19-05-2025 11:07:45 AM

FUNDAMENTALS OF POWER ELECTRONICS **Course Code : 313335**

Programme Name/s : **Electrical Engineering/ Electrical Power System**

Programme Code : **EE/ EP**

Semester : **Third**

Course Title : **FUNDAMENTALS OF POWER ELECTRONICS**

Course Code : **313335**

I. RATIONALE

Power Electronics finds extensive applications in domestic, commercial, industrial front and electric utilities particularly in terms of efficient conversion, control and conditioning of electric power from its available input into the desired electrical output form. This course will enable the diploma students to develop the knowledge and skill sets of operating and testing different power electronic devices and their applications.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

Test the Performance of Power Electronic Devices and Circuits.

III. COURSE LEVEL LEARNING OUTCOMES (COS)

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Test the functionality of a given power electronic device.
- CO2 - Test the switching performance of a thyristor.
- CO3 - Test the performance of given controlled converter.
- CO4 - Test the performance of given chopper.
- CO5 - Use suitable power electronic circuit for given application.

IV. TEACHING-LEARNING & ASSESSMENT SCHEME

Course Code	Course Title	Abbr	Course Category/s	Learning Scheme					Credits	Assessment Scheme												
				Actual Contact Hrs./Week			SLH	NLH		Paper Duration	Theory				Based on LL & TL				Based on SL		Total Marks
															Practical							
				CL	TL	LL					FA-TH	SA-TH	Total		FA-PR		SA-PR		SLA			
											Max	Max	Max	Min	Max	Min	Max	Min	Max	Min		
313335	FUNDAMENTALS OF POWER ELECTRONICS	FPE	SEC	3	-	4	1	8	4	3	30	70	100	40	25	10	25@	10	25	10	175	

FUNDAMENTALS OF POWER ELECTRONICS **Course Code : 313335**

Total IKS Hrs for Sem. : 0 Hrs
Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment
Legends: @ Internal Assessment, # External Assessment, *# On Line Examination , @$ Internal Online Examination
Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. * Self learning hours shall not be reflected in the Time Table.
7. * Self learning includes micro project / assignment / other activities.

V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
1	TLO 1.1 Illustrate the power electronic system using block diagram. TLO 1.2 Solve simple numerical on losses in the given switch. TLO 1.3 Explain the general characteristics of the given power electronic switch. TLO 1.4 Describe the construction of the given power electronic device. TLO 1.5 Explain the working principle of the given power electronic device. TLO 1.6 State the applications of the given power electronic device.	**Unit - I Power Electronic Devices** 1.1 Power electronic system: general block diagram, need, advantages and disadvantages 1.2 Switching in power electronic circuit: Need and its importance; Ideal switch and practical switch: concept, general characteristics, conduction losses, switching losses 1.3 SCR: Construction, working principle, Static V-I characteristics, switching characteristics, and applications 1.4 IGBT: Construction, working principle, Static V-I characteristics, switching characteristics, and applications 1.5 Power MOSFET: Construction, working principle, Static V-I characteristics, and applications 1.6 TRIAC: Construction, working principle, Static V-I characteristics, and applications	Lecture Using Chalk-Board Demonstration Video presentations Flipped Classroom

