, or the wind is blowing. Any excess electricity you produce is fed back into the grid.

Grid integration of renewable energy means reimagining operation and planning for a reliable, cost-effective, and efficient electricity system with cleaner new energy generators.
Grid integration studies are tailored to address specific concerns relevant to a given power system and involve modeling one or more of three categories: capacity expansion, production cost, and power flow.

- Wind Power,
- Solar Power,
- Bioenergy (Organic Matter Burned As A Fuel) And
- Hydroelectric, Including Tidal Energy.

What are the grids in user interface?

A UI grid is a foundational layout structure in design that organizes content into rows and columns, providing a systematic framework for arranging UI elements on a page or screen. UI grids establish a consistent and harmonious visual order, making navigating and comprehending content easier.

- Manuscript grid.
- Column grid.
- Module grid.
- Baseline grid.

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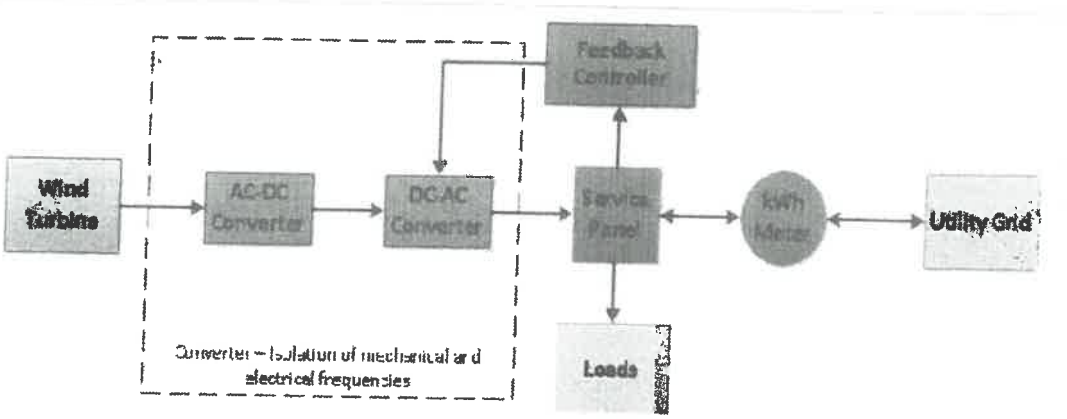

Grid integration of renewable energy means reimagining operation and planning for a reliable, cost-effective, and efficient electricity system with cleaner new energy generators.

Signature of the Faculty

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Register Number: | | | | | | | | | | | | |

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Internal Assessment Exam - I			Date/Session	17/07/19 AN	Marks	50
Course code	EE8552	Course Title	Power Electronics			
Regulation	2017	Duration	90 minutes	Academic Year	2019-20	
Year	3ND	Semester	V	Department	EEE	

COURSE OUTCOMES

CO1:	Understand different types of power semiconductor devices, their switching characteristics and driver circuits
CO2:	Classify the various performance parameters in controlled rectifiers with different load conditions
CO3:	Analyze DC –DC switching regulators with its Commutation Techniques and apply it for real time applications like SMPS
CO4:	Explain the various pulse width modulated inverters for different loads and infer the effect of power quality disturbances over the system.
CO5:	Analyze AC voltage controllers, Matrix Converters & Cyclo converters with various loads and infer its various configurations.
CO6:	Explain the working principle in 180 degree & 120 degree mode inverter.

Q.No.	Question	CO	BTS
	PART A (Answer all the Questions 10 x 2 = 20 Marks)		
1	Give any two differences between single phase full converter and semi converter?	CO1	K1
2	What is meant by line commutated converter?	CO1	K2
3	Define total harmonic distortion.	CO1	K2
4	Compare half controlled and fully controlled rectifier.	CO1	K1
5	What is the effect of source impedance?	CO3	K2
6	What is the displacement factor for two pulse converter?	CO1	K2
7	Why is power factor of semi converter better than full converter?	CO2	K2
8	What is the inversion mode of rectifiers?	CO1	K2
9	What is circuit turn off time for single phase full converter?	CO1	K2
10	Define Power factor.	CO1	K1
	PART B (Answer all the Questions 2 x 10 = 20 Marks)		
11a	Describe the operation of single phase two pulse bridge converter with RL load	CO1	K2
	OR		
11b	A single phase full converter is supplied from 220V, 50Hz source. The load consists of R = 12 Ω and a large inductance so as to render the load current constant. For a firing angle delay of 45°, determine i) average output voltage, ii) average output current iii) average and RMS values of thyristor currents and iv) power factor.	CO1	K3
12a	Describe the operation of three phase full bridge converter with RL load	CO4	K3
	OR		
12b	Explain the two functional modes of dual converter with waveforms	CO4	K2
	PART C (Answer all the Questions 1 x 10 = 10 Marks)		
13a	xplain the operation of single phase half wave controlled rectifier with RL load	CO3	K2
	OR		
13b	Explain the operation of single phase half wave controlled rectifier with RL load with freewheeling diode.	CO3	K2

