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Ref No:

Sri Krishna Institute of Technology, Bangalore

COURSE PLAN

Academic Year 2019

Program:	BE-Electrical and Electronics Engineering
Semester:	5
Course Code:	17EE53
Course Title:	Power Electronics
Credit/L-T-P:	4/4-0-0
Total Contact Hours:	50
Course plan Author:	Chaitra A S

Academic Evaluation and Monitoring Cell

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17EE53: Power Electronics

A. COURSE INFORMATION

1. Course Overview

Degree:	BE	Program:	EE
Year / Semester :	2019	Academic Year:	2019-20
Course Title:	Power Electronics	Course Code:	17EE53
Credit / L-T-P:	4-0-0	SEE Duration:	180 Minutes
Total Contact Hours:	50	SEE Marks:	60 Marks
CIA Marks:	40	Assignment	1 / Module
Course Plan Author:	Chaitra A S	Sign	Dt:
Checked By:		Sign	Dt:

2. Course Content

Module	Module Content	Teaching Hours	Module Concepts	Blooms Level
1	**Introduction:** Applications of Power Electronics, Types of Power Electronic Circuits, Peripheral Effects, Characteristics and Specifications of Switch. **Power Diodes:** Introduction, Diode Characteristics, Reverse Recovery Characteristics, Power Diode Types, Silicon Carbide Diodes, Silicon Carbide Schottky Diodes, Diode Switched RL Load, Freewheeling Diodes with Switched RL Load. **Diode Rectifiers:** Introduction, Single-Phase Full-Wave Rectifiers, Single-Phase Full-Wave Rectifier with RL Load, Single-Phase Full-Wave Rectifier with a Highly Inductive Load.	10	Basics of Power Converters Diode Rectification	L3,L4
2	**Power Transistors:** Introduction, Power MOSFETs – Steady State Characteristics, Switching Characteristics Bipolar Junction Transistors –Steady State Characteristics, Switching Characteristics. Switching Limits, IGBTs, MOSFET Gate Drive, BJT Base Drive, Isolation of Gate and Base Drives, Pulse transformers and Opto-couplers.	10	Switching Operation Driver circuit	L3, L4
3	**Thyristors:** Introduction, Thyristor Characteristics, Two-Transistor Model of Thyristor, Thyristor Turn- On, Thyristor Turn-Off, A brief study on Thyristor Types, Series Operation of Thyristors, Parallel Operation of Thyristors, di/dt Protection, dv/dt Protection, DIACs, Thyristor Firing Circuits, Unijunction Transistor	10	Switching Operation Firing Circuit	L3,L4
4	**Controlled Rectifiers:** Introduction, Single-Phase Full Converters, Single-Phase Dual Converters, Three- Phase Full Converters, Three-Phase Dual Converters. **AC Voltage Controllers:** Introduction, Single-Phase Full-Wave Controllers with Resistive Loads, Single- Phase Full-Wave Controllers with Inductive Loads, Three-Phase Full-Wave Controllers.	10	Rectification using controlled rectifier Performance parameters	L3,L4
5	**DC-DC Converters:** Introduction, principle of step down and step up chopper with RL load, performance parameters, DC-DC converter classification. **DC-AC converters:** Introduction, principle of operation single phase bridge inverters, three phase bridge inverters, voltage control of single phase inverters, Harmonic reductions, Current source inverters.	10	Principle Performance parameters	L4, L4

3. Course Material

Module	Details	Available
1	Text books	

1.	Power Electronics: Circuits Devices and Applications BY Mohammad H Rashid, Pearson 4th Edition, 2014.	In Lib
2	Reference books	
1.	Power Electronics: Converters, Applications and Design Ned Mohan et al Wiley 3rd Edition, 2014	In dept
2.	Power Electronics BY Daniel W Hart, McGraw Hill, 1 st Edition, 2011	
3	Elements of Power Electronics, Philip T Krein, Oxford, Indian Edition, 2008	
3	Others (Web, Video, Simulation, Notes etc.)	
	NPTEL VEDIOS	Not Available

4. Course Prerequisites

SNo	Course Code	Course Name	Module / Topic / Description	Sem	Remarks	Blooms Level
1	15ELN15	Basic Electronics	1. Knowledge on Basic working of semi conducting devices.	2	-	L2
2	15EE34	Analog Electronic Circuits	FET, MOSFET Construction, working, Characteristics	3	-	L3
					Plan Gap Course	

Note: If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

B. OBE PARAMETERS

1. Course Outcomes

#	COs	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
17EE53.1	Acquire the knowledge about fundamental concept and applications used in power electronic converters.	05	Basics of Power Converters	Lecture	Unit Test	L3 Apply
17EE53.2	Analyze the power diodes characteristics, types and their operation and the effect of power diode on RL circuit.	07	Diode Rectification	Lecture/ PPT	Assignment	L4 Analyze
17EE53.3	Understand the types, steady state, switching characteristics and their limitation of power transistors.	07	Switching Operation	Lecture	Assignment and unit Test	L3 Applying
17EE53.4	Design of gate and base drive circuit for turn-on and turn-off of power devices.	04	Driver circuit	Lecture / PPT	Assignment	L4 Analyze
17EE53.5	Describe the types of thyristors, characteristics and their limitations.	05	Switching Operationl	Lecture	unit test	L3 Apply
17EE53.6	Analyze the gate control requirement to produce firing pulses and to trigger the thyristor.	06	Firing Circuit	Lecture and Tutorial	Assignment	L4 Analyze
17EE53.7	Understand the principle of operation and designing of single phase and three phase controlled rectifier by producing firing pulses.	05	Rectification using controlled rectifier	Lecture	Assignment and Unit Test	L3 Apply
17EE53.8	Design and analyze the AC voltage controller	06	Performance parameters	Lecture	Assignment	L4 Analyze
17EE53.9	Understand the principle of operation	06	Principle		Assignment	L4

	of step up and step down chopper by varying the duty cycle.				and Unit Test	Analyze
17EE53.10	Design and analyse the single phase and three phase DC-AC converters	05	Performance parameters	Lecture	Assignment	L4 Analyze
-	**Total**	**61**	-	-	-	-

Note: Identify a max of 2 Concepts per Module. Write 1 CO per concept.

2. Course Applications

SNo	Application Area	CO	Level
1	Power diodes are used as isolating signals from supply.	CO2	L4
2	Power diodes can used as voltage reference, mixing and detection of signals	CO2	L4
3	Diode rectifiers can be used in controlling the size of the signal, used in lazer diodes.	CO2	L4
4	Transistors are used in audio amplifiers, sound reproduction, radio transmission	CO3	L3
5	BJT's are used in analog switches	CO3	L3
6	Transistors are used in low power logic gates, DC motor drives, AC motor drives	CO4	L4
7	Transistors are used in isolation circuit such as opto-couplers and pulse transformers.	CO4	L4
8	Thyristors are used in Industrial application such as induction heating, dielectric heating and lamp dimming.	CO6	L4
9	Thyristors are used in static AC /DC circuit breakers, tap changers	CO6	L4
10	TRIAC's are used in AC switches, starter circuit for lamps.	CO5	L3
11	Control rectifiers are used in speed control of DC motor, Universal motors, lamp dimming.	CO7	L3
12	AC voltage controllers are used in power generation, power transmission, electric heating, induction heating, cyclo converters, matrix converters, Electric welding.	CO8	L4
13	Choppers are used in railway traction, battery charges, switched capacitance filters, variable frequency drives, class D electronic amplifiers, battery operated electric cars.	CO9	L4
14	Inverters are used in HVDC power transmission at the receiving end, Uninterrupted power supply, Air conditioning, refrigeration, synchronverters, electroshock weapons	CO10	L4

Note: Write 1 or 2 applications per CO.