FUNDAMENTALS OF POWER ELECTRONICS **Course Code : 313335**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
2	TLO 2.1 Explain the need of the given protection for SCR TLO 2.2 Describe the given protection scheme of SCR TLO 2.3 Explain the given turn-on method of SCR TLO 2.4 Illustrate the given firing circuit of SCR TLO 2.5 Explain the given commutation technique of SCR	**Unit - II Protection and Firing Circuit of Thyristor** 2.1 di/dt protection: need, snubber circuit 2.2 dv/dt protection: need, snubber circuit 2.3 Overvoltage protection: need, internal & external overvoltage, voltage clamping device 2.4 Overcurrent protection: need, electronic crowbar circuit 2.5 Thermal Protection of SCR: Need, thermal resistance, and heat sink specification 2.6 Firing circuit: Features and general layout of firing scheme 2.7 SCR turn-on methods: forward voltage triggering, gate triggering, dv/dt triggering, temperature triggering, and light triggering 2.8 SCR Firing circuit: resistance firing circuit (no derivation), RC firing circuit (no derivation), pulse transformer based triggering 2.9 SCR commutation techniques: load commutation (Class A), line commutation (Class F)	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom
3	TLO 3.1 Define the given term(s) related to controlled converter. TLO 3.2 Illustrate the working of the given single phase controlled rectifier. TLO 3.3 Derive equation of DC output voltage of the given controlled converter. TLO 3.4 Compare voltage source inverter and current source inverter on the basis of the given criteria. TLO 3.5 Explain working of the given single phase inverter. TLO 3.6 Explain working principle of sinusoidal pulse width modulation.	**Unit - III Controlled Converters** 3.1 Basic terminologies: conduction angle, firing angle, output voltage, output current, voltage across switch, source current, source voltage 3.2 Single phase half wave controlled rectifier with R, RL load: Circuit diagram, working, input-output waveforms, derivation for average output voltage, equations for output currents, voltages & power, and effect of freewheeling diode 3.3 Single phase full wave controlled bridge rectifier with R, RL load: Circuit diagram, working, input-output waveforms, derivation for average output voltage, equations for output currents, voltages & power 3.4 Three phase full wave controlled bridge rectifier: working principle with R load, input-output waveforms 3.5 Inverters: concept of voltage source inverter and current source inverter 3.6 Single phase half wave bridge inverter with R, RL load: Circuit diagram, working, input-output waveforms 3.7 Single phase full wave bridge inverter with R, RL load: Circuit diagram, working, input-output waveforms 3.8 Pulse width modulation: importance/need, types; Sinusoidal pulse width modulation: concept, working principle and waveforms	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom

FUNDAMENTALS OF POWER ELECTRONICS **Course Code : 313335**

Sr.No	Theory Learning Outcomes (TLO's)aligned to CO's.	Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.	Suggested Learning Pedagogies.
4	TLO 4.1 Explain the given terminology related to chopper. TLO 4.2 Explain control strategies of chopper. TLO 4.3 Illustrate working of the given chopper. TLO 4.4 Calculate output voltage of the given chopper.	**Unit - IV DC-DC Converters** 4.1 Basic terminologies: duty ratio, turn on period, turn off period, chopping period 4.2 Control strategies of chopper: Constant frequency system, variable frequency system 4.3 Step up chopper: circuit diagram, working, waveforms and output voltage equation 4.4 Step down chopper: circuit diagram, working, waveforms and output voltage equation 4.5 Buck-Boost chopper: circuit diagram, working, waveforms and output voltage equation	Lecture Using Chalk-Board Presentations Video Demonstrations Flipped Classroom
5	TLO 5.1 Explain the operation of charge controller used in the photovoltaics (PV) system. TLO 5.2 Explain speed control of ceiling fan using TRIAC. TLO 5.3 Explain AC to AC converter used in Wind Power Generation. TLO 5.4 Explain the function of converter station in HVDC.	**Unit - V Applications of Power Electronics** 5.1 Charge Controller: Concept, types, applications in Photovoltaics (PV) system with block diagram 5.2 Speed control of ceiling fan using TRIAC: Working, Block Diagram, advantages 5.3 AC to AC converter using DC link: Concept, applications in Wind Power Generation 5.4 HVDC converter station: Concept, Circuit Diagram	Lecture Using Chalk-Board Presentations Video Demonstrations Site/Industry Visit Case Study

VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 1.1 Identify given power electronic device	1	*Power Electronic Devices.	2	CO1
LLO 2.1 Test the performance of SCR.	2	*V-I Characteristics of SCR.	2	CO1
LLO 3.1 Test the proper functioning of the power MOSFET.	3	*Testing of power MOSFET	2	CO1
LLO 4.1 Test the proper functioning of the IGBT.	4	*Testing of IGBT	2	CO1
LLO 5.1 Test the proper functioning of the TRIAC.	5	Testing of TRIAC.	2	CO1
LLO 6.1 Test the performance of Snubber circuit.	6	*Performance of Snubber circuit.	2	CO2
LLO 7.1 Test the effect of variation of resistance in R triggering circuit on the firing angle of SCR.	7	*Resistance triggering circuit of SCR.	2	CO2
LLO 8.1 Test the effect of variation of resistance and capacitance in RC triggering circuit on the firing angle of SCR.	8	RC triggering circuit of SCR	2	CO2
LLO 9.1 Perform the triggering of SCR using Pulse transformer	9	Triggering of SCR using Pulse transformer	2	CO2

