ADVANCE POWER ELECTRONICS **Course Code : 315340**

Programme Name/s	**: Electronics & Tele-communication Engg./ Electronics & Communication Engg./ Electronics Engineering/ Industrial Electronics/**
Programme Code	**: EJ/ ET/ EX/ IE**
Semester	**: Fifth**
Course Title	**: ADVANCE POWER ELECTRONICS**
Course Code	**: 315340**

I. RATIONALE

Advance Power Electronics course is designed to develop skills to use advance power electronic devices and control strategies for complex and industrial applications. This course will equip the students with the required knowledge and skill sets to provide solutions to real-world problems.

II. INDUSTRY / EMPLOYER EXPECTED OUTCOME

The aim of this course is to help students to attain the following industry/employer expected outcome through various teaching learning experiences:
"Maintain converters, drives comprising of power electronic devices"

III. COURSE LEVEL LEARNING OUTCOMES (COS)

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

- CO1 - Select relevant protection circuit for different power electronics devices.
- CO2 - Use DC-DC converters for different quadrant applications.
- CO3 - Analyze the performance of multilevel inverters.
- CO4 - Evaluate the performance parameters of voltage stabilizer and uninterrupted power supply.
- CO5 - Maintain electric drives used in various industrial applications.

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	
315340	ADVANCE POWER ELECTRONICS	APE	DSE	4	-	2	-	6	2	3	30	70	100	40	25	10	25#	10	-	-	150

Total IKS Hrs for Sem. : 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.* 10 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 Describe construction and working of given power electronic device. TLO 1.2 Suggest suitable power electronics devices for the given application. TLO 1.3 Describe the given protection circuit for the power electronic device with the help of suitable sketch. TLO 1.4 Explain thermal protection used for SCR.	**Unit - I Modern Power Devices and Protection Circuits** 1.1 SIT, MCT and FCT Power devices: Symbol, construction, working , V-I characteristics and applications 1.2 d_i/d_t protection circuit and snubber circuit 1.3 d_V/d_t protection circuit and snubber circuit 1.4 Thermal Protection of SCR : Need, thermal resistance and heat sinks specification	Lecture using Chalk-Board Demonstration Video Demonstrations Presentations
2	TLO 2.1 Describe the control strategies of chopper. TLO 2.2 Classify choppers on the basis of quadrant operation. TLO 2.3 Explain working of a given chopper with suitable sketches (circuit diagram and output waveforms). TLO 2.4 Describe the operation of given type of SMPS with suitable sketches.	**Unit - II DC to DC converters** 2.1 Function of Chopper, types, control strategies of chopper: constant frequency and variable frequency system 2.2 Classification of choppers on the basis of Quadrant operation 2.3 3Chopper Circuit diagram using MOSFET, mode of operation, wave forms : First-quadrant (Type-A),Second-quadrant (Type-B), Type-C (Two-quadrant Type-a), Type-D (Two-quadrant Type-b), Four-quadrant (Type-E) 2.4 SMPS: Fly back converter, Push pull converter	Lecture using Chalk-Board Hands-on Presentations Video Demonstrations

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.
3	TLO 3.1 Compare the features of VSI and CSI. TLO 3.2 Describe working principle of current source inverter. TLO 3.3 Select appropriate power electronics components to design three-Phase 180° Mode and 120° mode VSI circuit. TLO 3.4 Describe working principle of Sinusoidal pulse width modulated inverter circuit.	**Unit - III Multi level Inverters** 3.1 Inverter-Concept, types-Voltage Source Inverter(VSI) and Current Source Inverter(CSI) 3.2 Single phase CSI - Working with ideal switches and waveforms (R load) 3.3 Three phase bridge voltage source inverter: 180° mode 120° mode -Working with ideal switches and waveforms (R load) 3.4 Pulse width modulation : need, types: Sinusoidal Pulse Width Modulation (SPWM), Multiple Pulse Width Modulation(MPWM) SPWM: concept, working principle and waveforms	Lecture using Chalk-Board Video Demonstrations Presentations
4	TLO 4.1 Explain need of voltage stabilizer. TLO 4.2 Select relevant voltage stabilizer for the given application. TLO 4.3 Compare the features and specification of On-line and Off-line UPS. TLO 4.4 Compare features of the given types of batteries.	**Unit - IV AC voltage stabilizer and Uninterruptable Power supply** 4.1 Stabilizer: Need, definition, classification, basic block diagram, applications 4.2 Types of stabilizer: Relay type, Servo type, static voltage Stabilizer: Circuit diagram, Working, advantages, disadvantages and applications . 4.3 UPS specification: features of On-line and Off-line UPS Specifications Input Voltage Range, DC Voltage Range, Transient Response, Response Time, Total Harmonic Distortion, output frequency, output waveforms, Transient Recovery, load power factor and types of Protection circuit 4.4 Rechargeable Batteries – Classification- Lithium-Ion (Li-Ion) battery, Lithium Nickel Manganese Cobalt Oxide (NMC) and Lithium Nickel Cobalt Aluminum Oxide (NCA). Specification: back up time, power rating, and transfer time	Lecture using Chalk-Board Demonstration Video Demonstrations