3. Articulation Matrix

(CO – PO MAPPING)

-	Course Outcomes	Program Outcomes												
#	COs	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO 8	PO9	PO1 0	PO1 1	PO1 2	Level
17EE53.1	Acquire the knowledge about fundamental concept and applications used in power electronic converters.	2	3											L3
17EE53.2	Analyze the power diodes characteristics, types and their operation and the effect of power diode on RL circuit.	3	3	2										L4
17EE53.3	Understand the types, steady state, switching characteristics and their limitation of power transistors.	2	2											L3
17EE53.4	Design of gate and base drive circuit for turn-on and turn-off of power devices.	3	3	2						3				L4
17EE53.5	Describe the types of thyristors, characteristics and their	3	3	3										L3

	limitations.													
17EE53.6	Analyze the gate control requirement to produce firing pulses and to trigger the thyristor.	2	2	2						2				L4
17EE53.7	Understand the principle of operation and designing of single phase and three phase controlled rectifier by producing firing pulses.	2	2	2						2				L3
17EE53.8	Design and analyze the AC voltage controller	3	2	2						2				L4
17EE53.9	Understand the principle of operation of step up and step down chopper by varying the duty cycle.	2	2	3						2				L4
17EE53.10	Design and analyze the single phase and three phase DC-AC converters	2	2	2						2				L4
17EE53.	Average													
Note: Mention the mapping strength as 1, 2, or 3														

4. Mapping Justification

Mapping		Justification	Mapping Level
CO	**PO**	**-**	**-**
CO1	PO1	Knowledge on semiconductor materials, holes and electronics, working of p-n junction is required for construction of different types of power semi conducting devices.	L3
CO1	PO2	Identify the different types of power electronic converters and analyse the working of different converters.	L2
CO2	PO1	Knowledge on semiconductor materials, internal structure of a diode, operation and working of a rectifier.	L2
CO2	PO2	Identify the power diodes types and their operation.	L2
CO2	PO3	Design of half wave and full wave diode rectifiers with different loading conditions	L4
CO3	PO1	Knowledge on family of transistors, internal structure and its control methods are required.	L2
CO3	PO2	Mathematical analysis of models of npn transistors	L3
CO4	PO1	Knowledge on characteristics of different transistors (BJT, MOSFET, IGBT) are required.	L2
CO4	PO2	Identify the requirement of gate and base drive circuit for designing the drive circuits.	L2
CO4	PO3	Design of gate and base drive circuit for turn on and turn off of transistors.	L4
CO4	PO9	Projects or internship can be done on base or gate drive control of transistors.	L2
CO5	PO1	Knowledge on family of thyristors, internal structure and its different modes of operation is required.	L2
CO5	PO2	Analyze the working of thyristor by two transistor model.	L4
CO5	PO3	Design of snubber circuits for protection against dv/dt and over voltages.	L4
CO6	PO1	Knowledge on characteristics of different thyristor (SCR, RCT, GTO) are required.	L2
CO6	PO2	Analyze the gate control requirement to produce firing pulses and to trigger the thyristor.	L4
CO6	PO3	Design of different thyristor firing circuits for triggering the SCR	L4
CO6	PO9	Projects can be developed on different methods of firing the SCR.	L2

CO7	PO1	Knowledge on SCR and control of SCR is required to study the principle of operation of controlled rectifier.	L2
CO7	PO2	Identify the different types of controlled rectifier with R and RL laods.	L2
CO7	PO3	Design and working of controlled rectifier with R and RL laods.	L4
CO7	PO9	Projects based on controlled rectifier is done for many practical applications.	L2
CO8	PO1	Knowledge on SCR, diode and control of SCR is required to study the principle of operation of AC voltage controller.	L2
CO8	PO2	Identify the different types of AC voltage controller with R and RL laods.	L2
CO8	PO3	Design and working of single phase and three phase AC voltage controller with R and RL laods.	L4
CO8	PO9	Projects based on AC voltage controller is done for many practical applications.	L2
CO9	PO1	Knowledge on transistor and control of transistor is required to study the principle of operation of Chopper.	L2
CO9	PO2	Identify the different types of Choppers based on direction of current and voltage flow.	L2
CO9	PO3	Design the different types of chopper for different practical applications.	L4
CO9	PO9	Projects based on Choppers can be done for many practical applications.	L4
CO10	PO1	Knowledge on transistor and control of transistor is required to study the principle of operation of Inverters.	L2
CO10	PO2	Identify the different performance parameters which accounts for the amount of distortion in inverter output.	L2
CO10	PO3	Design the different types of Inverters for different practical applications.	L4
CO10	PO9	Projects based on inverters can be done for many practical applications.	L4

Note: Write justification for each CO-PO mapping.

5. Curricular Gap and Content

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					

Note: Write Gap topics from A.4 and add others also.

6. Content Beyond Syllabus

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					

Note: Anything not covered above is included here.

C. COURSE ASSESSMENT

1. Course Coverage

Module #	Title	Teaching Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
1	Introduction Power Diodes	12	2	-	-	1	1	2	CO1, CO2	L3, L4
2	Power Transistors	11	2	-	-	1	1	2	CO3, CO4	L3, L4
3	Thyristors	11	-	2	-	1	1	2	CO5, CO6	L3, L4

4	Controlled Rectifiers AC voltage controller	11	-	2	-	1	1	2	CO7, CO8	L3, L4
5	DC-DC Converters DC-AC Converter	11	-	-	4	1	1	2	CO9, CO10	L4, L4
-	**Total**	**61**	**4**	**4**	**4**	**5**	**5**	**10**	**-**	**-**

Note: Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

2. Continuous Internal Assessment (CIA)

Evaluation	Weightage in Marks	CO	Levels
CIA Exam – 1	30	CO1, CO2, CO3, CO4	L3, L4, L3, L4
CIA Exam – 2	30	CO5, CO6, CO7, CO8	L3, L4, L3, L4
CIA Exam – 3	30	CO9, CO10	L4, L4
Assignment - 1	05	CO1, CO2, CO3, CO4	L3, L4, L3, L4
Assignment - 2	05	CO5, CO6, CO7, CO8	L3, L4, L3, L4
Assignment - 3	05	CO9, CO10	L4, L4
Other Activities – define – Slip test		CO1 to Co9	L2, L3, L4 . ..
Final CIA Marks	**40**	**-**	**-**

Note : Blooms Level in last column shall match with A.2 above.

D1. TEACHING PLAN - 1

Module - 1

Title:	Divide and Conquer	Appr Time:	16 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Acquire the knowledge about fundamental concept and applications used in power electronic converters.	CO1	L3
2	Analyze the power diodes characteristics, types and their operation and the effect of power diode on RL circuit.	CO2	L4
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
1	Introduction: Applications of Power Electronics,	Co1	L3
2	Types of Power Electronic Circuits,	Co1	L2
3	Peripheral Effects	Co1	L3
4	Characteristics and Specifications of Switch.	Co1	L3
5	Power Diodes: Introduction, Diode Characteristics	Co2	L3
6	Reverse Recovery Characteristics, Power Diode Types, Silicon Carbide Diodes	Co2	L3
7	Silicon Carbide Schottky Diodes, Diode Switched RL Load	Co2	L4
8	Freewheeling Diodes with Switched RL Load.	Co2	L4
9	Diode Rectifiers: Introduction	Co2	L3
10	Single-Phase Full-Wave Rectifiers	Co2	L4
11	Single-Phase Full-Wave Rectifier with RL Load,	Co2	L4
12	Single-Phase Full-Wave Rectifier with a Highly Inductive Load	Co2	L4
c	**Application Areas**	**CO**	**Level**
1	Power diodes are used as isolating signals from supply.	CO2	L4

2	Power diodes can used as voltage reference, mixing and detection of signals	CO2	L4
	Diode rectifiers can be used in controlling the size of the signal, used in lazer diodes.	CO2	L4
d	**Review Questions**	-	-
1	What are the advantages of static power converters?	CO1	L3
2	What are the peripheral effects of power electronics system?	CO2	L4
3	Explain the 2 modes of operation of freewheeling diode.	CO2	L4
4	Mention and explain the different types of power electronics converter system and also specify the form of input & output with waveform.	CO1	L3
5	What is a switch. What are the characteristics of an ideal switch.	CO2	L4
6	Explain the diode characteristics with different regions of operation.	CO2	L4
7	What are the difference between pn junction diode & schottky diode. With the help of neat diagram explain the reverse recovery characteristics of a diode.	CO2	L4
8	With the help of circuit diagram, explain the working of diode with RC and RL load.	CO2	L4
9	A diode circuit is shown in figure with R=44Ω and C=0.1μF. The capacitor has an initial voltage, Vco=Vc(t=0)=220V. If switch S1 is closed at t=0, determine (a) the peak diode current (b) the energy dissipated in the resistor R and (c) the capacitor voltage at t=2μs.	CO2	L4
11	Give the symbol and characteristic features of the following devices (I) SCR (II) IGBT (iii) TRIAC (iv) SIT	CO1	L4
e	**Experiences**	-	-
1		CO1	L2
2			