Course Faculty

(Name /Sign / Date)

HoD

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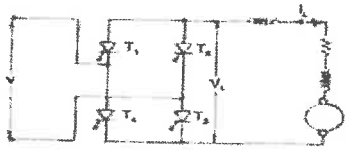
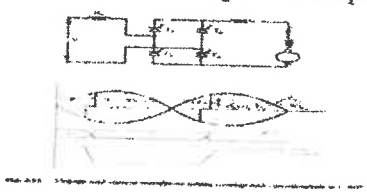
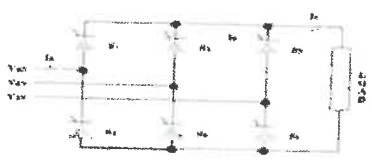
Q.No.	Question	CO	BTS
	PART A **(Answer all the Questions 10 x 2 = 20 Marks)**		
1	Give any two differences between single phase full converter and semi converter? Half-controlled converter or semi- converter: Uses a mixture of diode and thyristors and there is limited control over the level of DC Output voltage. It is one-quadrant converter	CO1	K1
2	What is meant by line commutated converter? Line-commutated indicates that the conversion process relies on a stable line voltage, with clear zero-crossings of the AC system.	CO1	K2
3	Define total harmonic distortion. Total harmonic distortion, or THD, is one way to gauge power supply quality. It indicates how much of a harmonic component the voltage and current waveforms	CO1	K2
4	Compare half controlled and fully controlled rectifier. When half control is used, load current never reverses. If full control is used, sometimes thyristors are fired at 3rd quadrant and allows negative current pass through the load.	CO1	K1
5	What is the effect of source impedance? The source impedance is calculated as the voltage drop from the local source to the relay location divided by the fault current in the relay.	CO3	K2
6	What is the displacement factor for two pulse converter? Two pulse converters is defined as two triggering pulses or two sets of triggering pulses are to be generated during every cycle of the supply to trigger the various SCRs.	CO1	K2
7	Why is power factor of semi converter better than full converter? The Power Factor Of A Single Phase Semi Converter Is Better Than A Full Converter Because Of The Freewheeling Action Of The Diode And Thyristor In Symmetrical Connection And The Freewheeling Action Of The Two Diodes In Asymmetrical Connection	CO2	K2
8	What is the inversion mode of rectifiers? Average output current in rectifier always positive in inversion ($\alpha > 90°$) and rectification ($\alpha < 90°$) mode. Power is positive in rectification and power flow from source to load	CO1	K2
9	What is circuit turn off time for single phase full converter? It is defined as the time between the instant anodes current becomes zero and the instant reverse voltage due to practical circuit reaches zero.	CO1	K2
10	Define Power factor. A power factor of 1 indicates that the voltage and current are in phase and have a low-harmonic content.	CO1	K1
	PART B **(Answer all the Questions 2 x 10 = 20 Marks)**		
11a	Describe the operation of single phase two pulse bridge converter with RL load A two pulse bridge converter is achieved as shown in Fig. 3.22 from two midpoint converters. They are connected in series on the dc side and in parallel on the ac side, It is also a single phase converter. At any given time two diagonally opposite thyristors conduct, one thyristor acting as a return path for the current  Fig. 3.22 *Two pulse bridge converter* (5marks)  The performance of a bridge converter with respect to the ac ripple superimposing the dc voltage, harmonics in the input current, power factor, reactive power requirement, and discontinuous condition lay out of smoothing reactor, is the same as that of a midpoint converter. **(5 Marks)**	CO1	K2
	OR		
11b	A single phase full converter is supplied from 220V, 50Hz source. The load consists of R = 12 Ω and a large inductance so as to render the load current constant. For a firing angle delay of 45°, determine i) average output voltage, ii) average output current iii) average and RMS values of thyristor currents and iv) power factor. **Vo = 187 V** **RMS values of thyristor currents: 16.88 A** **(5 Marks)** **Io = 18.7 A** **PF 0.8** **(5 Marks)**	CO1	K3
12a	Describe the operation of three phase full bridge converter with RL load Voltage and current waveforms of a three-phase full converter with a highly inductive load are shown in figure. This converter provides two quadrant operation and thyristors are fired at an interval of $\pi/3$ degrees. Since thyristors are fired every 60°, the frequency of the output ripple voltage is six times the frequency of the supply voltage. At $\omega t = \pi/6 + \alpha$, thyristor S6 is already conducting and thyristor S1 is turned on. From symmetry consideration it can be argued that each thyristor conducts for 120° of the input cycle. Now the thyristors are fired in the sequence T1 → T2 → T3 → T4 → T5 → T6 → T1 with 60° interval between each firing. Therefore thyristors on the same phase leg are fired at an interval of 180° and hence cannot conduct simultaneously. 	CO4	K3

