

**NATIONAL INSTITUTE OF TECHNOLOGY
ANDHRA PRADESH**



**Course Structure for the Post-Graduate Programme
MASTER OF TECHNOLOGY
in
POWER ELECTRONICS AND DRIVES
DEPARTMENT OF ELECTRICAL ENGINEERING
Effective from 2025-26**



NATIONAL INSTITUTE OF TECHNOLOGY ANDHRA PRADESH

VISION

To nurture and produce highly competent engineers, scientists and entrepreneurs committed towards catering to futuristic societal challenges through holistic education synergetic with innovations and vibrant research eco-system.

MISSION

- To implement best practices in teaching-learning methodologies for establishing dynamic knowledge-connected society.
- To create a conducive environment for carrying out research in multi-disciplinary areas and thereby nurturing novel thinking capabilities.
- To strengthen the industry-institute interface to inculcate entrepreneurship abilities.
- To address all technological needs of the nation for self-sustenance.

DEPARTMENT OF ELECTRICAL ENGINEERING

VISION

Aiming to nurture globally competent electrical engineers in research and innovation through quality education and develop cutting edge technologies for the betterment of society

MISSION

- M1. Effective technology adoption into teaching and learning Strategies by faculty that result in observable students' achievement
- M2. Create an open platform for innovative research work in sustainable electrical power systems
- M3. Nurture creative thinking with understanding engineering principles and develop real-time solutions for global problems with industry collaboration
- M4. Deploy energy efficient and green energy technologies to address social, environmental, and economical effects

Department of Electrical Engineering:

About the Department:

The Department of Electrical Engineering at the National Institute of Technology (NIT), Andhra Pradesh offers B. Tech., M.Tech., and Ph.D. programs which keenly emphasize global learning. The main theme of the department is to create a platform for knowledge assimilation, dissemination and generation. It is committed to work in emerging areas and develop sustainable technologies & innovations in the electrical engineering field. The students and faculty are encouraged to work in interdisciplinary projects with a stimulating and wonderful learning experience.



GRADUATE ATTRIBUTES

The Graduate Attributes are the knowledge skills and attitudes which the students are expected to possess at the time of graduation. These attributes are generic and are common to all engineering programs. These Graduate Attributes are identified by National Board of Accreditation.

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/Development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.



Programme Educational Objectives (PEOs) for the M.Tech. in Power Electronics and Drives (PED).

PEO1	To arm the engineering graduates with latest technology and skills in the areas of Power Electronics and Drives so as to excel in higher education and/or industry and/or teaching and/or research.
PEO2	To transform engineering graduates to expert engineers so that they could comprehend, analyse, design and create novel products and solutions to problems in the areas of Power Electronics and Drives that are technically sound, economically feasible and socially acceptable.
PEO3	To train engineering graduates to exhibit professionalism, keep up ethics in their profession and relate engineering issues to address the technical and social challenges
PEO4	To improve the communication skills, willingness to work in groups and to develop multidisciplinary approach in problem solving

Programme Articulation Matrix (PEO vs. Mission) for the M.Tech. in Power Electronics and Drives.

PEO\Mission	M1	M2	M3	M4
PEO1	3	1	3	3
PEO2	3	2	3	3
PEO3	2	1	2	1
PEO4	2	3	2	3

1- Low correlation; 2 - Medium correlation; 3 - Strong correlation



Programme Outcomes (POs) for the M.Tech. in Power Electronics and Drives.

At the end of any M.Tech. programme in Power Electronics and Drives, Department of Electrical Engineering, NIT Andhra Pradesh, graduates will be able to:

PO1	have an ability to evaluate and analyse problems related to Power Electronics and incorporate the principles in the state of art drives
P02	be able to investigate critical power electronics and drives problems and to arrive at possible solutions independently, by applying theoretical and practical considerations
P03	be able to work on small, well-defined projects with particular goals to provide real time solutions pertaining to power electronics and drives
P04	be able to choose, learn, apply and develop appropriate control techniques including prediction for modern power electronic and drives using sophisticated digital controllers and IT tools.
PO5	be able to participate in collaborative-multidisciplinary engineering / research tasks and work as a team member giving due consideration to ecological and economical intricacies, and lead the team in specific areas
PO6	be able to confidently interact with the industrial experts for providing consultancy
PO7	be a responsible professional with intellectual integrity, code of conduct and ethics of research, being aware of the research outcomes and serve towards the sustainable development of the society

**Degree Requirements for M.Tech. (PED) Programme**

Category	Category Description	Credits
PCC (T)	Programme Core Course (Theory)	18
PCC (P)	Programme Core Course (Practical)/ Seminar/ Dissertation	4
DEC (T)	Department Elective Course	8
OEC (T)	Open Elective Course (MOOCs)	2
HEC (T/P)	Humanities Elective Course	2
Diss.	Dissertation	26

NOTE: The no. of credits required to award M.Tech. degree is 60 as per the curriculum.