Module – 2

Title:	Divide and Conquer	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Understand the types, steady state, switching characteristics and their limitation of power transistors.	CO3	L3
2	Design of gate and base drive circuit for turn-on and turn-off of power devices.	CO4	L4
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
13	Power Transistors: Introduction	CO3	L3
14	Power MOSFETs – Steady State Characteristics, Switching Characteristics Bipolar Junction	CO3	L3
15	Transistors – Steady State Characteristics	CO3	L3
16	Switching Characteristics	CO3	L3
17	Switching Limits, IGBTs, MOSFET	CO3	L3
18	Problems	CO3	L3
19	Gate Drive	CO4	L4
20	BJT Base Drive	CO4	L4
21	Isolation of Gate and Base Drives,	CO4	L4
22	Pulse transformers and Opto-couplers.	CO4	L4
23	Problems	CO4	L3
c	**Application Areas**	**CO**	**Level**
1	Transistors are used in audio amplifiers, sound reproduction, radio	CO3	L3

	transmission		
2	BJT's are used in analog switches	CO3	L3
3	Transistors are used in low power logic gates, DC motor drives, AC motor drives	CO4	L4
4	Transistors are used in isolation circuit such as opto-couplers and pulse transformers.	CO4	L4
d	**Review Questions**	-	-
12	Explain how anti saturation base control improves the switching performance of a BJT.	CO3	L3
13	With the help of switching waveforms explain the switching times of a power MOSFET.	CO4	L4
14	Give the construction, static characteristic, and applications of IGBT.	CO3	L2
15	Write the circuit diagrams and discuss the methods of providing isolation of gate / base circuits from power circuits.	CO4	L4
16	Give the applications of BJT?	CO4	L4
17	Differentiate between MOSFET and IGBT.	CO3	L5
18	Why are IGBT becoming popular in their application to controlled converters?	CO3	L2
19	With the help of neat diagram explain the operation of BJT.	CO3	L3
20	Explain the switching characteristics of MOSFET	CO3	L3
21	Explain the driver circuit and protection circuits for MOSFET.	CO4	L4
22	For the switching circuit shown below, calculate forced β of the transistor. Also calculate the ODF if the manufacturer specified β is 10. Calculate the power loss PT of the transistor. VCC = 100 V ; VB = 5 V ; RB =0.8 Ω ; RC =12 Ω ; VCE (Sat) = 1.0 V ; VBE (Sat) = 1.0 V	CO3	L3
23	What is the need for isolation of gate drive circuits?	CO4	L4
24	Explain the terms over drive factor (ODF) and forced beta (β) for a power transistor in switching application.	CO3	L3
25	Name and explain various switching limits in case of power BJTs. With a circuit diagram, explain anti saturation control of BJT. Mention the improvement and drawback of this arrangement.	CO4	L4
26	Explain different methods of providing gate and base drive isolation.	CO4	L4
e	**Experiences**	-	-
1		CO1	L2
2			

E1. CIA EXAM – 1

a. Model Question Paper - 1

Crs Code:	17EE53	Sem:5	I	Marks:	30	Time:	75 minutes
Course:	Power Electronics						

-	-	**Note: Answer any 3 questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	What are the advantages of static power converters?	20	CO1	L1
	b	What are the peripheral effects of power electronics system?		CO1	L2
	c	Explain the 2 modes of operation of freewheeling diode.		CO2	L3
	d	Explain how anti saturation base control improves the switching performance of a BJT.		CO1	L1
2	a	With the help of switching waveforms explain the switching times of a power MOSFET.	20	CO1	L2
	b	Explain the diode characteristics with different regions of operation.		CO1	L4
	c	Write the circuit diagrams and discuss the methods of providing isolation of gate / base circuits from power circuits.		CO1	L3

	d	Give the applications of BJT?		CO1	L2
3	a	Give the construction, static characteristic, and applications of IGBT.	20	CO3	L1
	b	A diode circuit is shown in figure with R=44Ω and C=0.1μF. The capacitor has an initial voltage, Vco=Vc(t=0)=220V. If switch S1 is closed at t=0, determine (a) the peak diode current (b) the energy dissipated in the resistor R and (c) the capacitor voltage at t=2μs.		CO4	L2
	c	Give the symbol and characteristic features of the following devices (I) SCR (II) IGBT (iii) TRIAC (iv) SIT		CO1	L1
4	a	For the switching circuit shown below, calculate forced β of the transistor. Also calculate the ODF if the manufacturer specified β is 10. Calculate the power loss PT of the transistor. VCC = 100 V ; VB = 5 V ; RB =0.8 Ω ; RC =12 Ω ; VCE (Sat) = 1.0 V ; VBE (Sat) = 1.0 V	20	CO1	L2
	b	What is the need for isolation of gate drive circuits?		CO1	L2
	c	Explain the terms over drive factor (ODF) and forced beta (β) for a power transistor in switching application.		CO1	L1

b. Assignment -1

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	17EE53	Sem:	5	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	Power Electronics						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT16EE001 1KT16EE410	What are the advantages of static power converters?	5	CO1	L3
2	1KT16EE003 1KT16EE404	What are the peripheral effects of power electronics system?	5	CO2	L4
3	1KT16EE004 1KT16EE402	Explain the 2 modes of operation of freewheeling diode.	5	CO2	L4
4	1KT16EE006 1KT15EE017	Mention and explain the different types of power electronics converter system and also specify the form of input & output with waveform.	5	CO1	L3
5	1KT16EE007 1KT15EE015	What is a switch. What are the characteristics of an ideal switch.	5	CO2	L4
6	1KT16EE011 1KT15EE013	Explain the diode characteristics with different regions of operation.	5	CO2	L4
7	1KT16EE013 1KT15EE011	What are the difference between pn junction diode & schottky diode. With the help of neat diagram explain the reverse recovery characteristics of a diode.	5	CO2	L4
8	1KT16EE014 1KT14EE034	With the help of circuit diagram, explain the working of diode with RC and RL load.	5	CO2	L4
9	1KT16EE016 1KT14EE030	A diode circuit is shown in figure with R=44Ω and C=0.1μF. The capacitor has an initial voltage, Vco=Vc(t=0)=220V. If switch S1 is closed at t=0, determine (a) the peak diode current (b) the energy dissipated in the resistor R and (c) the capacitor voltage at t=2μs.	5	CO2	L4
10	1KT16EE017 1KT16EE019	Give the symbol and characteristic features of the following devices (I) SCR (II) IGBT (iii) TRIAC (iv) SIT	5	CO1	L4
11	1KT16EE020 1KT16EE005	Explain how anti saturation base control improves the switching performance of a BJT.	5	CO3	L3
12	1KT16EE021 1KT16EE026	With the help of switching waveforms explain the switching times of a power MOSFET.	5	CO4	L4
13	1KT16EE023 1KT16EE025	Give the construction, static characteristic, and applications of IGBT.	5	CO3	L2
14	1KT16EE025 1KT16EE023	Write the circuit diagrams and discuss the methods of providing isolation of gate / base circuits from power circuits.	5	CO4	L4

