COURSE NAME : Electrical Engineering Group

COURSE CODE : EE/EP

SEMESTER : Sixth

SUBJECT TITLE : Power Electronics

SUBJECT CODE :

Teaching and Examination Scheme:

Teaching Scheme			Examination Scheme					
TH	TU	PR	PAPER HRS.	TH	PR	OR	TW	TOTAL
04	--	02	03	100	--	--	25 @	125

 # - External **@ - Internal** ***** **On Line Examination**

NOTE:

- **Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.**
- **Total of tests marks for all theory subjects are to be converted out of 100 50 and to be entered in mark sheet under the head Sessional Work. (SW)**

❖ Rationale:

Power electronics is a branch of engineering that combines the fields of electrical power, electronics and control. As an electrical engineer it is necessary to exercise control on power given to the machines to control its speed, voltage and current to suit its load.

The invention of thyristor as a power device led to development of compact, reliable and maintenance free device drive circuits. The utility of power devices spread to industrial applications such as UPS, induction heating, high voltage DC transmission, Electrical welding etc.

Microprocessors and microcomputers have made their impact on power electronics based industrial equipment. Their application for control of electric devices is used as a brain and the power semiconductors are considered as muscles of the equipment.

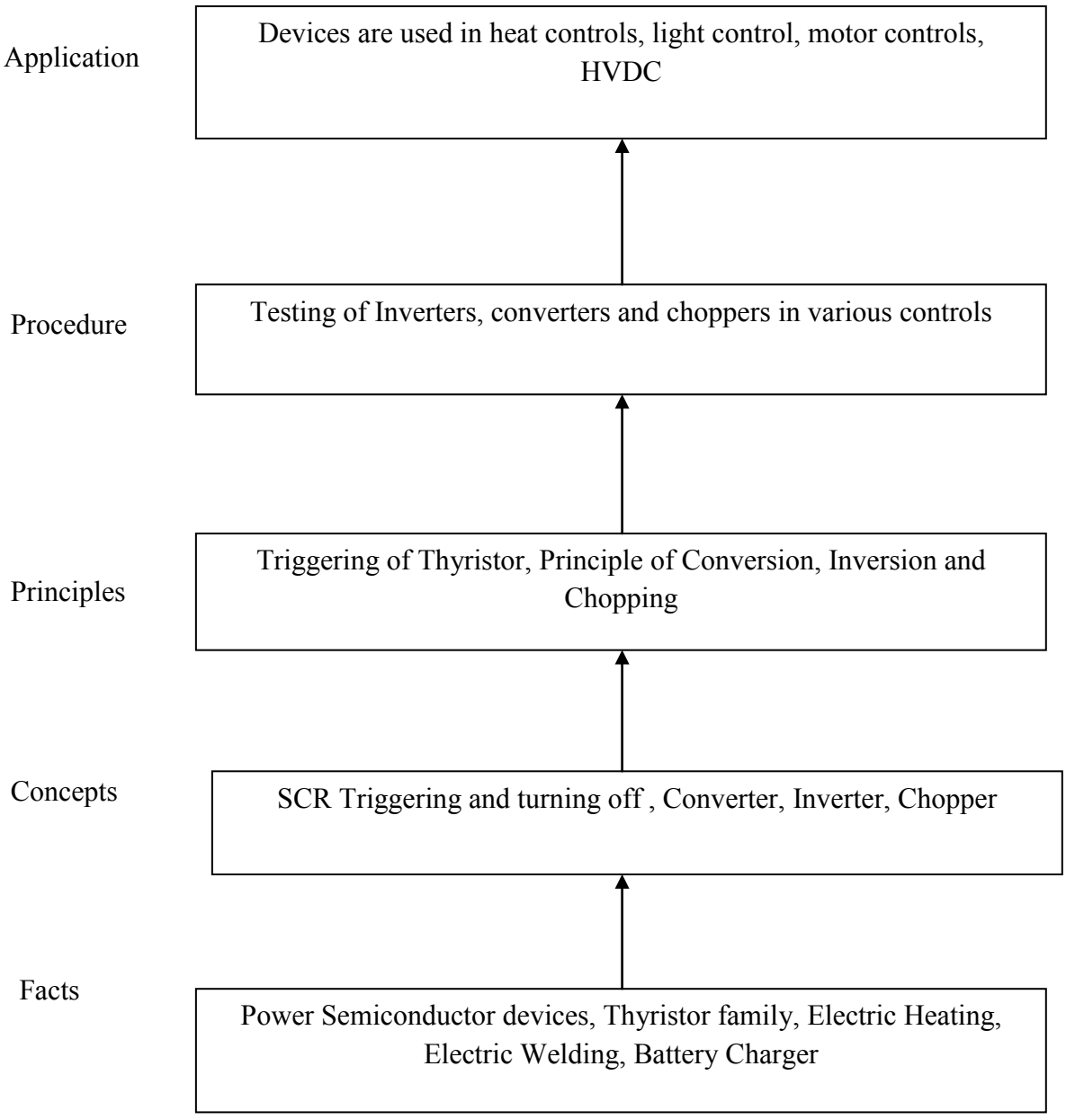
With rapid development in modern technology, power electronic equipments are integral part of control system.

