COEP Technological University Pune
(A Unitary Public University of Govt. of Maharashtra)

NEP 2020 Compliant

Proposed Curriculum Structure

M. Tech.

Electrical – Power Electronics and Machine Drives

(Effective from: A.Y. 2024-25)

PG Program [M. Tech. Electrical – Power Electronics and Machine Drives]
Proposed Curriculum Structure
W. e. f AY 2024-25

List of Abbreviations

Abbreviation	Title	No of courses	Credits	% of Credits
PSMC	Program Specific Mathematics Course	1	3	4.4%
PSBC	Program Specific Bridge Course	1	3	4.4%
PEC	Programme Elective Course	3	9	13.2%
MLC	Mandatory Learning Course	2	0	0%
PCC	Program Core Course	6	18	26.5%
LC	Laboratory Course	4	7	10.3%
OE/SE	Open/School Elective (OE/SE) other than particular program	1	3	4.4%
CCA	Co-curricular & Extracurricular Activities (CCA)	1	1	1.5%
SLC	Self Learning Course	2	6	8.8%
SBC	Skill Based Course	2	18	26.5%
	Total	**21**	**68**	**100%**

PG Program [M. Tech. Electrical – Power Electronics and Machine Drives]

Proposed Curriculum Structure

Semester I

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme L	T	P	S	Credits
1.	PSMC	PSMC-1	Mathematical Modeling of Electrical Machines	3	--	--	1	3
2.	PSBC	PSBC-1	Embedded Systems	3	--	--	1	3
3.	PEC-I	PEC-1	a. Wind and Solar Energy System b. Engineering Optimization c. Computational Electromagnetic d. Computer aided design of power electronics systems e. Any other course approved by BOS	3	-	--	1	3
4.	MLC	MLC-1	Research Methodology and Intellectual Property Rights	--	--	--	2	--
5.	MLC	MLC-2	Effective Technical Communication	--	--	--	1	--
6.	PCC	PCC-1	Advanced Control Theory	3	--	--	1	3
7.	PCC	PCC-2	Advanced Power Electronics	3	--	--	1	3
8.	PCC	PCC-3	DSP Applications to Power Electronics and Drives	3	--	--	1	3
9.	LC	LC-1	Embedded Systems Lab	--	--	4	--	2
10.	LC	LC-2	Advanced Power Electronics Lab	--	--	4	--	2
			Total	**18**		**8**	**9**	**22**

Note: Interdisciplinary Open Course (IOC): Every department shall offer one IOC course (in Engineering/Science/Technology). A student can opt for an IOC course offered by a department except the one offered by his /her department.

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PG Program [M. Tech. Electrical – Power Electronics and Machine Drives]
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Semester II

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme L	T	P	S	Credits
1.	OE	OE-1	Engineering Optimization	3	--	--	1	3
2.	PEC-II	PEC-2	a. Grid Interface of renewable Energy Systems b. Artificial Intelligence and Machine Learning c. Condition Monitoring of Electrical Apparatus d. Automotive Electronics e. Any course approved by BOS	3	--	--	1	3
3.	PEC-III	PEC-3	a. Energy Storage Systems b. Power Quality Issues and Mitigation c. Smart Grid Technologies d. High frequency magnetics for Power Converters e. Any other course approved by BOS	3	--	--	1	3
4.	CCA	CCA-1	Liberal Learning Course	1	--	--	1	1
5.	PCC	PCC-4	Advanced Electric Drives	3	--	--	1	3
6.	PCC	PCC-5	Special Electrical Machines	3	--	--	1	3
7.	PCC	PCC-6	Electric Mobility	3	--	--	1	3
8.	LC	LC-3	DSP Application Lab	1	--	2	--	2
9.	LC	LC-4	HIL Lab	--	--	2	--	1
			Total	**20**	**--**	**4**	**7**	**22**

➢ Exit option to qualify for **PG Diploma in Power Electronics and Machine Drives**:

- Eight weeks domain specific industrial internship in the month of June-July after successfully completing first year of the program.