15	1KT16EE026 1KT16EE021	Give the applications of BJT?	5	CO4	L4
16	1KT16EE005 1KT16EE020	Differentiate between MOSFET and IGBT.	5	CO3	L5
17	1KT16EE019 1KT16EE017	Why are IGBT becoming popular in their application to controlled converters?	5	CO3	L2
18	1KT14EE030 1KT16EE016	With the help of neat diagram explain the operation of BJT.	5	CO3	L3
19	1KT14EE034 1KT16EE014	Explain the switching characteristics of MOSFET	5	CO3	L3
20	1KT15EE011 1KT16EE013	Explain the driver circuit and protection circuits for MOSFET.	5	CO4	L4
21	1KT15EE013 1KT16EE011	For the switching circuit shown below, calculate forced β of the transistor. Also calculate the ODF if the manufacturer specified β is 10. Calculate the power loss PT of the transistor. VCC = 100 V ; VB = 5 V ; RB =0.8 Ω ; RC =12 Ω ; VCE (Sat) = 1.0 V ; VBE (Sat) = 1.0 V	5	CO3	L3
22	1KT15EE015 1KT16EE007	What is the need for isolation of gate drive circuits?	5	CO4	L4
23	1KT15EE017 1KT16EE006	Explain the terms over drive factor (ODF) and forced beta (β) for a power transistor in switching application.	5	CO3	L3
24	1KT16EE402 1KT16EE004	Name and explain various switching limits in case of power BJTs. With a circuit diagram, explain anti saturation control of BJT. Mention the improvement and drawback of this arrangement.	5	CO4	L4
25	1KT16EE404 1KT16EE003	Explain different methods of providing gate and base drive isolation.	5	CO4	L4
26	1KT16EE410 1KT16EE001	Differentiate between BJT and MOSFET.	5	CO3	L3

D2. TEACHING PLAN - 2

Module – 3

Title:	Divide and Conquer	Appr Time:	16 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Describe the types of thyristors, characteristics and their limitations.	CO5	L3
2	Analyze the gate control requirement to produce firing pulses and to trigger the thyristor.	CO6	L4
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Thyristors: Introduction	CO5	L3
2	Thyristor Characteristics,	CO5	L3
3	Two-Transistor Model of Thyristor	CO5	L3
4	Thyristor Turn-On	CO5	L3
5	Thyristor Turn-Off	CO5	L3
6	A brief study on Thyristor Types	CO6	L4
7	Series Operation of Thyristors	CO6	L4
8	Parallel Operation of Thyristors	CO6	L4
9	di/dt Protection, dv/dt Protection, DIACs	CO6	L4
10	Thyristor Firing Circuits- R firing circuit, RC firing circuit, digital firing circuit	CO6	L4
11	Unijunction Transistor.	CO6	L4
c	**Application Areas**	**CO**	**Level**
1	Thyristors are used in Industrial application such as induction heating, dielectric heating and lamp dimming.	CO6	L4

2	Thyristors are used iin static AC /DC circuit breakers, tap changers	CO6	L4
	TRIAC's are used in AC switches, starter circuit for lamps.	CO5	L3
d	**Review Questions**	-	-
1	Compare the features of BJT, MOSFET and SCR for use in power electronic circuits. Give the applications where these devices are preferred over others.	CO5	L3
2	Draw the I-V characteristics of SCR. Label the various voltages, current and the operating modes on this sketch?	CO5	L2
3	Enumerate the various methods by which thyristors be triggered into conduction?	CO5	L3
4	Define Latching and holding currents as applicable to an SCR? Show these currents on its state IV characteristics?	CO5	L2
5	Explain the switching characteristics of a Thyristor during turn on and turn off process?	CO5	L2
6	Discuss the two transistor model of a Thyristor? Derive an expression for the anode current and discuss there from the turn-on mechanisms of a thyristor?	CO5	L3
7	Explain how thyristors can be protected against dv/dt and di/dt ? what are the considerations for choosing circuit elements for protection?	CO6	L4
8	Using two transistor model, explain the switching action of a thyristor and significance of gate control. Also derive the expression for anode current.	CO6	L4
9	Distinguish between: 1.) Latching current and Holding current, 2) Converter grade thyristor and inverter grade thyristor, 3) thyristor turn-off time and circuit turn-off time.	CO5	L3
10	The thyristor shown in the circuit below has a latching current of 20 mA and is fired by a gate pulse of 50 µs. Show that without the resistor R, the thyristor will fail to remain ON. Also find the maximum value of R to ensure firing.	CO5	L3
11	With relevant diagram and waveforms, explain UJT relaxation oscillator.	CO6	L4
12	Explain the following terms in brief with respect to SCR: i) Holding current; ii) Latching current; iii) di/dt rating; iv) dv/dt rating; v) PIV	CO5	L2
13	With neat sketches, explain turn-on and turn-off characteristics of SCR.	CO6	L3
14	Explain in detail the following ratings of SCR - i) Average on state current ii) RMS on state current iii) I2t rating iv) Peak working reverse voltage v) Repetitive peak	CO6	L1
15	Design a UJT relaxation oscillator for triggering a SCR. The UJT has the following specifications: η= 0.7, Ip = 50 µA, Vv = 2 V, Iv = 6mA, VBB = 20 V, RBB = 7 kΩ and IEC = 2 mA. Also determine the limits for the output frequency of the oscillator	CO6	L3
e	**Experiences**	-	-
1		CO1	L2
2			

Module – 4

Title:	Divide and Conquer	Appr Time:	16 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Understand the principle of operation and designing of single phase and three phase controlled rectifier by producing firing pulses.	CO7	L3
2	Design and analyze the AC voltage controller	CO8	L4
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Controlled Rectifiers: Introduction	CO7	L3
2	Single-Phase Full Converters	CO7	L3

3	Single-Phase Dual Converters	CO7	L3
4	Three- Phase Full Converters	CO7	L3
5	Three-Phase Dual Converters	CO7	L3
6	Problems on coverters	CO7	L3
7	AC Voltage Controllers: Introduction	CO8	L4
8	Single-Phase Full-Wave Controllers with Resistive Loads	CO8	L4
9	Single-Phase Full-Wave Controllers with Inductive Loads	CO8	L4
10	Three-Phase Full-Wave Controllers	CO8	L4
11	Problems	CO8	L4
c	**Application Areas**	**CO**	**Level**
1	Control rectifiers are used in speed control of DC motor, Universal motors, lamp dimming.	CO7	L3
2	AC voltage controllers are used in power generation, power transmission, electric heating, induction heating, cyclo converters, matrix converters, Electric welding.	CO8	L4
3	Control rectifiers are used in speed control of DC motor, Universal motors, lamp dimming.	CO7	L3
d	**Review Questions**	-	-
1	For a single phase controlled rectifier with RL load, derive the expression for average and r.m.s values of output voltage with and without freewheeling diode. Also draw the waveforms of the output voltages in both the cases.	CO7	L3
2	What is the use of freewheeling diode in a converter circuit.	CO7	L3
3	Compare circulating and non circulating current modes dual converter.	CO7	L3
4	Write the effect of source impedance on performance of converters. Explain the operation of single-phase Fully-controlled bridge converter taking source impedance into account. Derive the expression for V& in terms of overlap angle and source inductance. Draw voltage and current waveforms.	CO7	L3
5	With the help of a neat diagram and associated wave forms, explain the operation of a single phase semi converter with RL load.	CO7	L3
6	A single phase full converter has a RL load having L = 6.5 mH, R = 0.5 Ω and E = 10 V. The input voltage is V = 120 sin 120 π t. Determine – (i) the load current IL at wt = α = 600 (ii) the average thyristor current IA (iii) the r.m.s thyristor current IR (iv) the rms output current IRMS and (v) the average output current IDC.	CO7	L3
7	Discuss Single phase Full wave Mid point converter.	CO7	L3
8	Discuss Single Phase Half wave current with RLE load.	CO7	L3
9	Discuss Single Phase Full wave full Bridge converters.	CO7	L3
10	Discuss Single Phase two pulse converter with Discontinuous load current.	CO7	L3
11	Discuss Single Phase symmetrical and Asymmetrical Semi-converters with the waveforms.	CO7	L3
12	With a circuit diagram and waveforms of gating pulses and output voltage, explain the operation of single phase ON-OFF type ac voltage controller. Derive an expression for V O (RMS) .	CO8	L4
13	Derive an expression for the r.m.s. value of the output voltage of a bi-directional AC voltagecontroller employing ON-OFF control.	CO8	L4
14	Explain the operation of a single phase control type voltage controller with RL load. Give an example to show that if firing angle is less than the load angle, output voltage of AC voltage controller can not be regulated.	CO8	L4
15	A single phase full wave voltage controller has an input voltage of 230 V, and aload having R =4Ω and L = 22 mH. The frequency id 50 Hz. Firing angles for both the SCRs is 60 degrees. Find the conduction angle of the thyristors and the r.m.s. output voltage.	CO8	L4
16	Draw the circuit diagram of single phase Ac voltage controller and explain	CO8	L3

	the principle of on –off control		
17	Differentiate between On-Off control and phase control of an ac voltage controller	CO8	L3
18	An AC voltage controller has a resistive load of 10Ω and r.m.s. input voltage of 230 V, 50 Hz.The thyristor switch is ON for 25 cycles and OFF for 75 cycles. Determine the r.m.s. output voltage and the input power factor.	CO8	L4
19	In an ON-OFF control circuit using single phase, 230 V, 50 Hz supply, the ON time is 10 cycles and the OFF time is 4 cycles. Calculate the RMS value of the output voltage	CO8	L4
20	A single phase ac voltage controller has resistive load of R = 10 Ω and the input voltage is Vs =120 V (rms), 60Hz. The delay angles of thyristors are equal α1 = α 2 = π / 3. Determine –(i) the rms output voltage (ii) the input power factor PF (iii) the average current of the thyristors IA (iv) the rms current of the thyristors IR. Also derive the voltage and current expressions.	CO8	L4
e	**Experiences**	-	-
1		CO7	L2
2			