FUNDAMENTALS OF POWER ELECTRONICS **Course Code : 313335**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 10.1 Perform the operation of Class A commutation circuit.	10	*Class A (Load Commutation) commutation circuit.	2	CO2
LLO 11.1 Perform the operation of Class F commutation circuit.	11	Class F (Line Commutation) commutation circuit	2	CO2
LLO 12.1 Measure output voltage of single phase half wave controlled rectifier by using CRO/DSO. LLO 12.2 Use various controls of the CRO/DSO	12	*Operation of single phase half wave controlled rectifier with resistive load.	2	CO2 CO3
LLO 13.1 Measure output voltage of single phase half wave controlled rectifier by using CRO/DSO. LLO 13.2 Use various controls of the CRO/DSO	13	Operation of single phase half wave controlled rectifier with RL load without freewheeling diode.	2	CO2 CO3
LLO 14.1 Measure output voltage of single phase half wave controlled rectifier by using CRO/DSO. LLO 14.2 Use various controls of the CRO/DSO	14	*Operation of single phase half wave controlled rectifier with RL load with freewheeling diode.	2	CO2 CO3
LLO 15.1 Measure output voltage of single phase full wave controlled rectifier by using CRO/DSO. LLO 15.2 Use various controls of the CRO/DSO	15	Operation of single phase full wave controlled rectifier with R load.	2	CO2 CO3
LLO 16.1 Measure output voltage of single phase full wave controlled rectifier by using CRO/DSO. LLO 16.2 Use various controls of the CRO/DSO	16	*Operation of single phase full wave controlled rectifier with RL load.	2	CO2 CO3
LLO 17.1 Measure output voltage of three phase full wave controlled rectifier by using CRO/DSO. LLO 17.2 Use various controls of the CRO/DSO	17	Operation of three phase full wave controlled rectifier with R load.	2	CO2 CO3
LLO 18.1 Measure the output voltage with different firing angles of the controlled rectifier available in your laboratory	18	*Voltage control using controlled rectifier.	2	CO2 CO3
LLO 19.1 Measure output voltage of single phase half wave bridge inverter by using CRO/DSO. LLO 19.2 Use various controls of the CRO/DSO	19	*Operation of single phase half wave bridge inverter with resistive load.	2	CO2 CO3
LLO 20.1 Measure output voltage of single phase full wave bridge inverter by using CRO/DSO. LLO 20.2 Use various controls of the CRO/DSO	20	Operation of single phase full wave bridge inverter with resistive load.	2	CO2 CO3

FUNDAMENTALS OF POWER ELECTRONICS **Course Code : 313335**

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 21.1 Measure output voltage of single phase half wave bridge inverter by using CRO/DSO. LLO 21.2 Use various controls of the CRO/DSO	21	Operation of single phase half wave bridge inverter with RL load.	2	CO2 CO3
LLO 22.1 Measure output voltage of single phase full wave bridge inverter by using CRO/DSO. LLO 22.2 Use various controls of the CRO/DSO	22	Operation of single phase full wave bridge inverter with RL load	2	CO2 CO3
LLO 23.1 Measure the output voltage of chopper by varying duty cycle. LLO 23.2 Use various controls of the CRO/DSO	23	Operation of step-up chopper.	2	CO2 CO4
LLO 24.1 Measure the output voltage of chopper by varying duty cycle. LLO 24.2 Use various controls of the CRO/DSO	24	*Operation of step-down chopper.	2	CO2 CO4
LLO 25.1 Test the performance of charge controller in PV system.	25	Charge controller in PV system	2	CO4 CO5
LLO 26.1 Observe the operation of AC to AC converter (with DC link). LLO 26.2 Interpret the input and output profile of the AC to AC converter (with DC link).	26	*Demonstration of AC to AC converter (with DC link) used in wind power plant.	2	CO3 CO4 CO5
LLO 27.1 Control the speed of fan using TRIAC.	27	*Speed control of fan using TRIAC.	2	CO3 CO5