Program Outcomes (POs)

PO1: Independently carry out research/investigation and development work to solve the practical problems.

PO2: Write and present a substantial technical report/document.

PO3: Demonstrate a degree of mastering over the area as per the specialization of the program.

Program Specific Outcomes (PSOs)

PO4: Design and analyze Electrical machine required for various applications.

PO5: Design and analyze Electrical Machine drive required to various applications.

PO6: Select, Configure, and use appropriate modern tool to solve and Analyze Electrical Machine Drive System

PG Program [M. Tech. Electrical – Power Electronics and Machine Drives]
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Semester-III

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme				Credits
				L	T	P	S	
1.	SBC	SBC-1	Dissertation Phase – I	-	-	18	12	9
2.	SLC	SLC-1	Massive Open Online Course –I	3	-	--	3	3
			Total	**3**	**-**	**18**	**15**	**12**

Semester-IV

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme				Credits
				L	T	P	S	
1.	SBC	SBC-2	Dissertation Phase – II	-	-	18	12	9
2.	SLC	SLC-2	Massive Open Online Course –II	3	-	--	3	3
			Total	**3**	**-**	**18**	**15**	**12**

- **MOOC Courses Identified:**
  - Digital control in switch mode power converters and FPGA based prototyping.
  - Design of photovoltaic system
  - Design of electric motor
  - Real Time Embedded Systems
  - Design of Internet of Things
  - High Power Multilevel Converters- Analysis, design, and operational issues
  - Semiconductor device modeling and Simulation
  - Analog Circuits and Systems Through SPICE Simulation
  - Any relevant course offered by NPTEL SWAYAM during that semester.

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Semester-I

[PSMC-1] Mathematical Modelling of Electrical Machines

Teaching Scheme:
Lectures:3 hrs/week
Self study: 1 hr/week

Examination Scheme:
T1, T2 – 20 marks each
End-Sem Exam - 60

Course Outcomes:

After successful completion of this course, students will be able to:

1. Analyze electromechanical devices and machines.
2. Use reference frame theory to study and analyze the behavior of induction and synchronous machines.
3. Calculate the machine inductances for use in machine analysis.
4. Model the electrical machine from the terminal junction with transmission systems.

Course Contents:

Principle of unified machine theory, generalized torque equation, performance evaluation of DC machine, Modeling of DC machines, three phase induction motor- dynamic modeling, transformation methods, stationary, rotor and synchronous frames and corresponding equivalent circuits, three phase synchronous motor: representation, Park transformation, permanent magnet synchronous motors, machine model (d-q), reluctance machines models, modeling of Brushless DC motor, Switched reluctance motor, Synchronous reluctance motor.

References:

1. P. C. Krause, "Analysis of Electric Machinery", McGraw Hill, New York, 1987.
2. P. Vas, "Vector Control of A.C. Machines", Clarendon Press, Oxford 1990.
3. J .M. D. Murphy and F.G. Turnbull, "Power Electronic Control of AC motors", Pergamum Press, 1988.
4. W. Leonhard, "Control of Electrical Drives", Springer Verlag, 1985.
5. Cheen Mun Ong, "Dynamic simulation of Machinery using MATLAB/Simulink" Prentice Hall PTR, 1997.
6. https://archive.nptel.ac.in/courses/108/106/108106023/#

[PEC-1] Embedded System

Teaching Scheme:
Lectures: 3 Hrs/week
Self study: 1 hr/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

After successful completion of this course the students will be able to,

1. Deploy low end applications using low- and high-level languages on microcontroller platform.
2. Test and debug peripherals in embedded system.
3. Identify and design applications on embedded platform.
4. Implement and deploy applications using embedded platform.