General Objectives:

The students will be able to:

1. Understand the physical processes for the switching of a thyristor.
2. Know the various methods of triggering a thyristor and different gate turn-on methods.
3. Develop logic about the turning off mechanism of a thyristor and get acquainted with some methods of turning a thyristor off.
4. Become familiar with other members of the thyristor family as well as other power electronic devices.
5. Know the characteristics of different power electronic devices.
6. Know the working of rectifiers, choppers, inverters and industrial applications of the thyristor.

Learning Structure



Contents

Topic Contents	Hours	Marks
Topic 1: Introduction to Power Electronics **Specific Objectives:** ➢ State purpose of power conversion. ➢ List application areas of Power Electronics. ➢ Select specific Thyristor device for required application. **Contents:** • Necessity of Power generation. conversion • Applications of Power Electronics • Thyristor family • Characteristics and symbolic representation , and list of applications of SCR, DIAC, TRIAC, GTO, SUS, LASCR, IGBT. • SCR: Construction, operation, Two transistor analogy ➢ Triggering methods of SCR • Voltage triggering. • dv/dt triggering. • Light triggering. • Gate triggering – DC gate triggering – AC gate triggering. – Pulse gate triggering. • SCR Turn-off process • SCR Specifications ratings Voltage rating , current rating , Power rating , Temperature rating • SCR selection factors • SCR testing	10	20
Topic 2 : Converters **Specific Objectives:** ➢ Operation of controlled converters ➢ List classification of Controlled converters. ➢ Identify different types of converters for required applications **Contents:** • Necessity of Convertors • Concept of firing angle and conduction angle • Single phase fully controlled half wave converter – With resistive load – RL load without freewheeling diode. – RL load with freewheeling diode. • Single phase full wave controlled converter – With resistive load – With RL load	12	20

• Single phase fully controlled bridge converter – With resistive load – With RL load • Three phase fully controlled bridge converter – With RL load • Comparison of 3Ø and 1Ø converters on the basis of efficiency, ripple factor , RMS Values and average values • Effect of source impedance on converter operation. • Cycloconverters and cycloinverters: 1Ø and 3Ø- Principle of operation, input and output waveforms.		
Topic 3 : Inverters **Specific Objectives:** ➢ List different types of inverters and applications. ➢ Selection of 1Ø or 3Ø inverters for required application. **contents:** • Need of Inverter • Classification : – 1Ø and 3Ø inverters. – Line (Natural) commutated Inverters – Forced commutated inverters: Series, parallel and bridge inverters.(circuit, description and waveforms) • Series inverters: Operation of basic series inverter , Modified series inverter, Three phase series inverter. • Parallel inverters: Operation of basic parallel inverter circuit. • Single Phase Bridge Inverter – Half bridge inverter – Full bridge inverter – Mc Murry Full Bridge Inverter – Mc Murry Bedford Inverter • Voltage and frequency control of 1Ø inverter – Necessity of control of output voltage. – Methods for output voltage control: External control of DC voltage, External control of AC voltage and internal control. – Pulse width modulation (PWM) method: Single pulse width modulation, multiple pulse width modulation, Sinusoidal pulse width modulation. • Waveform control (Harmonic Reduction): Single pulse width modulation, transformer connections, using filter (LC, Resonant and OTT filter) • Concept of MOSFET Inverter and comparison with thyristor based inverter • Inverter selection factors	14	20
Topic 4 : Choppers **Specific Objectives:**		