Note : Out of above suggestive LLOs -

- '*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING)

Micro project

- Build a power electronic circuit to produce variable voltage for a given application using following steps. 1) Identify voltage range for a given application. 2) Select circuit components suitable for the identified voltage range. 3) Connect circuit components to build power electronic circuit controlling voltage. 4) Test the circuit for the production of variable voltage. 5) Prepare a report on the circuit built and submit the same.
- Prepare a report on commercial or industrial applications of power electronics devices by performing following activities. 1) Identify 3 to 5 relevant applications. 2) Visit site and understand role of power electronic devices in identified applications. 3) Write the specifications of major components in the applications. 4) Prepare block diagram or process flow diagram of the applications.
- Prepare a report on the ratings/specifications and applications of various power electronic devices. 1) Select any 3 to 5 power electronic devices. 2) Visit manufacturers' site or official websites of power electronic devices

manufacturers and note the specifications or ratings of the selected power electronic devices. 3) Compare selected power electronics devices based on collected information along with their applications.

- Build a circuit of charge controller for a given battery using following steps. 1) Write specifications of a given battery. 2) Select circuit components required for charge controller circuit suitable for given battery. 3) Connect circuit components to build charge controller. 4) Test change controller for controlling power flow through battery. 5) Prepare a report on the charge controller and submit the same.
- Any other relevant microproject assigned by subject teacher.

Assignment

- Numerical on losses in power electronic device.
- Prepare a report on evolution of power electronic devices.
- Numerical on output voltage of given controlled converter.
- Numerical on DC output voltage of given chopper.
- Prepare a report on testing the performance of GTO.
- Any other relevant assignment given by subject teacher.

Note :

- Above is just a suggestive list of microprojects and assignments; faculty must prepare their own bank of microprojects, assignments, and activities in a similar way.
- The faculty must allocate judicial mix of tasks, considering the weaknesses and / strengths of the student in acquiring the desired skills.
- If a microproject is assigned, it is expected to be completed as a group activity.
- SLA marks shall be awarded as per the continuous assessment record.
- For courses with no SLA component the list of suggestive microprojects / assignments/ activities are optional, faculty may encourage students to perform these tasks for enhanced learning experiences.
- If the course does not have associated SLA component, above suggestive listings is applicable to Tutorials and maybe considered for FA-PR evaluations.

VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED

Sr.No	Equipment Name with Broad Specifications	Relevant LLO Number
1	SCR: Irms = 16A, IH = 100mA, IL = 200mA, IGT = 90 to 35 mA, VGT = 3 to 1 V, Vrms = 1600V	1,2,6,7,8,10,11,9,12,13,14,15,16,17,18
2	Power MOSFET: Vds-400V, ID-10A-6.3A Pd-125W	1,3,23,24
3	IGBT: Vces = 1200V, VGE = 20V, IC = 139 to 93A, PD = 650 to 300W	1,4,19,20,21,22
4	TRIAC: It = 4A, IGT = 10mA, Vt = 600V.	1,5
5	Rheostat: Nicrome wire, 300ohm, 10A, 400V	12,13,14,15,16,17,19,20,21,22
6	Variable inductive load: Single phase,250V, 2.5kW continuously variable core type	12,13,14,15,16,17,19,20,21,22
7	CRO/Digital Oscilloscope with probes: 20MHz, dual channel, sensitivity = 1mV/div., Max Input = 400V, Power supply = 230VAC.	12,13,14,15,16,17,19,20,21,22
8	Clamp on meter: Current = 0 to 400A, Voltage = 0 to 600V	2,3,4,5,25,27
9	AC and DC Ammeter: Range = 0 to 20A, Sensitivity = 0.5A/div.	25,27
10	AC and DC Voltmeter: 0 to 300V, Sensitivity = 1V/div.	25,27
11	Multimeter: 2000 count digital display, 1000V DC/750 V AC ranges, 10 A AC/DC ranges	All

