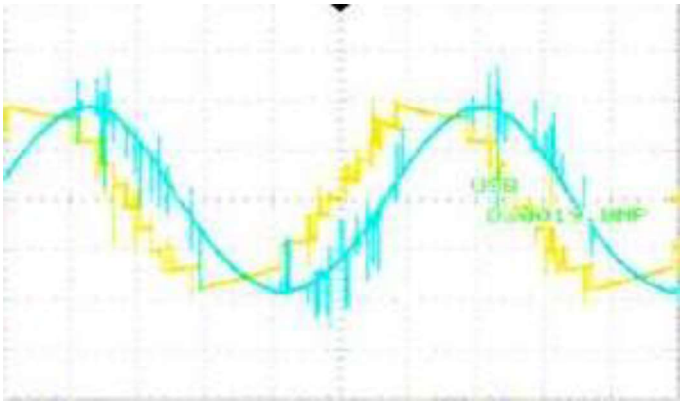
MUZAFFARPUR INSTITUTE OF TECHNOLOGY (MIT), MUZAFFARPUR

COURSE FILE

OF

POWER ELECTRONICS

(EE 03 1609)



Faculty Name: Dr. N Kumar

ASSISTANT PROFESSOR

DEPARTMENT OF ELECTRICAL ENGINEERIN

विज्ञान एवं प्रावैधिकी विभाग

Department of Science and Technology

Government of Bihar

CONTENTS

VISION STATEMENT OF ELECTRICAL ENGINEERING DEPARTMENT

To produce cutting edge Electrical Engineers, innovators, researchers, and entrepreneurs with high human values to serve society, industry, nation and the world.

MISSION STATEMENT OF ELECTRICAL ENGINEERING DEPARTMENT

M1. To create state-of-the-art facilities for under-graduate, post- graduate and R&D work.

M2. To cater the needs of society with recent technologies, innovative ideas and inculcate ethical responsibilities.

M3. To develop strong collaborative links with premier industries, institutions and the government agencies.

Program Educational Objectives (PEOs) of Electrical Engineering Department:

PEO 1. Students will be able to engage in life-long learning and research including supportive and responsible roles on multi-disciplinary tasks.

PEO 2. Students will acquire, use and develop skills as required for effective professional and societal practices and leadership quality.

PEO 3. Students will be able to create a new dimension of innovation and entrepreneurship.

Program Outcomes (POs) based on Program Educational Objectives (PEOs) of Electrical Engineering Department:

PO 1. Students will be able to apply knowledge of applied mathematics & science in electrical engineering problems.

PO 2. Students will be able to identify, formulate and solve society and industries related problems.

PO 3. Students will be able to apply knowledge to design a system, component or process to meet desired needs within realistic constraints.

PO 4. Students will be able to conduct laboratory experiments and to critically analyze and interpret experimental data.

PO 5. Students will be able to use the recent techniques, skills, and modern tools necessary for engineering practices.

PO 6. Students will be able to understand the impact of engineering problems, solutions in a global and societal context.

PO 7. Students will be able to demonstrate professional and ethical responsibilities.

PO 8. Students will be able to apply leadership quality to work with team in the area of electrical engineering towards the solution of multi-disciplinary tasks.

PO 9. Students will be able to communicate effectively through verbally, technical writing, reports and presentation.

PO 10. Students will be able to develop confidence for self-education and ability to engage in life-long learning.

Course Description

The course is to introduce students into the theory and applications of Power Electronic. All main types of Power Electronics converters are studied, employing various teaching methods. The students are required to implement a selection of laboratory experiments that cover all the main types of converters, providing relative laboratory reports. Furthermore, students are required to complete various assignments, dealing with simulating of power electronic circuits using specialized software, solving of problems and practical applications. Special emphasis is given to electronic constructions of converters through a relevant construction project that students must implement.

