Course Name: POWER ELECTRONICS
Course Code: EE603
Credit: 4

Prerequisites:

Sl. No.	Subject	Description	Level of Study
01	Basic Electronics	p-n junction, Diode, BJT, MOSFET	1st Sem, 2nd Sem
02	Circuit Theory	Laplace transforms, Fourier series	3rd Sem

Course Objective:

- To introduce students to the basic theory of power semiconductor devices and passive components, their practical applications in power electronics.
- To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.
- To provide strong foundation for further study of power electronic circuits and systems.

Course Outcomes:

At the end of the course, a student will be able to:

1. **Relate** basic semiconductor physics to properties of power devices, and **combine** circuit mathematics and characteristics of linear and non-linear devices.

2. **Describe** basic operation and **compare** performance of various power semiconductor devices, passive components and switching circuits

3. **Design** and **Analyze** power converter circuits and learn to **select** suitable power electronic devices by **assessing** the requirements of application fields.

4. **Formulate** and **analyze** a power electronic design at the system level and **assess** the performance.

5. **Identify** the critical areas in application levels and **derive** typical alternative solutions, **select** suitable power converters to control Electrical Motors and other industry grade apparatus.

6. **Recognize** the role power electronics play in the improvement of energy usage efficiency and the **applications** of power electronics in emerging areas.

CO- PO mapping:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1	2	1	2	1	-	-	-	-	-	-	-	-
2	1	1	2	2	-	-	-	-	-	-	-	-
3	1	2	2	1	1	-	-	1	-	-	-	1
4	1	1	1	2	1	-	-	1	-	1	-	1
5	1	1	2	2	-	1	1	-	1	-	1	1
6	1	2	2	1	-	2	2	-	1	-	1	2

Correlation levels 1, 2 or 3 as defined above: 1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) and "-" if there is no correlation.

Syllabus Indicating CO:

Module no:	Topics	Relevant COs
Module I	**Introduction:** Concept of power electronics, application of power electronics, uncontrolled converters, advantages and disadvantages of power electronics converters, power electronics systems, power diodes, power transistors, power MOSFETS, IGBT and GTO.	CO1, CO2, CO3.
Module II	**PNPN devices:** Thyristors, brief description of members of Thyristor family with symbol, V-I characteristics and applications. Two transistor model of SCR, SCR turn on methods, switching characteristics, gate characteristics, ratings, SCR protection, series and parallel operation, gate triggering circuits, different commutation techniques of SCR.	CO1, CO2, CO3.

Module III	**Phase controlled converters:** Principle of operation of single phase and three phase half wave, half controlled, full controlled converters with R, R-L and RLE loads, effects of freewheeling diodes and source inductance on the performance of converters. External performance parameters of converters, techniques of power factor improvement, single phase and three phase dual converters.	CO3, CO4, CO5.
Module IV	**DC-DC converters:** Principle of operation, control strategies, step up choppers, types of choppers circuits based on quadrant of operation, performance parameters, multiphase choppers and switching mode regulators.	CO3, CO4, CO5.
Module V	**Inverters:** Definition, classification of inverters based on nature of input source, wave shape of output voltage, method of commutation & connections. Principle of operation of single phase and three phase bridge inverter with R and R-L loads, performance parameters of inverters, methods of voltage control and harmonic reduction of inverters. Brief idea of Resonant Pulse inverters.	CO3, CO4, CO5.
Module VI	**AC controllers:** Principle of on-off and phase control, single phase and three phase controllers with R and R-L loads. Principle of operation of cycloconverters, circulating and non circulating mode of operation, single phase to single phase step up and step down cycloconverters, three phase to single phase Cycloconverters, three phase to three phase Cycloconvetter.	CO3, CO4, CO5.
Module VII	**Applications:** Speed control of AC and DC motors. HVDC transmission. Static circuit breaker, UPS, static VAR controller.	CO3, CO5, CO6.