FUNDAMENTALS OF POWER ELECTRONICS **Course Code : 313335**

IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table)

Sr.No	Unit	Unit Title	Aligned COs	Learning Hours	R-Level	U-Level	A-Level	Total Marks
1	I	Power Electronic Devices	CO1	8	2	6	4	12
2	II	Protection and Firing Circuit of Thyristor	CO1,CO2	11	4	10	4	18
3	III	Controlled Converters	CO2,CO3	14	2	14	6	22
4	IV	DC-DC Converters	CO2,CO4	7	2	4	4	10
5	V	Applications of Power Electronics	CO3,CO4,CO5	5	2	4	2	8
Grand Total				**45**	**12**	**38**	**20**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- 30 Marks of Theory FA shall be obtained from an average mark of two unit tests (each of 30 marks) held in the semester. At least 2 COs should be covered in each unit test.
- Continuous assessment shall be based on process and product related performance indicators and laboratory experiences. Each practical shall be assessed for 25 marks considering 60% weightage to process and 40% weightage to product.
- Rubrics of continuous assessment of practical, including performance indicators, shall be designed by concerned course teacher.

Summative Assessment (Assessment of Learning)

- End semester, theory summative assessment of 70 marks shall be based on offline mode of written examination.
- End semester, practical summative assessment of 25 marks shall be based on student's performance in end semester practical exam.

XI. SUGGESTED COS - POS MATRIX FORM

Course Outcomes (COs)	Programme Outcomes (POs)							Programme Specific Outcomes* (PSOs)		
	PO-1 Basic and Discipline Specific Knowledge	PO-2 Problem Analysis	PO-3 Design/ Development of Solutions	PO-4 Engineering Tools	PO-5 Engineering Practices for Society, Sustainability and Environment	PO-6 Project Management	PO-7 Life Long Learning	PSO-1	PSO-2	PSO-3
CO1	3	2	-	3	-	-	3			
CO2	3	2	1	3	-	-	2			
CO3	3	2	2	3	-	1	2			
CO4	3	2	2	3	-	1	2			
CO5	2	3	2	2	2	2	2			

FUNDAMENTALS OF POWER ELECTRONICS **Course Code : 313335**

Legends :- High:03, Medium:02,Low:01, No Mapping: -
*PSOs are to be formulated at institute level

XII. SUGGESTED LEARNING MATERIALS / BOOKS

Sr.No	Author	Title	Publisher with ISBN Number
1	P S. Bimbhra	Power Electronics	KHANNA PUBLISHERS, ISBN:978-8174092793
2	Muhammad H. Rashid	Power Electronics Handbook	Butterworth-Heinemann Inc, ISBN:978-0128114070
3	Muhammad H. Rashid	Power Electronics: Devices, Circuits, and Applications	Pearson Education, ISBN:978-8120345317
4	M D Singh, K B Khanchnadani	Power Electronics	McGraw Hill Education, ISBN:9780070583894

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://nptel.ac.in/courses/108102145	Course on Power Electronics by IIT Delhi
2	https://nptel.ac.in/courses/108105066	Course on Power Electronics by IIT Kharagpur
3	https://nptel.ac.in/courses/108101038	Course on Power Electronics by IIT Bombay
4	https://ocw.mit.edu/courses/6-334-power-electronics-spring-2007/	Course on Power Electronics by MIT Opencourseware
5	https://youtube.com/playlist?list=PLSnw1KE0TFkVu05Ws0Ax143gZYmxPMCoY&si=FWLw-jfnLxC_l-4j	Laboratory course on Power Electronics by RGUKT Basar
6	https://www.youtube.com/playlist?list=PL4emuJKx0B8aREwkC5BEOw2OZ48puPyOG	Videos on Power Electronics
7	https://3dcircuits.engineering.dartmouth.edu/powani.html	Animation on Chopper and Rectifier

Note :

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students