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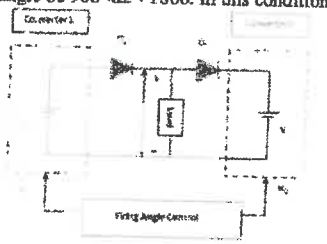
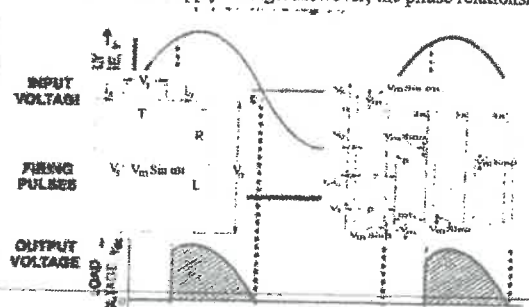
	OR		
12b	Explain the two functional modes of dual converter with waveforms Dual converter, the name itself says two converters. It is really an electronic converter or circuit which comprises of two converters. One will perform as a rectifier and the other will perform as an inverter. Therefore, we can say that double processes will occur at a moment. Here, two full converters are arranged in anti-parallel pattern and linked to the same dc load. Non Circulating Current Mode • One converter will perform at a time. So there is no circulating current between the converters. • During the converter 1 operation, firing angle (α1) will be 0<α1< 90o; Vdc and Idc are positive. • During the converter 2 operation, firing angle (α2) will be 0<α2< 90o; Vdc and Idc are negative. Circulating Current Mode • Two converters will be in the ON condition at the same time. So circulating current is present. • The firing angles are adjusted such that firing angle of converter 1 (α1) + firing angle of converter 2 (α2) = 180o. • Converter 1 performs as a controlled rectifier when firing angle be 0<α1< 90o and Converter 2 performs as an inverter when the firing angle be 90o<α2< 180o. In this condition, Vdc and Idc are positive. **(5 Marks)**  **(5 Marks)**	CO4	K2
	PART C **(Answer all the Questions 1 x 10 = 10 Marks)**		
13a	Explain the operation of single phase half wave controlled rectifier with RL load A single phase half wave controlled rectifier is a thyristors based circuit which produces output voltage for positive half of the supply voltage. However, the phase relationship between the initiation of load current and supply voltage n; it is called phase controlled half wave rectifier. In this tage; average load current and RMS load voltage for a  R	CO3	K2
13b	th RL load with freewheeling diode. SCR is used in the circuit. It is included in between the ac ge the voltage level to suit the requirements. The performance of the output (load) circuit.  	CO3	K2

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DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

ROOT CAUSE ANALYSIS

Name of the Faculty: D Praveen Sanjeeth Kumar
Degree & Program: BE & EEE
IA Test : I / II / III / Model
Target : 90 %

Course Code & Name : EE8552 / Power Electronics
Semester & Section : IV / B
University Exam/Month & Year :
Achieved : 30 %

S.NO	BATCH NO	NAME OF THE STUDENT	CAUSES FOR FAILURE	SIGNATURE OF THE STUDENT WITH DATE	CORRECTIVE ACTION TAKEN	PREVENTIVE ACTION TAKEN
	5	Kanmozhi S	2m Paper Presentation		Explained to Student & re Assignment	Assignment

Signature of the Faculty Member

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