Course Objectives

1. Recognize and describe the power semiconductor devices
2. Explain the principles of power electronics
3. Explain in detail the basic functions of all types of power converters
4. Assess and evaluate the individual circuits of every power converter category
5. Implement experiments in the laboratory and analyze their operation
6. Simulate basic power electronics circuits

Course Outcomes

1. Introduction the basics of power electronic devices
2. Express the design and control of rectifiers, inverters
3. Design of power electronic converters in power control applications
4. Ability to express characteristics of SCR, BJT, MOSFET and IGBT
5. Ability design AC voltage controller and Cyclo-Converter
6. Ability to design Chopper circuit, Inverter circuit

CO-PO MAPPING

Sr. No.	Course Outcome	PO
1.	Introduction the basics of power electronic devices	PO2
2.	Express the design and control of rectifiers, inverters	PO2,PO4
3.	Design of power electronic converters in power control applications	PO3, PO4,PO10
4.	Ability to express characteristics of SCR, BJT, MOSFET and IGBT	PO4,
5.	Ability design AC voltage controller and Cyclo Converter	PO2, PO6
6.	Ability to design Chopper circuit, Inverter circuit	PO3,PO6,PO10

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
1. Introduction the basics of power electronic devices		√								
2. Express the design and control of rectifiers, inverters		√		√						
3. Design of power electronic converters in power control applications			√	√						√
4. Ability to express characteristics of SCR, BJT, MOSFET and IGBT				√						
5. Ability design AC voltage controller and Cyclo Converter		√				√				
6. Ability to design Chopper circuit, Inverter circuit			√			√				√

B. Tech. VI Semester (EE)
EE- POWER ELECTRONICS

L T P/D Total		Max Marks:	100
3-0-3	6	Final Exam:	70 Marks
		Sessional:	20 Marks
		Internals:	10 Marks.

UNIT-I

Introduction to thyristor and control circuits : terminal characteristic, rating and protection.

UNIT-II

Thyristor firing circuit : Triggering circuit suitable for 1 phase and 3 phase fully controlled converters.

UNIT-III

Converters : Uncontrolled three phase power rectifiers, 1 phase & 3 phase line commutated A.C to D.C converters.

UNIT-IV

Inverters : Basic Bridge inverter circuit 1 phase & 3 phase phase McMurray-Bedford method of
communication,pulse width modulation inverters. Series inverter gating circuits.

UNIT-V

Choppers : Types of choppers, steady state analysis of type A chopper, communication methods, chopper control of D.C. Motor.

UNIT-VI

Other applications A.C., voltage regulator, cyclo-converter

UNIT-VII

Application of thyristors for industrial drives.

Books:

1 Power Electronics: Circuits, Devices, and Applications by M.H. Rashid', PHI
2 Power Electronics ' by . S. Bimbhra, Khanna
3 Power Electronics: Converters, Applications, and Design by Ned Mohan, Tore M. Undeland, William P. Robbins, 3rd, Wiley

GATE SYLLABUS

Power Electronics

Characteristics of semiconductor power devices: Diode, Thyristor, Triac, GTO, MOSFET, IGBT; DC to DC conversion: Buck, Boost and Buck-Boost converters; Single and three phase configuration of uncontrolled rectifiers, Line commutated thyristor based converters, Bidirectional ac to dc voltage source converters, Issues of line current harmonics, Power factor, Distortion factor of ac to dc converters, Single phase and three phase inverters, Sinusoidal pulse width modulation.