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.
5	TLO 5.1 Describe working principle of Variable frequency drives. TLO 5.2 Describe the operation of charge controller used in photovoltaic (PV) System. TLO 5.3 Explain why AC to AC converter used in wind power generation. TLO 5.4 Explain with sketches the working of the Electrical traction system. TLO 5.5 Explain the role of electronic control unit of electric vehicle. TLO 5.6 Describe the working of drive mechanism of electrical vehicle.	**Unit - V Electric Drives and Industrial Applications** 5.1 Variable frequency drives (VFD): Need, Block diagram, working principle, Advantages, disadvantages and its applications 5.2 Charge controller: Concept, types, applications in Photovoltaics (PV) system with block diagram with focus on inverter 5.3 AC to AC converter using DC link: Concept, applications in Wind Power Generation and with focus on VFD 5.4 Electrical traction system: Introduction, function of each block with focus on Drive mechanism and applications 5.5 Electrical vehicle(EV)- Plug-in Electrical vehicle (PEV) and Plug in Hybrid electric Vehicle(PHEV): Block diagram, function of each block with focus on Drive mechanism and applications	Lecture using Chalk-Board Presentations Video Demonstrations Site/Industry Visit

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 Test the protection scheme of SCR by d_V/d_t method.	1	*Protection circuit for SCR based on dv/dt method	2	CO1
LLO 2.1 Design and implementation of a Type-A chopper (Power MOSFET based) circuit in MATLAB LLO 2.2 Simulate Type-A chopper and observe the waveforms.	2	Simulation of Type-A chopper (Power MOSFET based) circuit using MATLAB Simulink/SCILAB /relevant software	2	CO2
LLO 3.1 Design and implementation of a Type-E chopper (Power MOSFET based) circuit in MATLAB LLO 3.2 Simulate Type-E chopper and observe the wavefomrs	3	*Simulation of Type-E chopper (Power MOSFET based) circuit using MATLAB Simulink/SCILAB /relevant software	2	CO2
LLO 4.1 Simulate Buck-Boost Converter Circuit using MATLAB/PSIM	4	Simulation of input output voltage of Buck-Boost Converter Circuit by varying duty ratio using MATLAB Simulink/SCILAB /relevant software	2	CO2
LLO 5.1 Simulate a three-phase voltage source inverter circuit operating in 180 degree mode using MATLAB and Simulink and observe the waveforms. LLO 5.2 Simulate a three-phase voltage source inverter circuit operating in 120 degree mode using MATLAB and Simulink and observe the waveforms.	5	Simulation of 180 degree mode and 120 degree mode of three Phase Voltage Source Inverter Circuit using MATLAB Simulink/SCILAB /relevant software	2	CO3

Practical / Tutorial / Laboratory Learning Outcome (LLO)	Sr No	Laboratory Experiment / Practical Titles / Tutorial Titles	Number of hrs.	Relevant COs
LLO 6.1 Simulate sinusoidal pulse width modulation (PWM)using MATLAB Simulink/SCILAB /relevant software	6	*Simulation of sinusoidal PWM Waves using MATLAB Simulink/SCILAB /relevant software	2	CO3
LLO 7.1 Set up the UPS in a test environment, ensuring correct connections to input and output loads, and configuring any necessary settings	7	Measurement of voltages at different test points and verify specifications of UPS with the datasheet	2	CO4
LLO 8.1 Measure and record the output voltage of the servo-type voltage stabilizer for a range of AC input voltages.	8	Measurement of the output voltage for servo type voltage stabilizer for different values of ac input voltage	2	CO4
LLO 9.1 Measure the voltage and current of a lithium-ion battery under various operating conditions, such as during charging, discharging, and at rest.	9	*Test Performance of lithium ion battery	2	CO4
LLO 10.1 Measure and record key electrical parameters of the PV system, including voltage, current, and power output from the PV panels.	10	*Test the performance of Charge controller in PV System	2	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

- Develop a Battery Management System (BMS) for lithium-ion or other rechargeable batteries, focusing on monitoring and balancing the cells to extend battery life and ensure safety.. (Components: Voltage and temperature sensors Balancing circuitry (resistive or active) Microcontroller or dedicated BMS IC
- Design a DC-DC converter circuit to efficiently step up (boost) or step down (buck) voltage levels for a specific application, such as powering a microcontroller or LED system.
- Develop a small solar-powered lighting system for use in gardens, pathways, or emergency lighting. (Components: PV panel (appropriate size for the desired lighting output) LED lights Rechargeable battery (e.g., Li-ion or NiMH) Charge controller (or a simple battery protection circuit) Light sensor (optional, for automatic control))
- Build a DC-DC converter circuit to efficiently step up (boost) or step down (buck) voltage levels for a specific application, such as powering a microcontroller or LED system.
- Develop a portable solar-powered USB charger for charging small electronic devices such as smartphones or tablets.(Components: PV panel (with enough output to charge devices) DC-DC converter (to step up voltage to 5V USB standard) USB output module Rechargeable battery (optional, for storing energy))
- Build a small, solar-powered fan for ventilation in areas like small rooms or greenhouses.(Components: Small PV panel (sufficient to power a DC fan) DC fan (12V or 5V) Battery for energy storage (optional for continuous operation) Basic DC-DC converter (if needed to match voltage requirements))