Sem.	PCC (T)	PCC (P)	DEC (T)	OEC (MOOCs)	HEC (T/P)	Diss.	Total
I	9	2	4	2	0	0	17
II	9	2	4	0	2	0	17
III	0	0	0	0	0	13	13
IV	0	0	0	0	0	13	13
Total						60	60

Note:

PCC: Programme Core Courses

OEC: Open Elective Courses

T: Theory

PED: Power Electronics and Drives

DEC: Departmental Elective Courses

HSC: Humanities Elective Courses

P: Practical

**I - Year I - Semester**

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	25EE601	Electrical Drive Systems	3	0	0	3	PCC (T)
2	25EE602	Design of Power Converters	3	0	0	3	PCC (T)
3	25EE603	Electrical Machine Analysis	3	0	0	3	PCC (T)
4	25EE604	Power Converters Lab	0	1	2	2	PCC (P)
5	25EE6XX	Department Elective – I	2	0	0	2	DEC (T)
6	25EE6XX	Department Elective – II	2	0	0	2	DEC (T)
7	XXXXXXX	Open Elective – I (MOOCs)	2	0	0	2	OEC
		Total	15	1	2	17	

I - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	25EE605	Advanced Power Converters	3	0	0	3	PCC (T)
2	25EE606	Converters for Renewable Energy Systems	3	0	0	3	PCC (T)
3	25EE607	Advanced Electric Drive Systems	3	0	0	3	PCC (T)
4	25HS601	Advanced Technical Communication	2	0	0	2	HEC (T)
5	25EE608	Electric Drives Lab	0	1	2	2	PCC (P)
6	25EE6XX	Department Elective – III	2	0	0	2	DEC (T)
7	25EE6XX	Department Elective - IV	2	0	0	2	DEC (T)
		Total	15	0	5	17	

II - Year I – Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	25EE698	Dissertation Part A				13	PCC
2	25EE695	PCB Design	0	0	0	0	Audit
		Total				13	

II - Year II - Semester

S. No.	Course Code	Course Title	L	T	P	Credits	Cat. Code
1	25EE699	Dissertation Part B				13	PCC
		Total				13	



List of Department Electives

Department Elective I:

1. 25EE621 Energy Storage Devices and Applications
2. 25EE622 Control Theory
3. 25EE623 Applications of AI in Energy Systems

Department Elective II:

1. 25EE624 Electric Vehicle Technologies
2. 25EE625 Power Electronic Applications in Power Systems
3. 25EE626 Embedded Systems

Department Elective III:

1. 25EE627 Special Machines
2. 25EE628 Applications of Digital Signal Processors
3. 25EE629 Industrial Control Electronics

Department Elective IV:

1. 25EE630 Digital Controller Design
2. 25EE631 Industrial Power Electronics
3. 25EE632 Hybrid Electric Vehicles



25EE601	Electrical Drive Systems	PCC	3-0-0	3 Credits
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Pre-requisites: Power electronics and electrical machines.

Course Objective: To introduce basic concepts of load and drive interaction, speed control concepts of DC drives, speed reversal, regenerative braking aspects, design methodology.

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

CO1	Understand the basic drive system.
CO2	Analyse DC motor drives.
CO3	Simulate and study motor characteristics with different converter configurations.
CO4	Understand the operation and control of motors.

Syllabus:

Basic power electronic drive system, components - different types of loads, shaft-load coupling systems - stability of power electronic drive.

Conventional methods of DC motor speed control - single phase and three phase converter fed DC motor drive - Power factor improvement techniques- four quadrant operation- closed loop control.

Chopper fed drives, input filter design - Braking and speed reversal of DC motor drives using choppers, multiphase choppers – closed loop control - PV fed DC drives.

Text Books:

1. P.C Sen, 'Thyristor DC Drives', John Wiley and Sons, New York, 1991.
2. R. Krishnan, 'Electric Motor Drives – Modeling, Analysis and Control', Prentice-Hall of India Pvt. Ltd., New
3. Ned Mohan, Undeland and Robbin, 'Power Electronics: converters, Application and design', John Wiley and sons. Inc, Newyork, 2006.
4. Rashid M.H., ' Power Electronics-Circuits, Devices and Applications', Prentice Hall India, New Delhi, 2009.



25EE602	Design of Power Converters	PCC	3-0-0	3 Credits
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Pre-requisites: Power electronics.

Course Objective: To apply systematic approach for steady state analysis and design of rectifier and *DC-DC* power converter topologies.

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

CO1	To study and analyse three phase uncontrolled and controlled rectifiers.
CO2	To understand the operation and control of multi-pules rectifiers.
CO3	To analyse and design various <i>DC-DC</i> power converter systems.
CO4	To understand the working of soft switching converters.

Syllabus:

Three-phase uncontrolled rectifiers, three-phase controlled half wave, full bridge, semi/half bridge rectifiers – analysis of output and input parameters in detail-continuous and discontinuous mode of operation.

PWM and multi-pulse rectifiers: analysis, operation and control.

DC- DC converters – operation and steady state analysis of buck, boost, buck-boost, cuk - continuous and discontinuous mode of operation- power loss calculations- control and design - cascaded *DC-DC* converters – ripple reduction and its advantages- Design of magnetics.

Soft-switching *DC-DC* converters: zero-voltage-switching converters, zero-current - switching converters, control and design.

Text Books:

1. Ned Mohan, Undeland and Robbin, 'Power Electronics: converters, Application and design', John Wiley and sons. Inc, Newyork, 2006.
2. Rashid M.H., ' Power Electronics-Circuits, Devices and Applications', Prentice Hall India, New Delhi, 2009.
3. P.C Sen., 'Modern Power Electronics', Wheeler publishing Company, 1st Edition, New Delhi, 2005.
4. Batarseh, 'Power Electronic Circuits', John Wiley, 2nd Edition, 2004.
5. Kimbark, E.W., 'Direct Current Transmission-vol.1', Wiley Inter science, New York, 1971.



25EE603	Electrical Machine Analysis	PCC	3-0-0	3 Credits
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Pre-requisites: Basic course in electric machines, and electric and magnetic circuits.