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	17EE53	Sem: 5	II	Marks:	30	Time:	75 minutes

Course: Power Electronics

-	-	**Note: Answer any 2 questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	Draw the I-V characteristics of SCR. Label the various voltages, current and the operating modes on this sketch?	20	CO5	L1
	b	Discuss the two transistor model of a Thyristor? Derive an expression for the anode current and discuss there from the turn-on mechanisms of a thyristor?		CO5	L3
	c	For a single phase controlled rectifier with RL load, derive the expression for average and r.m.s values of output voltage with and without freewheeling diode. Also draw the waveforms of the output voltages in both the cases.		CO	L3
2	a	Discuss Single Phase Half wave current with RLE load	20	CO7	L4
	b	Differentiate between On-Off control and phase control of an ac voltage controller		CO8	L4
	c	The thyristor shown in the circuit below has a latching current of 20 mA and is fired by a gate pulse of 50 µs. Show that without the resistor R, the thyristor will fail to remain ON. Also find the maximum value of R to ensure firing.		CO5	L3
3	a	With relevant diagram and waveforms, explain UJT relaxation oscillator.	20	CO6	L4
	b	An AC voltage controller has a resistive load of 10Ω and r.m.s. input voltage of 230 V, 50 Hz.The thyristor switch is ON for 25 cycles and OFF for 75 cycles. Determine the r.m.s. output voltage and the input power factor.		CO8	L3
	c	Explain how thyristors can be protected against dv/dt and di/dt ? what are the considerations for choosing circuit elements for protection?		CO6	L3
4	a	Derive an expression for the r.m.s. value of the output voltage of a bi-directional AC voltagecontroller employing ON-OFF control.	20	CO8	L3
	b	Explain the operation of a single phase control type voltage controller with RL load. Give an example to show that if firing angle is less than the load angle, output voltage of AC voltage controller can not be regulated.		CO8	L3

	c	Discuss Single Phase Full wave full Bridge converters.		CO7	L4

b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	17EE53	Sem:	5	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	POWER ELECTRONICS						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT16EE001 1KT16EE410	Compare the features of BJT, MOSFET and SCR for use in power electronic circuits. Give the applications where these devices are preferred over others.	5	CO5	L3
2	1KT16EE003 1KT16EE404	Draw the I-V characteristics of SCR. Label the various voltages, current and the operating modes on this sketch?	5	CO5	L2
3	1KT16EE004 1KT16EE402	Enumerate the various methods by which thyristors be triggered into conduction?	5	CO5	L3
4	1KT16EE006	Define Latching and holding currents as applicable to an SCR? Show these currents on its state IV characteristics?	5	CO5	L2
	1KT15EE017				
5	1KT16EE007 1KT15EE015	Explain the switching characteristics of a Thyristor during turn on and turn off process?	5	CO5	L2
6	1KT16EE011 1KT15EE013	Discuss the two transistor model of a Thyristor? Derive an expression for the anode current and discuss there from the turn-on mechanisms of a thyristor?	5	CO5	L3
7	1KT16EE013 1KT15EE011	Explain how thyristors can be protected against dv/dt and di/dt ? what are the considerations for choosing circuit elements for protection?	5	CO6	L4
8	1KT16EE014 1KT14EE034	Using two transistor model, explain the switching action of a thyristor and significance of gate control. Also derive the expression for anode current.	5	CO6	L4
9	1KT16EE016 1KT14EE030	Distinguish between: 1.) Latching current and Holding current, 2) Converter grade thyristor and inverter grade thyristor, 3) thyristor turn-off time and circuit turn-off time.	5	CO5	L3
10	1KT16EE017 1KT16EE019	The thyristor shown in the circuit below has a latching current of 20 mA and is fired by a gate pulse of 50 µs. Show that without the resistor R, the thyristor will fail to remain ON. Also find the maximum value of R to ensure firing.	5	CO5	L3
11	1KT16EE020 1KT16EE005	With relevant diagram and waveforms, explain UJT relaxation oscillator.	5	CO6	L4
12	1KT16EE021 1KT16EE026	Explain the following terms in brief with respect to SCR: i) Holding current; ii) Latching current; iii) di/dt rating; iv) dv/dt rating; v) PIV	5	CO5	L2
13	1KT16EE023 1KT16EE025	With neat sketches, explain turn-on and turn-off characteristics of SCR.	5	CO6	L3
14	1KT16EE025 1KT16EE023	Explain in detail the following ratings of SCR - i) Average on state current ii) RMS on state current iii) I2t rating iv) Peak working reverse voltage v) Repetitive peak	5	CO6	L1
15	1KT16EE026 1KT16EE021	Design a UJT relaxation oscillator for triggering a SCR. The UJT has the following specifications: η= 0.7, Ip = 50 µA, Vv = 2 V, Iv = 6mA, VBB = 20 V, RBB = 7 kΩ and IEC = 2 mA. Also determine the limits for the output frequency of the oscillator	5	CO6	L3
16	1KT16EE005 1KT16EE020	For a single phase controlled rectifier with RL load, derive the expression for average and r.m.s values of output voltage with and without freewheeling diode. Also draw the waveforms of the output voltages in both the cases.	5	CO7	L3
17	1KT16EE019 1KT16EE017	What is the use of freewheeling diode in a converter circuit.	5	CO7	L3
18	1KT14EE030	Compare circulating and non circulating current modes dual	5	CO7	L3

	1KT16EE016	converter.			
19	1KT14EE034 1KT16EE014	Write the effect of source impedance on performance of converters. Explain the operation of single-phase Fully-controlled bridge converter taking source impedance into account. Derive the expression for V& in terms of overlap angle and source inductance. Draw voltage and current waveforms.	5	CO7	L3
20	1KT15EE011 1KT16EE013	With the help of a neat diagram and associated wave forms, explain the operation of a single phase semi converter with RL load.	5	CO7	L3
21	1KT15EE013 1KT16EE011	A single phase full converter has a RL load having L = 6.5 mH, R = 0.5 Ω and E = 10 V. The input voltage is V = 120 sin 120 π t. Determine – (i) the load current IL at wt = α = 600 (ii) the average thyristor current IA (iii) the r.m.s thyristor current IR (iv) the rms output current IRMS and (v) the average output current IDC.	5	CO7	L3
22	1KT15EE015 1KT16EE007	Discuss Single phase Full wave Mid point converter.	5	CO7	L3
23	1KT15EE017 1KT16EE006	Discuss Single Phase Half wave current with RLE load.	5	CO7	L3
24	1KT16EE402 1KT16EE004	Discuss Single Phase Full wave full Bridge converters.	5	CO7	L3
25	1KT16EE404 1KT16EE003	Discuss Single Phase two pulse converter with Discontinuous load current.	5	CO7	L3
26	1KT16EE410 1KT16EE001	Discuss Single Phase symmetrical and Asymmetrical Semi-converters with the waveforms.	5	CO7	L3
27	1KT16EE001 1KT16EE410 1KT15EE013	With a circuit diagram and waveforms of gating pulses and output voltage, explain the operation of single phase ON-OFF type ac voltage controller. Derive an expression for V O (RMS) .	5	CO8	L4
28	1KT16EE003 1KT16EE404 1KT16EE011	Derive an expression for the r.m.s. value of the output voltage of a bi-directional AC voltagecontroller employing ON-OFF control.	5	CO8	L4
29	1KT16EE004 1KT16EE402	Explain the operation of a single phase control type voltage controller with RL load. Give an example to show that if firing angle is less than the load angle, output voltage of AC voltage controller can not be regulated.	5	CO8	L4
30	1KT16EE006	A single phase full wave voltage controller has an input voltage of 230 V, and aload having R =4Ω and L = 22 mH. The frequency id 50 Hz. Firing angles for both the SCRs is 60 degrees. Find the conduction angle of the thyristors and the r.m.s. output voltage.	5	CO8	L4
31	1KT16EE007 1KT15EE015	For a single phase controlled rectifier with RL load, derive the expression for average and r.m.s values of output voltage with and without freewheeling diode. Also draw the waveforms of the output voltages in both the cases.	5	CO8	L3
32	1KT16EE011 1KT15EE013	What is the use of freewheeling diode in a converter circuit.	5	CO8	L3
33	1KT16EE013 1KT15EE011	Compare circulating and non circulating current modes dual converter.	5	CO8	L4
34	1KT16EE014 1KT14EE034	Write the effect of source impedance on performance of converters. Explain the operation of single-phase Fully-controlled bridge converter taking source impedance into account. Derive the expression for V& in terms of overlap angle and source inductance. Draw voltage and current waveforms.	5	CO8	L4
35	1KT16EE016 1KT14EE030	With the help of a neat diagram and associated wave forms, explain the operation of a single phase semi converter with RL load.	5	CO8	L4
36	1KT16EE017 1KT16EE019	A single phase full converter has a RL load having L = 6.5 mH, R = 0.5 Ω and E = 10 V. The input voltage is V = 120 sin 120 π t.	5	CO7	L3