Course contents:

Introduction to Embedded System and Embedded System Design Flow. Signal Conditioning & Various Signal Chain Elements, Critical Specifications, how to smartly choose elements from wide choice available in market. Use Case Analysis. Systems on Chip, Memory Subsystem, Bus Structure, Interfacing Protocol, Peripheral interfacing, Testing & Debugging, Power Management, Software for Embedded Systems, Design of Analog Signal Chain from Sensor to Processor with noise, power, signal bandwidth, Accuracy Considerations. Software Programming Optimization, Concurrent Programming. Real Time Scheduling, I/O Management, Embedded Operating Systems. RTOS, Developing Embedded Systems, Building Dependable Embedded Systems.

References:

1. Steve Heath, "Embedded Systems Design", Newnes (an imprint of Butterworth-Heinemann Ltd); 2nd edition (30 October 2002).
2. Wyne Woff "Principles of Embedded computing system design", Morgan Koffman publication 2000
3. Rajkamal, "Embedded Systems- Architecture, Programming and Design", 2007- TMH.
4. Qing Li, "Real Time Concepts for Embedded Systems", Elsevier, 2011.
5. Shibu K.V, "Introduction to Embedded Systems", Mc Graw Hill.
6. https://nptel.ac.in/courses/108102045

[PEC-1] Wind and Solar Energy Systems

Teaching Scheme:	**Examination Scheme:**
Lectures:3 hrs/week	T1, T2 – 20 marks each
Self study: 1 hr/week	End-Sem Exam - 60

Course Outcomes:

After successful completion of this course, students will be able to:

1. Understand the basics of wind energy, wind turbines, solar energy and grid integration.
2. Classify and explain wind turbines, instruments for measuring solar radiation, solar collectors, solar cell and solar MPPT techniques.
3. Analyze different types of wind generators, solar cells, and solar collectors.
4. Outline about integration of solar and wind energy systems.

Course Contents:

Wind energy Basics History of wind power, Indian and Global statistics, Characteristics of Wind, principles and components of wind energy conversion system, classification of wind turbines, modern wind turbine technologies, different types of Induction generator, and their characteristics, power quality standards for wind turbines, technical regulations for interconnections of wind farm with power systems, isolated wind systems.
Solar Thermal Physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, instruments for measuring solar radiation. Classification of concentrating collectors, orientation and thermal analysis, advanced collectors.
Solar photovoltaic energy conversion, solar cell fundamentals, solar cell classification-Amorphous, mono-crystalline, polycrystalline, performance of solar cell, V-I characteristics of a PV panel, Maximum Power point Tracking (MPPT) algorithm
Integration of solar and wind Wind power integration into grid-power system stability, economics of grid network, codes and standards for grid integration, grid connected PV systems, control scheme used for single stage grid connected PV system, case study on hybrid system (PV-Wind)

References:

1. Thomas Ackermann, Editor, "Wind power in Power Systems", John Willy and sons ltd.2005.
2. Siegfried Heier, "Grid integration of wind energy conversion systems", John Willy and sons ltd., 2006.
3. K. Sukhatme and S.P. Sukhatme, "Solar Energy". Tata MacGraw Hill, Second Edition, 1996.

4. https://nptel.ac.in/courses/103103206

[PEC-01] Engineering Optimization

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/week	T1, T2 – 20 marks each
Self Study: 1 hr/week	End-Sem Exam: 60 Marks

Course Outcomes:

After successful completion of this course the students will be able to,

1. Explain and use the basic theoretical principles of optimization and various optimization techniques.
2. Develop and select appropriate models corresponding to problem descriptions in engineering and solve them correctly.
3. Solve and analyze complex optimization problems in power system/control system/machine drive.
4. Develop and implement various optimization software tools to solve engineering problems.