6th Semester Electrical Engineering								ROOM NO. 36
Day/ time	10:00-10:50	10:50-11:40	11:40-12:30	12:30-01:20	12:40-01:35	01:35-02:30	02:30-03:25	03:25-04:20
MON		Power Electronics NK			B	Power Electronics Lab NK +HCV		
TUE		Power Electronics NK			R			
WED	Power Electronics NK				E	Power Electronics Lab NK +HCV		
THU					A			
FRI					K			
SAT								

Student List

S. NO.	Roll No	Name of Students
1.	15E01	PRASOON BALA
2.	15E02	SUMI SINGH
3.	15E03	SURYA SINGH
4.	15E04	BINDIA RANI
5.	15E06	MADHU KUMARI
6.	15E07	VIVEK KUMAR
7.	15E08	KAJAL RAJ
8.	15E09	ANKITA KUMARI SINDURIYA
9.	15E10	NIRAJ KUMAR
10.	15E11	SANDEEP KUMAR SITESH
11.	15E12	NISHANT GUPTA
12.	15E13	PRAKASH KUMAR
13.	15E14	PRADEEP KUMAR
14.	15E15	RAVI RANJAN
15.	15E16	RAVI SHANKAR SAH
16.	15E17	ALOK KUMAR
17.	15E18	RAVI KANT SINGH
18.	15E19	OM PRAKASH CHAUDHARY
19.	15E20	AMAN KUMAR
20.	15E21	MD SARFARAJ AHMAD
21.	15E22	AZIM ANSARI
22.	15E23	NAYAN PRIYA
23.	15E24	JYOTI KUMARI
24.	15E25	SUJEET KUMAR
25.	15E26	ATUL SHAKTI
26.	15E27	RAHUL KUMAR

27.	15E28	ABHISHEK KISHORE
28.	15E29	RUHI KUMARI
29.	15E30	RAJEEV KUMAR CHOUDHARY
30.	15E31	SAURAV KUMAR
31.	15E32	KISHAN KUMAR
32.	15E33	MANISH KUMAR
33.	15E34	AMIT KUMAR
34.	15E35	HAPPY KUMAR
35.	15E36	RAVI RANJAN
36.	15E37	SHASHANK SUDHANSHU
37.	15E38	NEHA GUPTA
38.	15E39	SWETA JAMUAR
39.	15E40	SURUCHI KUMARI
40.	15E41	SOURAV SRIKANT
41.	15E42	TAHA ALAM
42.	15E44	NIKET NIRAJ
43.	15E45	MAYANK KASHYAP
44.	15E46	SATISH KUMAR
45.	15E47	ASHUTOSH SHIVAM
46.	15E48	PAVAN KUMAR
47.	15E49	MEDHA CHAUDHARY
48.	15E50	NAGESHWAR SHARMA
49.	15E51	PRIYANKA SUMAN
50.	15E52	PALLAVI KUMARI
51.	15E54	SHASHI RANJAN
52.	15E55	DEO
53.	15E56	KRISHNA KUMAR
54.	15E57	RAJLAXMI KUMARI
55.	15E59	AJIT KUMAR
56.	15E61	NAYAN Kr NAYAN
57.	15E62	SUDEEP KUMAR
58.	15E63	RAJU KUMAR

59.	15E64	PREM N CHAUDHARY
60.	15E65	PRIYANKA KUMARI
61.	15E66	DEEPAK KUMAR SINGH
62.	16(LE)E01	SHAFAQUE NAZREEN
63.	16(LE)E02	PAVAN KUMAR
64.	16(LE)E03	PRIYANKA KUMARI
65.	16(LE)E04	ROHAN RAJ
66.	16(LE)E06	SHEKHAR KUMAR
67.	16(LE)E07	MD MOIN
68.	16(LE)E09	PINTU KUMAR
69.	16(LE)E10	GAUTAM BHARTI

Institute / School Name :	Muzaffarpur Institute of Technology (MIT), Muzaffarpur		
Program Name	**B.Tech. EE**		
Course Code	03 1609		
Course Name	POWER ELECTRONICS		
Lecture / Tutorial (per week):	3/0	**Course Credits**	5
Course Coordinator Name	Dr. N Kumar		

1. Scope and Objectives of the Course

Scope of the course is to introduce students into the theory and applications of Power Electronic. All main types of Power Electronics converters are studied, employing various teaching methods. The students are required to implement a selection of laboratory experiments that cover all the main types of converters, providing relative laboratory reports. Furthermore, students are required to complete various assignments, dealing with simulating of power electronic circuits using specialized software, solving of problems and practical applications. Special emphasis is given to electronic constructions of converters through a relevant construction project that students must implement.