		Determine – (i) the load current IL at wt = α = 600 (ii) the average thyristor current IA (iii) the r.m.s thyristor current IR (iv) the rms output current IRMS and (v) the average output current IDC.			
37	1KT16EE020 1KT16EE005	What is the use of freewheeling diode in a converter circuit.	5	CO7	L3
38	1KT16EE021 1KT16EE026	Compare circulating and non circulating current modes dual converter.	5	CO7	L3
39	1KT16EE023 1KT16EE025	Write the effect of source impedance on performance of converters. Explain the operation of single-phase Fully-controlled bridge converter taking source impedance into account. Derive the expression for V& in terms of overlap angle and source inductance. Draw voltage and current waveforms.	5	CO7	L3
40	1KT16EE025 1KT16EE023	With the help of a neat diagram and associated wave forms, explain the operation of a single phase semi converter with RL load.	5	CO7	L3
41	1KT16EE026 1KT16EE021	A single phase full converter has a RL load having L = 6.5 mH, R = 0.5 Ω and E = 10 V. The input voltage is V = 120 sin 120 π t. Determine – (i) the load current IL at wt = α = 600 (ii) the average thyristor current IA (iii) the r.m.s thyristor current IR (iv) the rms output current IRMS and (v) the average output current IDC.	5	CO7	L3
42	1KT16EE005 1KT16EE020	Draw the circuit diagram of single phase Ac voltage controller and explain the principle of on –off control	5	CO7	L3
43	1KT16EE019 1KT16EE017	Differentiate between On-Off control and phase control of an ac voltage controller	5	CO7	L3
44	1KT14EE030 1KT16EE016	An AC voltage controller has a resistive load of 10Ω and r.m.s. input voltage of 230 V, 50 Hz.The thyristor switch is ON for 25 cycles and OFF for 75 cycles. Determine the r.m.s. output voltage and the input power factor.	5	CO7	L3
45	1KT14EE034 1KT16EE014	In an ON-OFF control circuit using single phase, 230 V, 50 Hz supply, the ON time is 10 cycles and the OFF time is 4 cycles. Calculate the RMS value of the output voltage	5	CO7	L3
46	1KT15EE011 1KT16EE013	A single phase ac voltage controller has resistive load of R = 10 Ω and the input voltage is Vs =120 V (rms), 60Hz. The delay angles of thyristors are equal α1 = α 2 = π / 3. Determine –(i) the rms output voltage (ii) the input power factor PF (iii) the average current of the thyristors IA (iv) the rms current of the thyristors IR. Also derive the voltage and current expressions.	5	CO7	L3

D3. TEACHING PLAN - 3

Module – 5

Title:	Divide and Conquer	Appr Time:	16 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Understand the principle of operation of step up and step down chopper by varying the duty cycle.	CO9	L4
2	Design and analyse the single phase and three phase DC-AC converters	CO10	L4
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	DC-DC Converters: Introduction	CO9	
2	principle of step down and step up chopper with RL load	CO9	L4
3	performance parameters	CO9	L3
4	DC-DC converter classification	CO9	L4
5	Problems	CO9	L3

6	DC-AC converters: Introduction	CO9	L3
7	principle of operation single phase bridge inverters	CO10	L3
8	three phase bridge inverters,	CO10	L3
9	voltage control of single phase inverters	CO10	L4
10	Harmonic reductions	CO10	L4
11	Current source inverters, Problems	CO10	L4
c	**Application Areas**	**CO**	**Level**
1	Choppers are used in railway traction, battery charges, switched capacitance filters, variable frequency drives, class D electronic amplifiers, battery operated electric cars.	CO9	L4
2	Inverters are used in HVDC power transmission at the receiving end, Uninterrupted power supply, Air conditioning, refrigeration, synchronverters, electroshock weapons	CO10	L4
d	**Review Questions**	-	-
1	Define the term duty cycle of dc choppers.	CO9	L1
2	Differentiate between constant frequency and variable frequency control strategies of varying duty cycle of dc choppers.	CO9	L3
3	Distinguish step down and step up converters.	CO9	L3
4	Give the applications of choppers	CO9	L3
5	Explain the buck-boost converter.	CO9	L2
6	Discuss the principle of operation of DC step down chopper with suitable waveforms. Derive the expression for its average dc voltage.	CO9	L2
7	A step down dc chopper has input voltage of 230V with 10 ohm load, voltage drop across chopper is 2V, when it is on. For a duty cycle of 0.5, Calculate (i) average and rms values ofoutput voltage and (ii) power delivered to the load.	CO9	L3
8	Explain the two quadrant dc chopper operation with RLE load with suitable waveforms.	CO9	L3
9	Explain time ratio control and current limit control strategies.	CO9	L2
10	Explain the resonant switching based SMPS.	CO9	L3
11	Explain any one type of switched mode regulator and derive the expression for it	CO9	L3
12	Explain the working of class E chopper.	CO9	L3
13	Derive the expression for the output voltage of step up chopper.	CO9	L3
14	Explain how the choppers are classified with reference to load voltage and load current.	CO9	L3
15	A dc chopper has a resistive load of 20 ohms and an input voltage of 220 V. When the chopper is On, its voltage drop is 1.5 V and chopping frequency is 10 KHz. If the duty cycle is 80 %, determine the average and RMS values of the output voltage.	CO9	L3
16	A step up DC chopper has an input of 200 volts and an output of 250 volts. The blocking period in each cycle of operation is 0.6 x 10 -3 seconds. Find the period of conduction in each cycle. Derive the equation for average output.	CO9	L3
17	Differentiate between half bridge and full bridge inverter.	CO10	L3
18	What are the performance parameters of inverters? What are the arrangements for obtaining 3 phase output voltage connected with inverter.	CO10	L4
19	What are the reasons for adding a filter on the inverter output?	CO10	L3
20	What is current source inverter?	CO10	L4
21	Differentiate between VSI and CSI.	CO10	L3
22	List different methods of controlling output voltage of inverters	CO10	L4
23	What is the purpose of connecting diode in antiparallel with thyristors in inverters?	CO10	L4
24	With necessary waveforms, explain the operation of a single phase half bridge inverter.	CO10	L4
25	Draw the circuit diagram of a three phase bridge inverter with Y connected	CO10	L4

	resistive load. Sketch the gating signals and line to line output voltages for 180˚ conduction operation.		
26	A full wave bridge inverter has an input voltage of 200 V. The load is a series RLC circuit with R = 10 ohms, L = 20 mH and C = 100 μF. The inverter frequency is 50 Hz. (I) Express the instantaneous load current as Fourier series. Consider up to 9 th harmonic only. (ii) Find the RMS value of the fundamental component of load current, and (iii) Total harmonic distortion of the load current.	CO10	L3
27	A single phase full bridge inverter has a resistive load of 2.4 ohms and the DC input voltage of V. Determine the RMS output voltage at the fundamental frequency and the output power	CO10	L3
28	Derive an expression for rms value of output voltage for half bridge inverter having square wave output. Assume the peak value of the output as V / 2.	CO10	L4
e	**Experiences**	-	-
1		CO10	L2
2			