Syllabus Contents:

Introduction to optimization, Classical Optimization: Single variable optimization, Multivariable optimization with no constraints, Multivariable optimization with equality constraints, Multivariable optimization with inequality constraints. Linear Programming: Simplex Method, Duality, Transportation problems. Nonlinear Programming: One dimensional minimization methods, unconstrained and constrained optimization.
Dynamic Programming: Development of dynamic programming, Principle of optimality. Practical Aspects of Optimization: Reduced basic techniques, Sensitivity of optimum solution to problem parameters, evolutionary optimization techniques, applications of optimization techniques to power system/control systems/power electronics and machine drives.

References:

1. R. Fletcher, "Practical Optimization", Second edition, John Wiley and Sons, New York, 1987.
2. S. S. Rao, "Engineering Optimization-Theory and practice", fourth edition, Wiley Easter Publications, January 2009.
3. K. V. Mital and C. Mohan, "Optimization Methods in Operations Research and System Analysis", New age International Publishers, Third edition, 1996.
4. Bazaraa M. S., Sherali H.D. and Shetty C. "Nonlinear Programming Theory and

Algorithms", John Wiley and Sons, New York 1993.
5. Bertsekas D. P., "Constrained Optimization and Lagrange Multiplier Methods", Academic Press, New York, 1982.
6. Durga Das Basu, "Introduction to the Constitution of India" Prentice Hall EEE, 19th/20th Edn. 2001, (Students Edn.).

[PEC-1] Computational Electromagnetics

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/week	T1 and T2: 20 Marks each
Self Study: 1 hr/week	End-Sem Exam: 60 Marks

Course Outcomes:

After successful completion of this course, students will be able to:

1. Develop computational skills in applied electromagnetic and related disciplines.
2. Use electromagnetic software effectively with understanding of various codes.
3. Solve real world modern Electromagnetic and computational problems with FEA software.
4. Apply computational methods to get solution for real time problems.

Course Contents:

Introduction to electromagnetic fields: review of vector analysis, electric and magnetic potentials, boundary conditions, Maxwell's equations, diffusion equation, Poynting vector, wave equation. Finite Difference Method (FDM): Finite Difference schemes, treatment of irregular boundaries, accuracy and stability of FD solutions, Finite-Difference Time-Domain (FDTD) method. Finite Element Method (FEM): overview of FEM, Variational and Galerkin Methods, shape functions, lower and higher order elements, vector elements, 2D and 3D finite elements, efficient finite element computations. Method of Moments (MOM): integral formulation, Green's functions and numerical integration, other integral methods: boundary element method, charge simulation method. Special topics: hybrid methods, coupled circuit - field computations, electromagnetic - thermal and electromagnetic - structural coupled computations, solution of equations. Applications: low frequency and high frequency electrical devices, static / time-harmonic / transient problems in transformers, rotating machines, waveguides, antennas, scatterers

References:

1. M. V. K. Chari and S. J. Salon, "Numerical methods in electromagnetism", Academic Press, 2000.
2. M. N. O. Sadiku, Numerical techniques in electromagnetics, CRC Press, 1992.
3. N. Ida, Numerical modeling for electromagnetic non-destructive evaluation, Chapman and Hall, 1995.

4. S. R. H. Hoole, Computer aided analysis and design of electromagnetic devices, Elsevier Science Publishing Co., 1989.
5. J. Jin, The Finite Element Method in electromagnetics, 2nd Ed., John Wiley and Sons, 2002.
6. P. P. Silvester and R. L. Ferrari, Finite elements for electrical engineers, 3rd Ed., Cambridge University Press, 1996.
7. https://archive.nptel.ac.in/courses/108/106/108106152/

[PEC-1] Computer aided design of power electronics systems

Teaching Scheme:
Lectures: 3 Hrs/week
Self Study: 1 hr/week

Examination Scheme:
T1 and T2: 20 Marks each
End-Sem Exam: 60 Marks

Course Outcomes:

After successful completion of this course students will be able to,

1. Apply modeling tools to obtain model of power converters.
2. Analyze performance characteristics of dc-dc converters through simulation.
3. Design and simulate filter circuits for converters.
4. Evaluate performance of converters with different control techniques in simulation.