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The course outcomes are:

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5. Ability design AC voltage controller and Cyclo Converter
6. Ability to design Chopper circuit, Inverter circuit

2. Textbooks

TB1: 'Power Electronics: Circuits, Devices, and Applications by M.H. Rashid', PHI
TB2: 'Power Electronics ' by . S. Bimbhra, Khanna

Reference Books

RB1: 'Power Electronics: Converters, Applications, and Design by Ned Mohan, Tore M. Undeland, William P. Robbins, 3rd, Wiley

Other readings and relevant websites

S.No.	**Link of Journals, Magazines, websites and Research Papers**
1.	https://in.mathworks.com/help/physmod/sps/ug/simpowersystems-block-libraries.html?requestedDomain=true
2.	http://digital-library.theiet.org/content/journals/iet-pel
3.	http://nptel.ac.in/courses/108105066/
4.	http://ieeexplore.ieee.org/xpl/RecentIssue.jsp?reload=true&punumber=63

5. Course Plan

Lecture Number	Date of Lecture	Topics	Web Links for video lectures	Text Book / Reference Book / Other reading material	Page numbers of Text Book(s)
Assignment 1					
1-4		**Introduction to thyristor and control circuits**	http://nptel.ac.in/courses/108101038/4	TB1, RB1,TB2	RB1:596-612 TB1:307-343 TB2:132-184
		Introduction to thyristor and control circuits : terminal characteristic, rating and protection			
Assignment 2					
5-10		**Thyristor firing circuitTriggering**	http://nptel.ac.in/courses/108101038/5	TB1, RB1,TB2	TB2:213-236
		Thyristor firing circuit: Triggering circuit suitable for 1 phase and 3 phases fully controlled converters.			
Assignment 3					
Mid-Semester Exam					
11-21		**Converters**	http://nptel.ac.in/courses/108101038/10 http://nptel.ac.in/courses/108101038/11	TB1, RB1,TB2	TB2:272-379
		Uncontrolled three phase power rectifiers, 1 phase & 3 phase line commutated A.C to D.C converters.			
Assignment 4					
22-30		**Inverters**	http://nptel.ac.in/courses/108101038/33 http://nptel.ac.in/courses/108101038/34 http://nptel.ac.in/courses/108101038/35 http://nptel.ac.in/courses/108101038/36	TB1, RB1,TB2	TB2 :454-537
		Basic Bridge inverter circuit 1 phase & 3 phase phase McMurray-Bedford method of Communication, pulse width modulation inverters. Series inverter gating circuits.	http://nptel.ac.in/courses/108101038/37 http://nptel.ac.in/courses/108101038/38		
31-39		**Choppers**		TB2:380-453	141-202
		Types of choppers, steady state analysis of type A chopper, communication methods, chopper control of D.C. Motor.			

40-44		**Other applications**			TB2:557-588,589-608
		A.C., voltage regulator, cyclo-converter.			
45-46		**Application**		TB1, RB1,TB2	TB2:651-753
		Thyristors for industrial drives			
Tutorial – 0					
Tutorial – 0, Assignment 07					

1. **Evaluation Scheme:**

Component 1*	Sessional Test (ST)*	20
Component 2	Assignment Evaluation	10
Component 3**	End Term Examination**	70
	Total	**100**

SYLLABUS

Topics	No of lectures	Weightage
Introduction to thyristor and control circuits : terminal characteristic, rating and protection	4	10%
Thyristor firing circuit : Triggering circuit suitable for 1 phase and 3 phase fully controlled converters	6	10%
Converters : Uncontrolled three phase power rectifiers, 1 phase & 3 phase line commutated A.C to D.C converters	10	20%
Inverters: Basic Bridge inverter circuit 1 phase & 3 phase phase McMurray-Bedford method of communication pulse width modulation inverters. Series inverter gating circuits	8	20%
Choppers : Types of choppers, steady state analysis of type A chopper, communication methods, chopper control of D.C. Motor	8	20%
Other applications A.C., voltage regulator, cyclo-converter	4	15%
Application of thyristors for industrial drives	2	5%