Course Objective: This course deals with the development of mathematical models for electrical machines, suitable for the transient analysis of machine performance. This course gives a comprehensive understanding of various reference frame theory used in electrical machine analysis; mathematical transformations for decoupling variables. Mathematical modeling of induction motor and synchronous motor.

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

CO1	Understand the fundamental principles in electrical machine analysis.
CO2	Understand the concept of various reference frames and determine the dynamic model of an induction machine based on the dq0 transformation.
CO3	Determine the instantaneous torque developed in an induction machine.
CO4	Determine the torque developed in a salient pole synchronous machine.

Syllabus:

Basic principles of electrical machine analysis: introduction, magnetic circuits, singly excited electromechanical system- linear and nonlinear magnetics.

Reference frame theory: stationary reference frame- arbitrary speed reference frame- synchronous reference frame- rotating reference frame- power invariance and non-power invariance.

Symmetrical induction machines: introduction to steady state and transient modelling of electrical machines- derivation of dq0 model for a symmetrical induction machine- voltage, flux and torque equations - analysis of steady state model of induction machine.

Synchronous machines: review of steady state modelling of synchronous motors- voltage, flux, and torque- derivation of dq0 model for a salient pole synchronous machine- torque expression, analysis of steady state model of synchronous machine.

Text Books:

1. L.F Blume, 'Transformer Engineering', *John Wiley & Sons, Inc*, New York, 1967.
2. Fitzgerald & Kingsley, 'Electric Machinery' *McGraw Hill Co*. New Delhi, 2004.
3. Langsdorf A., 'Theory of Alternating Current Machinery', *McGraw Hill Co*. New Delhi, 2004.
4. Boldea I. & S.A.Nasar, 'Induction Machine Handbook', *CRC Press*, New York, 2002.
5. C.M.Ong, 'Dynamic Simulation of Electric Machinery using Matlab/Simulink', *Prentice Hall PTR*, New Jersey, 1998.
6. P.C. Krause, *Analysis of Electric Machinery*, McGraw Hill, New York, 1987.
7. C.V. Jones, *The Unified Theory of Electrical Machines*, Butterworth, London, 1967.



25EE604	Power Converters Lab	PCC	0-1-2	2 Credits
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Pre-requisites: Power electronics and electrical machines.

Course Objective: Analysis of basic power electronic circuits using simulation software and experimentation.

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

CO1	Test and analyze controlled and uncontrolled rectifier circuits and evaluating their performance parameters.
CO2	Design, test, and evaluate the performance of DC-DC converter topologies.
CO3	Develop and implement control strategies for DC motor drives using power converters.

Syllabus:

Simulation and Experimentation*:

1. Single phase half-controlled rectifier
2. Single phase full-controlled rectifier
3. Single phase full-wave controlled rectifier
4. Three phase half-controlled rectifier
5. Three phase full-controlled rectifier
6. *DC-DC* boost converter
7. *DC-DC* buck converter
8. *DC-DC* buck-boost converter
9. *DC-DC* interleaved converter
10. *DC-DC* bidirectional converter
11. Fly-back converter
12. Forward converter
13. Open-loop control of DC motor
14. Closed loop control of DC motor
15. Voltage control method for DC drive
16. Modelling of DC motor
17. Speed control techniques using controlled rectifiers
18. *DC-DC* resonant converter

*Minimum 10 number of experiments should be performed to fulfil curriculum

Text Books:

1. P.C Sen, 'Thyristor DC Drives', John Wiley and Sons, New York, 1991.
2. R. Krishnan, 'Electric Motor Drives – Modeling, Analysis and Control', Prentice-Hall of India Pvt. Ltd., New
3. Ned Mohan, Undeland and Robbin, 'Power Electronics: converters, Application and design', John Wiley and sons. Inc, Newyork, 2006.
4. H. W. Whittington, B. W. Flynn, D. E. Macpherson, 'Switched Mode Power Supplies', John Wiley & Sons Inc., 2nd Edition, 1997.



25EE605	Advanced Power Converters	PCC	3-0-0	3 Credits
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Pre-requisites: Power electronics.

Course Objective:

To analyse single and three phase inverter and ac-ac converter circuits and address relevant advanced topological and control techniques.

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

CO1	Analyze the operation and performance of inverter circuits and AC-AC converters.
CO2	Develop and implement control strategies for AC output power converters.
CO3	Evaluate and compare multilevel inverter topologies.
CO4	Review advanced power converter topologies.

Syllabus:

PWM techniques: VSI and CSI Analysis, numerical analysis.

Cyclo-converters: operation and analysis, numerical analysis.

Voltage Regulators: operation and analysis, numerical analysis.

Multilevel topologies-cascaded h-bridge, diode clamped, NPC, flying capacitor – operation-control.

Advance converter topologies: interleaved converters, matrix converters and multi-phase inverters- operation-control.

Text Books:

1. Ned Mohan, Undeland and Robbin, 'Power Electronics: converters, Application and design', John Wiley and sons. Inc, Newyork, 2006.
2. Rashid M.H., ' Power Electronics-Circuits, Devices and Applications', Prentice Hall India, New Delhi, 2009.
3. P.C Sen., 'Modern Power Electronics', Wheeler publishing Company, 1st Edition, New Delhi, 2005.
4. Andrzej M Trzynadlowski, 'Introduction to Modern Power Electronics, John Wiley and sons. Inc, New York, 1998.
5. BIN Wu, ' High Power Converters and AC Drives', IEEE press Wiley Interscience, a John wiley& sons Inc publication 2006.