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	17EE53	Sem:	5	Marks:	30	Time:	75 minutes
Course:	Power Electronics						

-	-	**Note: Answer any 2 questions, each carry equal marks.**	**Marks**	**CO**	**Level**
1	a	Discuss the principle of operation of DC step down chopper with suitable waveforms. Derive the expression for its average dc voltage.	20	CO9	L2
	b	A step down dc chopper has input voltage of 230V with 10 ohm load, voltage drop across chopper is 2V, when it is on. For a duty cycle of 0.5, Calculate (i) average and rms values ofoutput voltage and (ii) power delivered to the load.		CO9	L3
	c	What is current source inverter?		CO10	L1
				CO9	
2	a	Explain the two quadrant dc chopper operation with RLE load with suitable waveforms.	20	CO9	L4
	b	Differentiate between half bridge and full bridge inverter.		CO10	L3
	c	What are the performance parameters of inverters? What are the arrangements for obtaining 3 phase output voltage connected with inverter.		CO10	L4
3	a	Explain how the choppers are classified with reference to load voltage and load current.	20	CO9	L3
	b	With necessary waveforms, explain the operation of a single phase half bridge inverter.		CO10	L3
	c	Draw the circuit diagram of a three phase bridge inverter with Y connected resistive load. Sketch the gating signals and line to line output voltages for 180˚ conduction operation.		CO10	L4
4	a	Define the term duty cycle of dc choppers.	20	CO9	L1
	b	Differentiate between constant frequency and variable frequency control strategies of varying duty cycle of dc choppers.		CO9	L3
	c	Differentiate between VSI and CSI.		CO10	L3

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	CS501PC	Sem:	5	Marks:	5 / 10	Time:	90 – 120 minutes

Course:	Power Electronics		

Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT16EE001 1KT16EE410	Differentiate between VSI and CSI.	5	CO10	L3
2	1KT16EE003 1KT16EE404	List different methods of controlling output voltage of inverters	5	CO10	L4
3	1KT16EE004 1KT16EE402	What is the purpose of connecting diode in antiparallel with thyristors in inverters?	5	CO10	L4
4	1KT16EE006	With necessary waveforms, explain the operation of a single phase half bridge inverter.	5	CO10	L4
5	1KT16EE007 1KT15EE015	Draw the circuit diagram of a three phase bridge inverter with Y connected resistive load. Sketch the gating signals and line to line output voltages for 180˚ conduction operation.	5	CO10	L4
6	1KT16EE011 1KT15EE013	A full wave bridge inverter has an input voltage of 200 V. The load is a series RLC circuit with R = 10 ohms, L = 20 mH and C = 100 μF. The inverter frequency is 50 Hz. (I) Express the instantaneous load current as Fourier series. Consider up to 9 th harmonic only. (ii) Find the RMS value of the fundamental component of load current, and (iii) Total harmonic distortion of the load current.	5	CO10	L3
7	1KT16EE013 1KT15EE011	A single phase full bridge inverter has a resistive load of 2.4 ohms and the DC input voltage of V. Determine the RMS output voltage at the fundamental frequency and the output power	5	CO10	L3
8	1KT16EE014 1KT14EE034	Derive an expression for rms value of output voltage for half bridge inverter having square wave output. Assume the peak value of the output as V / 2.	5	CO10	L4
9	1KT16EE016 1KT14EE030	Differentiate between VSI and CSI.	5	CO10	L3
10	1KT16EE017 1KT16EE019	List different methods of controlling output voltage of inverters	5	CO10	L4
11	1KT16EE020 1KT16EE005	What is the purpose of connecting diode in antiparallel with thyristors in inverters?	5	CO10	L4
12	1KT16EE021 1KT16EE026	With necessary waveforms, explain the operation of a single phase half bridge inverter.	5	CO10	L4
13	1KT16EE023 1KT16EE025	Draw the circuit diagram of a three phase bridge inverter with Y connected resistive load. Sketch the gating signals and line to line output voltages for 180˚ conduction operation.	5	CO10	L4
14	1KT16EE025 1KT16EE023	A full wave bridge inverter has an input voltage of 200 V. The load is a series RLC circuit with R = 10 ohms, L = 20 mH and C = 100 μF. The inverter frequency is 50 Hz. (I) Express the instantaneous load current as Fourier series. Consider up to 9 th harmonic only. (ii) Find the RMS value of the fundamental component of load current, and (iii) Total harmonic distortion of the load current.	5	CO10	L3
15	1KT16EE026 1KT16EE021	A single phase full bridge inverter has a resistive load of 2.4 ohms and the DC input voltage of V. Determine the RMS output voltage at the fundamental frequency and the output power	5	CO10	L3
16	1KT16EE005 1KT16EE020	Derive an expression for rms value of output voltage for half bridge inverter having square wave output. Assume the peak value of the output as V / 2.	5	CO10	L4
17	1KT16EE019 1KT16EE017	Differentiate between VSI and CSI.	5	CO10	L3
18	1KT14EE030	Explain any one type of switched mode regulator and derive	5	CO9	L3

	1KT16EE016	the expression for it			
19	1KT14EE034 1KT16EE014	Explain the working of class E chopper.	5	CO9	L3
20	1KT15EE011 1KT16EE013	Derive the expression for the output voltage of step up chopper.	5	CO9	L3
21	1KT15EE013 1KT16EE011	Explain how the choppers are classified with reference to load voltage and load current.	5	CO9	L3
22	1KT15EE015 1KT16EE007	A dc chopper has a resistive load of 20 ohms and an input voltage of 220 V. When the chopper is On, its voltage drop is 1.5 V and chopping frequency is 10 KHz. If the duty cycle is 80 %, determine the average and RMS values of the output voltage.	5	CO9	L3
23	1KT15EE017 1KT16EE006	A step up DC chopper has an input of 200 volts and an output of 250 volts. The blocking period in each cycle of operation is 0.6 x 10 -3 seconds. Find the period of conduction in each cycle. Derive the equation for average output.	5	CO9	L3
24	1KT16EE402 1KT16EE004	Differentiate between half bridge and full bridge inverter.	5	CO10	L3
25	1KT16EE404 1KT16EE003	What are the performance parameters of inverters? What are the arrangements for obtaining 3 phase output voltage connected with inverter.	5	CO10	L4
26	1KT16EE410 1KT16EE001	What are the reasons for adding a filter on the inverter output?	5	CO10	L3
27	1KT16EE001 1KT16EE410	What is current source inverter?	5	CO10	L4
28	1KT16EE003 1KT16EE404	Explain any one type of switched mode regulator and derive the expression for it	5	CO9	L3
29	1KT16EE004 1KT16EE402	Define the term duty cycle of dc choppers.	5	CO9	L1
30	1KT16EE006 1KT15EE017	Differentiate between constant frequency and variable frequency control strategies of varying duty cycle of dc choppers.	5	CO9	L3
31	1KT16EE007 1KT15EE015	Distinguish step down and step up converters.	5	CO9	L3
32	1KT16EE011 1KT15EE013	Give the applications of choppers	5	CO9	L3
33	1KT16EE013 1KT15EE011	Explain the buck-boost converter.	5	CO9	L2
34	1KT16EE014 1KT14EE034	Discuss the principle of operation of DC step down chopper with suitable waveforms. Derive the expression for its average dc voltage.	5	CO9	L2
35	1KT16EE016 1KT14EE030	A step down dc chopper has input voltage of 230V with 10 ohm load, voltage drop across chopper is 2V, when it is on. For a duty cycle of 0.5, Calculate (i) average and rms values ofoutput voltage and (ii) power delivered to the load.	5	CO9	L3
36	1KT16EE017 1KT16EE019	Explain the two quadrant dc chopper operation with RLE load with suitable waveforms.	5	CO9	L3
37	1KT16EE020 1KT16EE005	Explain time ratio control and current limit control strategies.	5	CO9	L2
38	1KT16EE021 1KT16EE026	Explain the resonant switching based SMPS.	5	CO9	L3
39	1KT16EE023 1KT16EE025	Define the term duty cycle of dc choppers.	5	CO9	L1