This Document is approved by:

Designation	Name	Signature
Course Coordinator	Dr. N KUMAR	
H.O.D	DR. YAGYANAND SHARMA	
Dean	DR. JAGNANAND JHA	
Date	22-06-2018	

Evaluation and Examination Blue Print:

Internal assessment is done through quiz tests, presentations, assignments and project work. Two sets of question papers are asked from each faculty and out of these two, without the knowledge of faculty, one question paper is chosen for the concerned examination. The components of evaluations alongwith their weightage followed by the University is given below

Sessional Test	20%
Internals	10%
End term examination	70%

Institute / School Name :	Muzaffarpur Institute of Technology (MIT), Muzaffarpur		
Program Name	**B.Tech. EE**		
Course Code	03 1609		
Course Name	POWER ELECTRONICS		
Lecture / Tutorial (per week):	3/0	**Course Credits**	5
Course Coordinator Name	Dr. N Kumar		

LECTURE PLAN

Topics	Lecture Number	Date on which the Lecture was taken
Introduction to thyristor and control circuits		
Introduction	**1**	
terminal characteristic	**2**	
rating	**3**	
protection	**4**	
Thyristor firing circuit		
Introduction	**5**	
Triggering circuit suitable for 1 phase converters	**6-8**	
Triggering circuit suitable for 3 phase fully controlled converters	**9-11**	
Converters		
Introduction, Uncontrolled three phase power rectifiers	**12-13**	
1 phase line commutated A.C to D.C converters	**14-17**	
3 phase line commutated A.C to D.C converters	**17-20**	
Inverters		
Basic Bridge inverter circuit 1 phase & 3 phase phase McMurray-Bedford method of communication pulse width modulation inverters	**21-24**	
Series inverter gating circuits	**25-28**	
Choppers		
Introduction	**29**	
Types of choppers	**30-31**	
steady state analysis of type A chopper	**32-33**	
communication methods, chopper control of D.C. Motor	**33-36**	
Other applications		
A.C., voltage regulator,	**37-38**	
cyclo-converter	**39-40**	
Application		
thyristors for industrial drives	**41-42**	

Department of EE

Power Electronics

Assignment I

1. Sketch static I-V characteristics of a thyristor. Lebel the various voltage, current and the operating mode on this sketch.
2. SCR with a rating of 1000V and 200A are available to be used in a sgtring to handle 6 kV and 1 kV. Calculate the no. of derating factor is (1) 0.1 and (2) 0.2.
3. Define latching and holding currents as applicable to an SCR. Show these on the V-I characteristics.
4. Why dv/dt and di/dt protection in case of thyristor important.
5. Explain the 2-transistor analogy of thyristor.
6. Discuss the various mechanisms that can be used to trigger thyristors.
7. Snubber circuit for an SCR should primarily consist of capacitor only. But in actual practice , a resistor is used in series with capacitor. Explain.
8. Explain the working of an oscillator employing an UJT. Derive expression for the frequency of triggering.
9. An SCR requires 50 mA gate current to switch it on. It has a resistive load and is supplied from a 100 V DC supply. Specify the Pulse transformer details and the circuit following it, if the driver circuit supply voltage is 10 V and the gate-cathode drop is about 1 V.
10. A thyristor has a maximum average current rating 1200 Amps for a conduction angle of 180°. Find the corresponding rating for $\Phi = 60$. Assume the current waveforms to be half cycle sine wave.
11. An unregulated dc. power supply of average value 12 V and peak to peak ripple of 20% is to be designed using a single phase half wave rectifier. Find out the required input voltage, the output capacitance and the diode RMS current and PIV ratings. The equivalent load resistance is 50 ohms.
12. Explain the Boost converter and buck converter design and its operations.
13. Advantages and Disadvantages of Cyclo-converter.