25EE606	Converters for Renewable Energy Systems	PCC	3-0-0	3 Credits
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Pre-requisites: Fundamental knowledge about power electronic circuits, renewable energy systems.

Course Objective: This course offers a comprehensive understanding and analysis of various power electronic converters topologies used in renewable energy systems applications.

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

CO1	To understand the basic power electronic converter circuits for renewable energy systems applications.
CO2	Assess emerging power electronic technologies and common mode elimination techniques.
CO3	To analyse the topologies and working principles of the power electronic converter circuits used in renewable energy systems integration.
CO4	This is a higher level of subject that will help to work in demanding areas of power electronics in renewable energy systems.

Syllabus:

Fundamentals of power electronics in RES: Electrical characteristics of PV and wind, basic power converter topologies in solar based PV system and wind systems– PWM scheme and control for RES grid integration.

Advanced converters and control in RES: Multilevel inverters, interleaved converters, current source inverters, common mode voltage elimination topologies, control in mitigating capacitor unbalance issues. Case studies.

Bidirectional power flow converters and control for grid integration of energy storage systems and RES. Case studies.

Text Books:

1. N. Mohan, T. M. Undeland and W. P. Robbins, Power Electronics Converter Application and Design, Third Edition, John Wiley & Sons, 2004.
2. M. H. Rashid, Power Electronics, Circuits, Devices and Applications, Pearson, 2002, India.
3. K. Billings, Switch Mode Power Supply Handbook, McGraw-Hill, 1999, Boston.
4. Bin Wu, High-Power Converters and AC Drives, IEEE Press, A John Wiley & Sons, Inc Publication, New York, 2006.
5. Relevant literature review for case studies and course applications.



25EE607	Advanced Electric Drive Systems	PCC	3-0-0	3 Credits
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Pre-requisites: Electrical machines analysis.

Course Objective: This course gives a comprehensive understanding of various variable speed controls used in electrical drives. In addition, mathematical modeling of vector and direct torque control methods for induction motor and synchronous motor.

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

CO1	Understand the concept of vector and direct torque control of induction motor drive.
CO2	Understand the concept of space vector modulation.
CO3	Develop vector and direct torque control of PMSM drive.
CO4	Develop sensorless speed control techniques for AC drives.

Syllabus:

Induction motor drives: introduction of variable speed controls- scalar, vector control, direct and indirect field orientation-field weakening, direct torque control, direct torque control with space vector modulation, model predictive control (MPC).

PM synchronous motor: introduction to PM synchronous motor- various configurations - sinusoidal back-Emf PMSM- field oriented - direct torque control.

Sensorless speed control: signal injection- observer based methods-model based methods-back EMF-rotor-flux, reactive power- resistance estimation.

Text Books:

1. Paul C. Krause, Oleg Wasynczuk, Scott D. Sudhoff: "Analysis of Electric Machinery & Drive systems" *IEEE Press*, 2002.
2. Rama Krishnan: Electric motor drives: modeling, analysis, and control, *Prentice Hall*, 2001.
3. Rik De Doncker, Duco W. J. Pulle, André Veltman, 'Advanced Electrical Drives: Analysis, Modeling, Control' *Springer*, 2011.
4. Bimal K. Bose, 'Modern Power Electronics & AC Drives' *Phi Learning Pvt. Ltd*, 2nd Edition, New Delhi, 2002.
5. Fitzgerald & Kingsley, 'Electric Machinery' *McGraw Hill Co*. New Delhi, 2004.
6. D.W.Novotny, T.A. Lipo, and T.M. Jahns, 'Introduction to Electric Machines and Drives' *University of Wisconsin*, 1st Edition, 2010.



25HS601	Advanced Technical Communication	HEC	2-0-0	2 Credits
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Pre-requisites: None.

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

CO1	To gain foundational understanding of science communication.
CO2	To critically analyze and communicate scientific ideas.
CO3	To conceptualize and refine a research topic using scientific process.

Syllabus:

Module 1: Key characteristics of scientific writing- types of documents (journal articles, conference papers, reports, theses) IMRAD structure in detail (Introduction, Methods, Results, Discussion)-abstract- drafting titles.

Module 2: Scientific language- (clarity, brevity, precision)-common errors and how to fix them (grammar, style, tone)-organizing and synthesizing information-literature review and referencing-citation styles- using reference managers.

Module 3: Research paper writing and its constituents-research publication and ethics.

Module 4: Writing proposals (grants, research, project)- presenting research.

Text Books:

1. Bagla, Pallava, and V. V. Binoy, editors. *Bridging the Communication Gap in Science and Technology: Lessons from India*. Springer Nature, 2017.
2. Dean, Cornelia. *Am I Making Myself Clear? A Scientist's Guide to Talking to the Public*. Harvard University Press, 2009.
3. Gastel, Barbara, and Robert A. Day. *How to Write and Publish a Scientific Paper*. 8th ed., Cambridge University Press, 2016.
4. Hofmann, Angelika H. *Scientific Writing and Communication: Papers, Proposals, and Presentations*. 5th ed., Oxford University Press, 2022.
5. Schimel, Joshua. *Writing Science: How to Write Papers That Get Cited (and Proposals That Get Funded)*. Oxford University Press, 2012.
6. van Dam, Frans, Liesbeth de Bakker, Anne M. Dijkstra, and Eric A. Jensen, editors. *Science Communication: An Introduction. World Scientific Series on Science Communication*, vol. 1, World Scientific Publishing Co. Pte Ltd, 2020.