F. EXAM PREPARATION

1. University Model Question Paper

Course:	Power Electronics					Month / Year	May /2018
Crs Code:	17EE53	Sem:	5	Marks:		Time:80	180 minutes

17EE53

-	**Note**	Answer all FIVE full questions. All questions carry equal marks.	**Marks**	**CO**	**Level**
1	a	What is power electronics? Mention its industrial applications.	16 / 20	CO1	L2
	b	Explain the function of a freewheeling diode n a switched RL load circuit. Draw the circuit diagram and waveforms.			L4
	c	What are the advantages of static power converters?		CO2	L2
	d	What are the peripheral effects of power electronics system?			L4
		OR			
-	a	Explain in brief, the different types of power electronic converter circuits and also specify the form of input and output with waveforms	16 / 20	CO1	L4
	b	If a single phase full wave rectifier with center tapped transformer has a purely resistive load of R, determine (a) the efficiency, (b) the RF, (c) the TUF and (d) the input power factor PF.		CO2	L3
	c	If a single phase full wave rectifier with center tapped transformer has a purely resistive load of R, determine (a) the efficiency, (b) the RF, (c) the TUF and (d) the input power factor PF			L3
2	a	Draw the circuit diagram for an IGBT and explain its typical output characteristics.	16 / 20	CO3	L2
	b	The bipolar transistor is specified to have βF in the range of 8 to 40. The load resistance is RC= 15 Ω. The dc supply voltage is VCC= 150 V and the input voltage to the base circuit isVB= 8 V. If VCE (sat) =1.0 V, VBE(sat)=1.5 V and RB= 1.047 Ω, determine (a)the ODF, (b)the forced β and (c)the power loss in the transistor PT			L3
	c	What is the need for isolation of gate drive circuits?		CO4	L3
		OR			
-	a	With the help of waveforms, explain the switching characteristics of a BJT.	16 / 20	CO3	L2
	b	Explain the terms over drive factor (ODF) and forced beta (β) for a power transistor in switching application.		CO4	L2
	c	Differentiate between MOSFET and IGBT.			L3
3	a	Discuss the two transistor model of a Thyristor? Derive an expression for the anode current and discuss there from the turn-on mechanisms of a thyristor?	16 / 20	CO5	L3
	b	Explain how thyristors can be protected against dv/dt and di/dt ? what are the considerations for choosing circuit elements for protection?			L4
	c	Design a UJT relaxation oscillator for triggering a SCR. The UJT has the following specifications: η= 0.7, Ip = 50 μA, Vv = 2 V, Iv = 6mA, VBB = 20 V, RBB = 7 kΩ and IEC = 2 mA. Also determine the limits for the output frequency of the oscillator		CO6	L3
		OR			
-	a	Draw the I-V characteristics of SCR. Label the various voltages, current and the operating modes on this sketch?	16 / 20	CO5	L4
	b	Briefly explain the following:(i) LASCR (ii) GTO (iii) TRIAC			L2
	c	Explain with a neat diagram UJT triggering circuit		CO6	L2
4	a	With the help of suitable diagrams, explain the working of a single phase dual converter	16 / 20	CO7	L2
	b	Draw the circuit diagram of a three phase bidirectional controller for a resistive load and show the waveforms for (a) Input line voltages, (b) Input phase voltages, (c) thyristor gate pulses, and (d) Output phase voltage at a firing angle of 60.			L4
	c	Discuss Single Phase Full wave full Bridge converters.		CO8	L2
		OR			
-	a	Discuss Single Phase Half wave current with RLE load.	16 / 20	CO7	L2

	b	Differentiate between On-Off control and phase control of an ac voltage controller		CO8	L3
	c	Discuss Single Phase two pulse converter with Discontinuous load current.			L2
5	a	Explain the principal of step up chopper and derive an expression for the average output voltage.	16 / 20	CO9	L2
	b	Draw the circuit diagram for a four quadrant converter and explain its working.		CO10	L2
	c	What are the main differences between voltage source and current source inverters?			L3
	a	Define the term duty cycle of dc choppers.	16 / 20	CO9	L2
	b	Explain 120 conduction mode of operation in a 3 phase inverter along with circuit and neat waveform.			L3
	c	In a single phase full bridge inverter has a resistive load of R=2.4Ohm and a DC input voltage is Vs=48V. Determine (a) the rms output voltage at the fundamental frequency (b) the output power p0.		CO10	L3

2. SEE Important Questions

Course:	Power Electronics					Month / Year	May /2018	
Crs Code:	17EE53	Sem:	5	Marks:	100	Time:	180 minutes	
	Note	Answer all FIVE full questions. All questions carry equal marks.				-	-	
Module	Qno.	Important Question				**Marks**	**CO**	**Year**
1	1	What are the advantages of static power converters?				16 / 20	CO1	2014
	2	What are the peripheral effects of power electronics system?					CO1	2014
	3	Explain the 2 modes of operation of freewheeling diode.					CO2	2014
	4	Plot the input and output characteristics of any four power semiconductor devices.					CO1	2017
	5	If a single phase full wave rectifier with center tapped transformer has a purely resistive load of R, determine (a) the efficiency, (b) the RF, (c) the TUF and (d) the input power factor PF					CO2	2017
2	1	With the help of waveforms, explain the switching characteristics of a BJT.				16 / 20	CO3	2015
	2	Explain the isolation of gate drive using (i) pulse transformers and (ii) opto-couplers					CO4	2015
	3	Explain the terms over drive factor (ODF) and forced beta (β) for a power transistor in switching application.					CO3	2019
	4	Name and explain various switching limits in case of power BJTs. With a circuit diagram, explain anti saturation control of BJT. Mention the improvement and drawback of this arrangement.					CO3	2016
	5	For the switching circuit shown below, calculate forced β of the transistor. Also calculate the ODF if the manufacturer specified β is 10. Calculate the power loss PT of the transistor. VCC = 100 V ; VB = 5 V ; RB =0.8 Ω ; RC =12 Ω ; VCE (Sat) = 1.0 V ; VBE (Sat) = 1.0 V					CO4	2014
3	1	Compare the features of BJT, MOSFET and SCR for use in power electronic circuits. Give the applications where these devices are preferred over others.				16 / 20	CO5	2016
	2	Draw the I-V characteristics of SCR. Label the various voltages, current and the operating modes on this sketch?					CO5	2016
	3	Enumerate the various methods by which thyristors be triggered into conduction?					CO6	2017

	4	Discuss the two transistor model of a Thyristor? Derive an expression for the anode current and discuss there from the turn-on mechanisms of a thyristor?		CO5	2014
	5	Explain how thyristors can be protected against dv/dt and di/dt ? what are the considerations for choosing circuit elements for protection?		CO6	2014
4	1	Discuss Single Phase Half wave current with RLE load.	16 / 20	CO7	2014
	2	Differentiate between On-Off control and phase control of an ac voltage controller		CO8	2014
	3	Discuss Single Phase two pulse converter with Discontinuous load current.		CO8	2016
	4	With the help of suitable diagrams, explain the working of a single phase dual converter		CO7	2014
	5	Draw the circuit diagram of a three phase bidirectional controller for a resistive load and show the waveforms for (a) Input line voltages, (b) Input phase voltages, (c) thyristor gate pulses, and (d) Output phase voltage at a firing angle of 60.		CO7	2017
5	1	Explain the principal of step up chopper and derive an expression for the average output voltage.	16 / 20	CO9	2019
	2	Draw the circuit diagram for a four quadrant converter and explain its working.		CO9	2017
	3	Explain 120 conduction mode of operation in a 3 phase inverter along with circuit and neat waveform.		CO10	2017
	4	What are the main differences between voltage source and current source inverters?		CO10	2014
	5	In a single phase full bridge inverter has a resistive load of R=2.4Ohm and a DC input voltage is Vs=48V. Determine (a) the rms output voltage at the fundamental frequency (b) the output power p0.		CO10	2015