Gaps in Syllabus:

S. No.	Gap	Action taken	Relevance to POs, PSOs
1	**Heating, Cooling and Mounting of Thyristors:** *This topic highlights how thermal heat produced by electrical losses, is removed using cooling.* **Topics covered:** Thermal resistance, Heat sink specifications, Thyristor mounting techniques.	These topics are covered in continuation with rating of thyristors by **lectures**.	**PO 1, PO 2, PO 3, PO 4**
2	**Isolated DC to DC choppers:** *Isolated DC to DC chopper has advantages of smaller size, less weight and high efficiency compared to linear dc power supply and also provides isolation between input and output.* **Topics covered:** Fly-back converter, Forward Converter, Push-pull converter, Half bridge converter, and Full bridge converter.	Additional **lecture classes** are organized to cover the topics.	**PO 1, PO 2, PO 3, PO 4**
3	**Multilevel Inverter:** *Capable of providing desired alternating voltage level at the output using multiple lower level DC voltages as input.* **Topics covered:** Flying capacitor, Diode clamped and cascaded H-bridge multilevel inverters.	Additional **lecture classes** are organized to cover the topics.	**PO 1, PO 3, PO 4, PO 5**

Lecture Plan:

Cl. No.	Topics	Remarks
1	Concept of power electronics, application of power electronics, advantages and disadvantages of power electronics converters, power electronics systems.	
2	Power diodes, Its characteristics, types.	
3	Brief Discussion about uncontrolled converters (Diode rectifiers).	Problems to be solved
4	Power transistors, Steady state characteristics, switching performance, safe operating area.	

5	Power mosfets, characteristics, comparison with BJT.	
6	IGBT, characteristics.	
7	Thyristors, V-I characteristics and applications. SCR turn on methods.	
8	Switching characteristics of thyristor, Two transistor model of SCR	
9	Gate characteristics, ratings.	Problems to be solved on gate characteristics
10	Thyristor protection.	Problems to be solved on di/dt& dv/dt protection.
11& 12	Series and parallel operation of thyristor, Gate triggering circuits of thyristor.	Problems to be solved
13	Different commutation techniques of SCR.	
14	Brief description of members of thyristor family with symbol, GTO.	
15 & 16	Principle of operation of single phase half wave controlled rectifiers with R, RL and RLE load, effects of freewheeling diodes. Calculation of performance parameters	Problems to be solved
17&18	Principle of operation of single phase full wave controlled and half controlled rectifiers with R, RL and RLE loads, effects of freewheeling diodes. Calculation of performance parameters	Problems to be solved
19 & 20	Three phase half wave and full wave controlled and half controlled rectifiers with different loads. Effects of source inductance on the performance of converters.	Problems to be solved
21	Techniques of power factor improvement, single phase and three phase dual converters.	
22	DC-DC converters:Principle of operation, control strategies.	
23 & 24	Step-down chopper, performance parameters.	Problems to be solved
25 & 26	Step-up chopper, performance parameters.	Problems to be solved

27 & 28	Step-down/ step-up chopper, performance parameters.	Problems to be solved
29	Types of chopper circuits based on quadrant of operation.	
30	Multiphase choppers and switching mode regulators.	
31	Inverters:Definition, classification of inverters based on nature of input source, wave shape of output voltage, method of commutation & connections.	
32 & 33	Principle of operation of single phase bridge inverter with R and R-L loads, performance parameters.	Problems to be solved
34 & 35	Principle of operation of three phase bridge inverter with R and R-L loads,performance parameters.	Problems to be solved
36	Methods of voltage control and harmonic reduction of inverters.	
37	Brief idea of Resonant Pulse inverters.	
38	AC controllers:Principle of on-off and phase control	
39 &40	Single phase and three phase controllers with R and R-L loads, performance parameters.	Problems to be solved
41	Principle of operation of cycloconverters, single phase to single phase step up and step down cycloconverters, circulating and non circulating mode of operation.	Problems to be solved
42	Three phase to single phase Cycloconverters, three phase to three phase Cycloconverter.	
43	Speed control of AC and DC motors.	
44	HVDC transmission, Static circuit breaker.	
45	UPS, static VAR controller.	

Recommended Books:

1. Power Electronics by **M.H. Rashid**, PHI.
2. Power Electronics by **P.S. Bhimra**, Khanna Publishers.
3. Power Electronics by **M.D. Singh and K.B. Khanchandani**, TMH.