14. Explain the operating principle of a three-phase inverter (1) 120^0 and (2) 180^0.
15. Explain 3 phase phase McMurray-Bedford method of Communication.
16. Explain the concept of sine-modulated PWM inverter.
17. Design a simple controller for the sine-PWM inverter.
18. What is the principle of series resonant inverters. What are the effects of both series and parallel loadingin a series resonant inverter. Enumerate its advantages and disadvantages.
19. Describe breifly sinusoidal PWM.What is the purpose of over modulation.
20. Draw the schematic of Class E chopper and explain the working of the same.
21. Descrive the basic principle of working of 1-phase to 1-phase cycoloconverter for continuous and discontinuous conductions for a bridge type cycloconverter. Mark the condition of various thyristers also

Tutorial Sheet

1. What is power electronics? State Applications of power electronics.
2. Define latching and holding currents as applicable to an SCR. Show these on the V-I characteristics.
3. Why dv/dt and di/dt protection in case of thyristor important.
4. Snubber circuit for an SCR should primarily consist of capacitor only. But in actual practice , a resistor is used in series with capacitor. Explain.
5. For a single-phase full wave ac voltage controller feeding a resistive load, draw the wave forms of source voltage and output current and voltage across SCRs. Describe its working with reference to the wave forms drawn.
6. An SCR requires 50 mA gate current to switch it on. It has a resistive load and is supplied from a 100 V DC supply. Specify the Pulse transformer details and the circuit following it, if the driver circuit supply voltage is 10 V and the gate-cathode drop is about 1 V.
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9. Explain the Boost converter and buck converter design and its operations.
10. Explain in detail working principle of step up and step down chopper.
11. Advantages and Disadvantages of Cyclo-converter.
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18. Draw the schematic of Class E chopper and explain the working of the same.

19. Descrive the basic principle of working of 1-phase to 1-phase cycoloconverter for continuous and discontinuous conductions for a bridge type cycloconverter. Mark the condition of various thyristers also.
20. Draw and explain working of Mc Murray inverter.
21. Write a short note on current source inverter.
22. Write a short note on voltage source inverter.
23. Explain the operation of 180 degree mode three phase voltage source inverter (VSI)

Muzaffarpur Institute of Technology (MIT), Muzaffarpur

Mid-Semester (UG) Examinations, 2018

Subject Code: EE031609 **Subject: Power Electronics**

Semester: 6th **Department: Electrical Engg.**

Duration: 2 Hrs. **Total marks: 20**

Instructions:

(i) The marks are indicated in the right hand margin.

(ii) There are **Six** questions in this paper.

(iii) Attempt **Four** questions in all.

1. Answer the following questions **5**

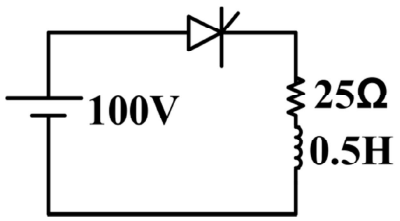
(a) Define latching and holding currents as applicable to an SCR.

(b) How can thyristor turn off.

2. For a single-phase full wave ac voltage controller feeding a resistive load, draw the wave forms of source voltage and output current and voltage across SCRs. Describe its working with reference to the wave forms drawn. **5**

3. Snubber circuit for an SCR should primarily consist of capacitor only. But in actual practice, a resistor is used in series with capacitor. Explain. **5**

4. The latching current of SCR is 50mA, triggered by short duration of gate pulse as shown in Fig. calculate the minimum pulse width required to turn on SCR. **5**



5. Why dv/dt and di/dt protection in case of thyristor are important. **5**

6 Explain the different methods to turn on the thyristor. **5**