25EE608	Electric Drives Lab	PCC	0-1-2	2 Credits
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Pre-requisites: Power electronics and electrical machines.

Course Objective: Analysis of AC Drives using simulation software and experimentation.

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

CO1	Test and analyse the inverter circuits.
CO2	Develop V/F, vector control and DTC methods for IM and PMSM drives.
CO3	Develop sensorless speed control of IM and PMSM drives.

Syllabus:

Simulation and Experimentation*:

1. Single phase inverter
2. Analysis of 2-Level PWM techniques - simulation
3. Three phase inverter 120⁰ mode operation
4. Three phase inverter 180⁰ mode operation
5. Multi-phase inverter
6. Diode clamped MLI
7. Cascaded H-bridge MLI
8. Asymmetrical MLI topology
9. Analysis of MLI PWM techniques
10. V/F control of induction motor drive – open loop
11. V/F control of induction motor drive – closed loop
12. Direct field-oriented control of IMD
13. In-direct field-oriented control of IMD
14. Parameter estimation of IM
15. BLDC motor drive
16. Inductor generator operation
17. V/F control of PMSM drive
18. DTC of IMD - simulation
19. Sensor-less speed control of IMD – simulation

*Minimum 10 number of experiments should be performed to fulfil curriculum

Text Books:

1. P.C Sen, 'Thyristor DC Drives', John Wiley and Sons, New York, 1991.
2. R. Krishnan, 'Electric Motor Drives – Modeling, Analysis and Control', Prentice-Hall of India Pvt. Ltd., New
3. Ned Mohan, Undeland and Robbin, 'Power Electronics: converters, Application and design', John Wiley and sons. Inc, Newyork, 2006.
4. H. W. Whittington, B. W. Flynn, D. E. Macpherson, 'Switched Mode Power Supplies', John Wiley & Sons Inc., 2nd Edition, 1997.



25EE621	Energy Storage Devices and Applications	PCC	2-0-0	2 Credits
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Pre-requisites: Basic course in electric machines, electric and magnetic circuits

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

CO1	Understand the energy storage in power systems.
CO2	Analyse the energy storage technologies.
CO3	Analyse the applications of energy storage systems.

Syllabus:

Introduction to energy storage in power systems: importance of energy storage in modern energy systems, renewable and non-renewable resources, types of energy storage systems, applications of energy storage, challenges and future trends in energy storage.

Energy storage technologies and renewable power sources: electrochemical energy: batteries, fuel cells, electrostatic energy, electromagnetic energy, comparative analysis, environmental impacts of different technologies.

Features of energy storage systems: classification of energy storage systems, mechanical storage systems, types of storage systems, secondary batteries, flow batteries, chemical energy storage, hydrogen, synthetic natural gas.

Applications: utility use, consumer use, battery SCADA– aggregation of many dispersed batteries.

Text Books:

1. A.G.Ter-Gazarian, Energy Storage for Power Systems, The Institution of Engineering and Technology (IET) Publication, UK, (ISBN - 978-1 84919-219-4),2011, Second Edition.
2. Francisco Díaz-González, Andreas Sumper, Oriol Gomis-Bellmunt, Energy Storage in Power Systems, Wiley Publication, ISBN: 978-1-118-97130-7, Mar 2016.
3. Jenny Nelson, The Physics of solar cell, Imperial college Press.
4. James M. Eyer, Joseph J. Iannucci and Garth P. Corey, Energy Storage Benefits and Market Analysis, Sandia National Laboratories, 2004.
5. Pistoia, Gianfranco, and Boryann Liaw, Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost, Springer International Publishing AG, 2018.



25EE622	Control Theory	PCC	2-0-0	2 Credits
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Pre-requisites: Basic control, and linear algebra.

Course Objective: The main objective of the course is to understand the fundamental of physical systems in terms of its non-linear models.

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

CO1	Analyse the stability of linear systems.
CO2	Design state feedback controllers and observers.
CO3	Analyse non-linear systems using linear approximations.

Syllabus:

Introduction and linear foundations: state-space modeling of physical systems, vector differential equations and state transition matrix, review of stability and controllability and controller for linear systems.

Non-linear systems: characteristics and classification of nonlinear systems; phase plane analysis of nonlinear systems using linear approximation. limit cycle and periodic solutions. singular points and qualitative behaviour near singular points.

Stability and control of non-linear systems: lyapunov direct and indirect methods. input-to-state stability and relative stability; sliding mode control fundamentals, conceptual introduction to adaptive control.

Applications of non-linear control systems in power and energy systems.

Text Books:

1. Ogata, K., 'Modern Control Engineering', Prentice Hall of India, 2010.
2. C.T. Chen, 'Linear Systems Theory and Design', Oxford University Press, 3rd Edition, 1999.
3. M. Vidyasagar, 'Nonlinear Systems Analysis', 2nd edition, Prentice Hall, Englewood Cliffs, New Jersey 07632.
4. Hassan K. Khalil, 'Nonlinear Systems', Pearson Educational International Inc. Upper Saddle River, 3rd Edition.



25EE623	Applications of AI in Energy Systems	PCC	2-0-0	2 Credits
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Pre-requisites: None.

Course Objective:

The course is designed to expose the students to various artificial intelligence techniques and its applications to engineering field.

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

CO1	Understand ANN and apply ANN for controlling energy systems.
CO2	Develop Fuzzy Logic components for solving electrical engineering problems.
CO3	Program Bio-inspired optimization techniques and apply for solving few engineering problems.