➢ Necessity of chopper. ➢ Selection of chopper as per the requirement of application. **contents:** • Chopper principle • Control techniques: Constant Frequency System, Variable Frequency System. • Classification of choppers :Class A, class B, class C, class D, class E • Commutation methods for choppers: Auxiliary commutation, load commutation. • Jones chopper • Step up chopper.	10	16
Topic 5 : Applications of Power Electronics **Specific Objectives:** ➢ State basic principles of AC and DC Machines. ➢ Selection of SCR control circuit as per the requirement of application. **contents:** ➢ DC Drives • Speed control of DC series motor with 1Ø and 3Ø half and full control converter, step up and step down chopper • DC servo motor(working and Construction): speed control of DC servo motor Close loop speed control method for D C servo motor • AC servo motor(working and Construction): speed control of AC servo motor ➢ AC Drives • Speed control of 3Ø induction motor – Variable frequency control : Voltage source inverter, current source inverter, cycloconverter • Stepper motor :Variable reluctance , Permanent magnet- step control Open loop control system for stepper motor, stepper motor specifications • Other applications: Circuit diagram, operation – Static circuit breaker(DC and AC) – Induction heating control – Dielectric heating control – Electric welding control – Battery charger control – Automatic street lighting circuit using SCR – Static VAR compensation system	18	16 08

Practical:

Skills to be developed:

- **Intellectual Skills**
  1. Select appropriate circuits and instruments

2. Testing and troubleshooting

- **Motor Skills**
  1. Accuracy of measurement
  2. Proper connection
  3. Draw characteristics

List of Practical:

1. To understand the V-I characteristics of SCR and to determine the latching current, holding current and the forward break over voltage
2. To understand 1-phase full wave controlled rectifier using SCR and plot input and output waveforms for R and RL load with and without freewheel diode . To learn effect of variation in firing angle .
3. To study 3-phase full wave controlled rectifier with R and R-L load and plot input and output waveforms for R and RL load with and without freewheel diode .
4. To study 1-phase series inverter and to measure the output signal resonance frequency and voltage
5. To study current commutated step down chopper and to observe the change in output voltage.
6. To understand operation of SCR based DC static circuit breaker using SCR.
7. To understand operation of battery charger using SCR and observe change in charging voltage and current
8. To understand the speed control of DC shunt series motor using SCR phase control and plot speed armature voltage characteristics (as D C series motor is not safe under no load condition . It may cause accident)
9. To understand the speed control of 3-phase induction motor using PWM inveter inverter and plot its speed –torque characteristics
10. To understand operation of stepper motor and verify stepping sequence by measuring step angle.
11. To understand the operation of D C servomotor and plot variation in speed with change in reference voltage

- Assignments

  1 During visit to traction system / coal handling in thermal power station / process industry / Oil extraction plant or any other similar industry identify role of thyristor devices for speed control Student shall observe appearance and mounting , cooling arrangement of high rating thyristors . Based on these observation students shall prepare a report

Learning Resources:

Books

Sr. No.	Author	Title	Publisher
1	M D Singh K B Khanchnadani	Power Electronics	Tata Mcgraw Hill
2	S K Bhatacharya S Chattarjee Ttti Chandigad	Industrial Electronics & control	Tata Mcgraw Hill
3	P C Sen	Power Electronics	Tata Mcgraw Hill
4	M D Rashid	Power Electronics	Pearson
5	V R Moorthi	Power Electronics	OXFORD
6	Mohan, Undeland Riobbins	Power Electronics	Willey Student Edition
7	S K Bhatacharya	Fundamentals of Power Electronics	Vikas Publication
8	V. Jagannathan	Power Electronics Devices & Circuits	PHI
9		SCR Manual	General Electric Co.

Websites:

- *free**video**lectures.com/Course/2351/**Power**-**Electronics***
- *free**video**lectures.com/.../Industrial-Drives-and-**Power**-...*
- www.learnerstv.com/Free-Engineering-**Video**-lectures-ltv127
- www.circuitstoday.com/**scr-characteristics**
- *en.wikipedia.org/wiki/**Thyristor***
- www.freepatentsonline.com/5216683.html
- *en.wikipedia.org/wiki/Inverter_(electrical)*