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=35 to 90mA,VGT= 1 to 3 V,Vrms=1600V	1
2	CRO : Dual Channel, 4 Trace CRT / TFT based Bandwidth 20 MHz/30 Mhz X10 magnification 20 nS max sweep rate, Alternate triggering ,Component tester and with optional features such as Digital Read out , USB interface	1,7,8
3	Multimeter : 2000 count digital display , 1000V DC / 750 V AC ranges, 10A AC/DC range	1,7,8,9,10
4	Regulated power supply: 0- 30 Volt, 2 A with digital display, with S.C. protection	1,8,9
5	MATLAB-SIMULINK / Scilab software, Proteus software, Multisim software	2,3,4,5,6
6	Lamp Load 2 kVA, 10 bulbs each 200 W	7,9
7	Servo Voltage Stabilizer- 2KVA, Output Voltage: 230 V, Load current: 8.5 A, Input Voltage: 170-290 V, Input frequency: 50Hz-60Hz	8
8	"UPS (uninterrupted power supply) kit:Mains : 230V AC 1-phase, 50 Hz,DC input : 12v DC Output : 230v AC(Sine Wave), Battery:12V,26 AH, 60W Bulb:holder with power chord for loading "	8

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	Modern Power Devices and Protection Circuits	CO1	6	2	4	4	10
2	II	DC to DC converters	CO2	10	4	6	6	16
3	III	Multi level Inverters	CO3	8	2	6	8	16
4	IV	AC voltage stabilizer and Uninterruptable Power supply	CO4	8	2	4	6	12
5	V	Electric Drives and Industrial Applications	CO5	8	2	4	10	16
Grand Total				**40**	**12**	**24**	**34**	**70**

X. ASSESSMENT METHODOLOGIES/TOOLS

Formative assessment (Assessment for Learning)

- Two offline unit tests of 30 marks and average of two unit test marks will be consider for out of 30 marks. For formative assessment of laboratory learning 25 marks Each practical will be assessed considering 60% weightage to process, 40% weightage to product.

Summative Assessment (Assessment of Learning)

- End semester assessment of 70 marks. End semester summative assessment of 25 marks for laboratory learning.

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	2	1	1	1	1		2			
CO2	1	2	2	2	2		2			
CO3	1	2	2	2	2		2			
CO4	1	2	2	2	2	2	2			
CO5	1	2	2	2	3	2	3			

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	Muhammad H. Rashid	Power Electronics: Devices, Circuits, and Applications, 4e	Pearson Education, ISBN-13 978-8120345317
2	M D Singh K B Khanchandani	Power Electronics	McGraw Hill Education, ISBN-13 978-0070583894
3	P.S.Bimbhra	Power Electronics	Khanna Publisher, New Delhi, SBN-13 ?978-8195123124
4	B.R.Gupta And V.Singhal	Power Electronics	S.K.Kataria and Sons, ISBN-13 978-8185749532
5	Madhukar Waware, D.S.More, Vijay Mohale, Abhay Wagh	Power Electronics and Its Applications	Khanna Book Publishing ,ISBN-13 ? : ? 978-9355380425

XIII . LEARNING WEBSITES & PORTALS

Sr.No	Link / Portal	Description
1	https://www.ti.com/lit/ml/slua618a/slua618a.pdf?ts=1673408094214&ref_url=https%253A%252F%252Fwww.google.com%252F	dv/dt Protection, di/dt Protection
2	https://afdc.energy.gov/fuels/electricity-research	Electric Vehicle Smart-Charge Management

ADVANCE POWER ELECTRONICS **Course Code : 315340**

Sr.No	Link / Portal	Description
3	https://nptel.ac.in/courses/108102145	Course on Power Electronics by IIT Bombay
4	https://nptel.ac.in/courses/108101038	Course on Power Electronics by IIT Bombay
5	https://www.youtube.com/watch?v=39toaD7jFZo	electric locomotive circuit diagram | power circuit of locomotive | electric traction
6	https://www.youtube.com/watch?v=VbrQVcrVcmc	DC -DC converters
7	https://www.youtube.com/watch?v=vCrFplXxuaQ&list=PL9JVQL_o-6m_Hw3aF9d81M7SzmmqPfPFN	Power Electronics using MATLAB Simulink
8	https://www.youtube.com/watch?v=dgKmdbuSOVc&list=PL0ocI_oN1DbKGskIeaFidBoL68jMWutF8	Power Electronics using MATLAB Simulink

Note :

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