Syllabus:

Introduction to AI: artificial neural networks (ANN): introduction, neural network models, architectures, knowledge representation, ANN learning process, multi-layer perceptrons-case studies.

Fuzzy logic fundamentals: introduction, fuzzy sets, membership function, fuzzy inference, defuzzification methods- -case studies.

GA-selection of optimization parameters, termination criterion, -case studies.

PSO-selection of optimization parameters, termination criterion, -case studies.

Text Books:

1. M.N. Cirstea, A. Dinu, J.G. Khor and M. McCormick: Neural and Fuzzy Logic Control of Drives and Power System, Newnes, 2002.
2. P. Vas: Artificial-Intelligence-Based Electrical Machines and Drives: Application of Fuzzy, Neural, Fuzzy- Neural, and Genetic-Algorithm-Based Techniques, Oxford University Press, 1999.
3. T. J. Ross: Fuzzy Logic with Engineering Application, 3rd Edition, John Wiley and Sons, 2010.
4. Dan Simon, Evolutionary Optimization Algorithms. 1st Edition, John Wiley and Sons, 2013.



25EE624	Electric Vehicle Technologies	2-0-0	2 Credits
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Pre-requisites: None.

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

CO1	Understand the global developments, standards and emerging research in EV sector.
CO2	Analyze the performance of Battery energy systems for electric vehicles.
CO3	Illustrate the configurations of different types of EV charging stations.

Syllabus:

Basic concepts of vehicle energy and fuel consumption: main elements of the energy conversion scheme in vehicles, energy domains in vehicle propulsion systems, upstream processes, energy density of on-board energy carriers, fuel efficiency, pathways to better fuel economy.

Vehicle power management in electric and hybrid electric vehicles: configurations and types of HEVs and EVs, regenerative braking.

Battery technologies and their performance in EVs: battery parameters, types of batteries, battery efficiency, battery testing, factors affecting battery failures.

EV charging infrastructure: wired charging station (Static): electric vehicle supply equipment, classifications, DC/AC charging station, wireless charging station (Dynamic), IEC standards.

Text Books:

1. Lino Guzzella and Antonio Sciarretta “Vehicle Propulsion Systems”, Springer, 2005
2. Xi Zhang and Chris Mi “Vehicle Power Management” Springer, 2011
3. James Larminie, John Lowry, “Electric Vehicle Technology Explained,” 2nd edition Wiley, 2012.
4. Sandeep Dhameja, “Electric Vehicle Battery Systems,” 1st edition Elsevier, 2001.
5. Naoui Mohamed, Flah Aymen, Mohammed Alqarni, Rania A. Turky, Basem Alamri, Ziad
6. M. Ali, Shady H.E. Abdel Aleem, “A new wireless charging system for electric vehicles using two receiver coils,” Ain Shams Engineering Journal, Volume 13, Issue 2, 2022.

Online Resources:

1. <https://www.iea.org/>, IEA Global EV Outlook 2023
2. <https://fame2.heavyindustries.gov.in/>, National Automotive Board (NAB), Ministry of Heavy Industries, Govt of India
3. <https://www.iso.org/>, International Organization for Standardization
4. <https://www.araiindia.com/>, Automotive Research Association of India (ARAI)
5. <https://www.siam.in/>, Society of Indian Automobile Manufacturers (SIAM)



25EE625	Power Electronic Applications in Power Systems	PCC	2-0-0	2 Credits
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Pre-requisites: Fundamental knowledge about power electronic circuits and power systems.

Course Objective: This course primarily serves to highlight the requirements of modern transmission and distribution systems and specific power electronic solutions to realize them. Transmission system behaviour is analysed in great detail in the basic and advanced courses on power systems.

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

CO1	Classify and explain the functioning of FACTS devices.
CO2	Understanding the harmonics and compensation techniques using power electronics.
CO3	Design of filter for transmission systems.

Syllabus:

Steady state and dynamic problems in AC systems: Flexible AC transmission systems (FACTS),

Principles of series and shunt compensation, description of static var compensators (SVC), thyristor controlled series compensators (TCSC), static phase shifters (SPS), static compensator (STATCOM), static synchronous series compensator (SSSC), modes of operation, voltage regulator and phase angle regulator (PAR), multi functional FACTS controller - unified power flow controller (UPFC), Interline power flow controller.

Filters: passive filters, shunt active filter - mitigation of harmonics and reactive power compensation.

Analysis of HVDC converters, rectifier and Inverter operation of graetz circuit without and with overlap. Output voltage waveforms and DC voltage in both rectifier and inverter operation.

Text Books:

1. N.G. Hingorani & Laszlo Gyugyi , Understanding FACTS , IEEE Press.
2. K.R. Padiyar, FACTS controllers in power transmission and distribution, New Age International publishers.
3. E. F. Fuchs & Mohammad A.S. Masoum, Power Quality in Power Systems and Electrical Machines, Elsevier Academic Press.
4. Antonio L., Steven H., Hand Book of Photovoltaic science and Engineering, 2nd Edition 2010



25EE626	Embedded Systems	PCC	2-0-0	2 Credits
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Pre-requisites: None.

Course Objective: This course gives a comprehensive understanding of hardware and software basics demanded by embedded industry, evaluating an embedded system, introduces ARM cortex M series cores employed for building application specific programmes.

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

CO1	Develop programs on embedded system for an application.
CO2	Understand the architectural features of ARM cortex M4 microcontrollers.
CO3	Understand the exception, interrupts and interrupt handling schemes.

Syllabus:

Fundamentals of embedded systems: overview of embedded; classification, applications, design metrics, and challenges; general purpose and domain specific processors; memory types; memory interfacing; sensors; Actuators

Embedded communication interfaces and software design: onboard and external communication- UART, SPI; embedded software development flow: build, flash, debug.

ARM cortex-M4 architecture and programming: evolution of arm processors, pipelining, and core families; ARM cortex-M4 architecture; instruction set overview

Exception and interrupt handling: exception types and vector table; NVIC and nested interrupt handling in cortex-M4; interrupt service routines, prioritization and latency considerations.

Text Books:

1. Introduction to Embedded Systems -Shibu K.V, McGraw Hill.
2. Embedded Systems Design –Santanu Chattopadhyay, PHI, 2013.
3. Joseph Yiu, The Definitive Guide to ARM Cortex-M3 and Cortex-M4 Processors, Newnes Publications; Third Edition, 2013.
4. David E. Simon -An Embedded Software Primer -, Pearson Education.



25EE627	Special Machines	PCC	2-0-0	2 Credits
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Pre-requisites: Fundamental knowledge about electrical machines.

Course Objective: This course imparts knowledge on construction, principle of operation and performance of special machines and development of control techniques for driving special machines.

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

CO1	To understand the construction of various special machines.
CO2	To understand the operation and performance of special machines.
CO3	To develop control schemes for converters which drive special machines.

Syllabus:

Permanent magnet brushless DC motors: Permanent magnet materials-principle of operation –types – magnetic circuit analysis – emf and torque equations – power converter circuits and their controllers – motor characteristics and control– applications.

Permanent magnet synchronous motors: principle of operation – ideal PMSM – EMF and torque equations – armature MMF –synchronous reactance – phasor diagram – torque/speed characteristics – power controllers – converter volt ampere requirements– applications.

Stepper motors: constructional features –operating principles-control- applications.

Synchronous reluctance motors: constructional features –operating principles – applications.

Text Books:

1. K. Venkataratnam, 'Special Electrical Machines', Universities Press (India) Private Limited, 2008.
2. T.J.E. Miller, 'Brushless Permanent Magnet and Reluctance Motor Drives', Clarendon Press, Oxford, 1989.
3. T. Kenjo, 'Stepping Motors and Their Microprocessor Controls', Clarendon Press London, 1984.
4. P.P. Aearnley, 'Stepping Motors – A Guide to Motor Theory and Practice', Peter Perengrinus London, 1982.
5. T. Kenjo And S. Nagamori, 'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1988.
6. E.G. Janardanan, 'Special Electrical Machines', PHI Learning Private Limited, Delhi, 2014.



25EE628	Applications of Digital Signal Processors	PCC	2-0-0	2 Credits
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Pre-requisites: Fundamental knowledge about digital signal processing and microprocessor.

Course Objective: This course introduces the fundamental concepts, analysis and design of signal processing applications using digital signal processors.

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

CO1	Analyze DSP architectures and develop programs using DSP instruction sets for real-time applications.
CO2	Implement signal processing algorithms on DSP platforms.
CO3	Design DSP based applications.

Syllabus:

Fundamentals of DSP and architectures: comparison of DSP and general-purpose microcontrollers; characteristics of real-time DSP applications; overview of DSP architectures; Introduction to popular DSP families

DSP programming and development: DSP instruction sets- addressing modes; fixed-point vs floating-point arithmetic considerations; development tools; introduction to TI's C2000 digital control ecosystem

Real-time signal processing applications: DSP implementation of filtering algorithms (FIR, IIR); frequency-domain processing using FFT; real-time sampling

DSP applications in power electronics and drives: DSP-based PWM generation for power converters, digital control, field-oriented control, PWM generation.

Text Books:

1. B. Venkataramani & M. Bhaskar, Digital Signal Processors: Architecture, Programming and Applications, 2nd Ed., Tata McGraw-Hill, 2010
2. Avtar Singh & S. Srinivasan, Digital Signal Processing Implementations Using DSP Microprocessors (TMS320C54x), 1st Ed., Thomson/Brooks Cole, 2004
3. Rulph Chassaing, DSP Applications Using C and the TMS320C6x DSK, 1st Ed., Wiley, April 2002



25EE629	Industrial Control Electronics	PCC	2-0-0	2 Credits
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Pre-requisites: Fundamental knowledge about analog, digital and Power electronic circuits.

Course Objective: This course gives a comprehensive understanding of various control circuits used in industries. Digital and analog control concepts are elaborated for design of various power electronic circuits. Further an overview of PLC's, stepper motor and servomotor with associated control circuits is given.

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

CO1	To understand the working of various Power electronic circuits and components used in industrial applications.
CO2	To analyze various analog controllers and signal conditioning circuits.
CO3	To design control circuits for industrial application.

Syllabus:

Analog Controllers - PID controllers, derivative overrun, integral windup, cascaded control, feed forward control, digital control schemes.

Sensors for high voltage and current applications

Signal conditioners-Instrumentation amplifiers; isolation circuits – cabling; magnetic and electro static shielding and grounding opto-electronic devices and control, electronic circuits for photo-electric switches-output signals for photo-electric controls; applications of opto-isolation, interrupter modules and photo sensors; fibre-optics; bar code equipment, application of barcode in industry.

Programmable logic controllers – logic systems- PLC programming- PLC wiring and ladder programmes.

Text Books:

1. Michael Jacob, 'Industrial Control Electronics – Applications and Design', Prentice Hall, 1995.
2. Petruzella, Frank D.. Programmable Logic Controllers, 3rd ed. McGraw Hill
3. Thomas E. Kissell, 'Industrial Electronics', Prentice Hall India, 2003
4. James Maas, 'Industrial Electronics', Prentice Hall, 1995



25EE630	Digital Controller Design	PCC	2-0-0	2 Credits
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Pre-requisites: Switch mode power conversion, fundamentals of electric drives, analysis and design of power electronic converters.

Course Objective: This course is designed to provide the students with a theoretical knowledge of the implementation of digital control of power electronic converters and motor drives using microcontroller/field programmable gate array (FPGA). This course will help the students to explore the benefits and challenges of implementing digital control.

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

CO1	Analyze the digital and microprocessor controllers.
CO2	Understand the closed-loop control of DC-DC converters.
CO3	Design of digital proportional-resonant and proportional integral controller.

Syllabus:

Introduction to digital control, microprocessor/FPGA: Why digital control, challenges in digital platform, fixed-point and floating-point representations, sampling, mathematical modelling of sampling, quantization and its impact on stability, s-domain to z-domain mapping, stability analysis in z-domain, discretization of analog controllers.

Closed-loop control of DC-DC converters: controller design techniques, discretization of analog controllers, different types of delays introduced by the digital controllers.

Digital proportional-resonant and proportional Integral controller design for a single-phase and a three-phase voltage source inverter.

Design of a digital controller in a buck fed DC motor. Digital V/F controller design in an induction machine.

Text Books:

1. B. C. Kuo, Digital Control Systems, Oxford University Press, 2012.
2. S. N. Vukosavic, Digital Control of Electrical Drives, Springer, 2017.
3. R. W. Erickson and D. Maksimovic, Fundamentals of Power Electronics, 2nd ed. Dordrecht, The Netherlands: Kluwer, 2001.



25EE631	Industrial Power Electronics	PCC	2-0-0	2 Credits
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Pre-requisites: Fundamental knowledge about power electronic circuits.

Course Objective: This course helps in devising the suitable power converters for various engineering applications.

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

CO1	Analyze the Power Electronic Application requirements.
CO2	Develop improved power converters for any stringent application requirements.
CO3	Improvise the existing control techniques to suit the application.

Syllabus:

Overview of the course- power converter topologies for induction heating- welding- lighting.

High voltage power supplies - power supplies for X-ray applications - power supplies for radar applications - power supplies for space applications - low voltage high current power supplies.

Applications of PE in automobiles: batteries, chargers, inverters, bi-directional DC-DC converters, motors, automotive electronics.

High-power drive systems for industrial applications: high power electric drives. industrial standards.

Text Books:

1. Ali Emadi, A. Nasiri, and S. B. Bekiarov: Uninterruptible Power Supplies and Active Filters, CRC Press, 2005.
2. M. Ehsani, Y. Gao, E. G. Sebastien and A. Emadi: Modern Electric, Hybrid Electric and Fuel Cell Vehicles, 1st Edition, CRC Press, 2004.
3. William Ribbens: Understanding Automotive Electronics, Newnes, 2003.



25EE632	Hybrid Electric Vehicles	PCC	2-0-0	2 Credits
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Pre-requisites: Fundamental knowledge about electrical machines, power converters.

Course Objective: This course introduces the fundamental concepts, analysis and design of hybrid and electric vehicles.

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

CO1	Understand mathematical models, performance and characteristics of hybrid electric vehicles.
CO2	Analyse the concepts, topologies and power flow control of electric traction systems.
CO3	Appraise the configuration and control of various hybrid electric motor drives.

Syllabus:

Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance.

Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, fuel efficiency analysis.

Introduction to electric components used in hybrid electric vehicles, configuration and control of DC and AC motor drives, drive system efficiency.

Matching the electric machine and the internal combustion engine (ICE), sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, communications, supporting subsystems.

Text Books:

1. Sira Ramirez, R. Silva Ortigoza, 'Control Design Techniques in Power Electronics Devices', Springer, 2006.
2. Siew-Chong Tan, Yuk-Ming Lai, Chi Kong Tse, 'Sliding mode control of switching Power Converters', CRC Press, 2011.
3. Bimal Bose, 'Power electronics and motor drives', Elsevier, 2006.
4. Ion Boldea and S. A. Nasar, 'Electric drives', CRC Press, 2005.



25EE695	PCB DESIGN	PCC	0-0-0	0 Credits
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Pre-requisites: Basic electronics.

Course Objective: This course is designed with an aim to make students familiar with printed circuit board (PCB) design and fundamentals of electronic circuits. Students will gain practical skills in activities such as circuit construction, exporting circuits to PCB layout, working and performing routing, among other techniques.

Syllabus:

Introduction, passive circuit elements: R, L and C, Resistor color coding, active circuit elements, surface mounting on PCBs.

Circuit Simulations using SPICE: operating point analysis, DC simulations, small-signal AC simulations, large signal simulations.

Understanding PCBs, single layer and multi-layer PCBs, holes, vias, layers limitations. hands-on training on PCB prototyping.

PCB layout design using PCB design software: Component footprint creation, design rule checking-practical PCB designing.

Text Books:

1. Jr. Coombs, Clyde F. (Editor), Happy T. Holden, 'Printed Circuits Handbook', McGraw-Hill, 2016.
2. Tim Williams 'The Circuit Designer's Companion', Newnes, 2004.