Course Contents:

Introduction to modern simulation tools used for the power electronic systems analysis such as PSPICE, MATLAB, PSIM, SABER etc. Advantages and disadvantages of circuit, netlist-oriented simulators. Steady-state and dynamic modeling of the switched mode power converter and converter transfer function formulation. Introducing to advanced modeling techniques and their transformation into software platform, modelling of the grid connected converters. Closed-loop power electronic systems modeling and their simulation.
PWM rectifiers, filter design for rectifiers. Dc-dc converters, non-isolated and isolated topologies Push-pull and forward converter Flyback, Half-bridge and Full-bridge topologies. Controller Design, Voltage mode and current mode control strategies, ramp compensation, introduction to PWM ICs.
Inverters, control strategies interfacing and stability issues of power electronic systems with filters, design problems and UPS system, design problems.
STATCOM and active filtering, Reactive power compensation, Power quality and power filters, Shunt active power filter.

References:

1. Abraham I Pressman, “Switching Power supply design”, McGraw-Hill.

2. Christophe P. Basso, "Switch mode Power Supplies, SPIC simulation and practical designs", McGraw-Hill.
3. Chee-Mun Ong, "Dynamic Simulation of Electric Machinery using MATLAB/SIMULINK".
4. Jhon Okyere Attia, "PSPICE and MATLAB for Electronics-An integrated approach".
5. Robert Erickson, "Fundamental of Power Electronics".
6. Muhammad H. Rashid, "Power Electronics, Circuits, Devices and Applications".
7. Barry W. Williams, "Power Electronic, Devices, Applications, and Passive Components".
8. http://www.digimat.in/nptel/courses/video/108101126/L93.html

[ML-01] Research Methodology and Intellectual Property Rights

Teaching Scheme :	**Examination Scheme:**
Self Study: 2 hrs/week	Continuous evaluation
	Assignments/Presentation/Quiz/Test

Course Outcomes:

After successful completion of this course the students will be able to,

1. Demonstrate research problem formulation and approaches of investigation of solutions for research problems.
2. Learn ethical practices to be followed in research and apply research methodology in case studies and acquire skills required for presentation of research outcomes
3. Discover how IPR is regarded as a source of national wealth and mark of an economic leadership in context of global market scenario
4. Summarize that it is an incentive for further research work and investment in R & D, leading to creation of new and better products and generation of economic and social benefits

Course Content:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.
Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations.

Effective literature studies approaches, analysis. Use Design of Experiments /Taguchi Method to plan a set of experiments or simulations or build prototype. Analyze your results and draw conclusions or Build Prototype, Test and Redesign.

Plagiarism, Research ethics, Effective technical writing, how to write report, Paper.

Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives and Importance of understanding Intellectual Property Rights.

Understanding the types of Intellectual Property Rights: -Patents-Indian Patent Office and its Administration, Administration of Patent System – Patenting under Indian Patent Act , Patent Rights and its Scope, Licensing and transfer of technology, Patent information and database. Provisional and Non Provisional Patent Application and Specification, Plant Patenting, Idea Patenting,

Integrated Circuits, Industrial Designs, Trademarks (Registered and unregistered trademarks), Copyrights, Traditional Knowledge, Geographical Indications, Trade Secrets, Case Studies.

New Developments in IPR, Process of Patenting and Development: technological research, innovation, patenting, development, International Scenario: WIPO, TRIPs, Patenting under PCT

References:

1. Aswani Kumar Bansal, "Law of Trademarks in India"
2. B L Wadehra, "Law Relating to Patents, Trademarks, Copyright, Designs and Geographical Indications".
3. G.V.G Krishnamurthy, " The Law of Trademarks, Copyright, Patents and Design".
4. Satyawrat Ponkse, "The Management of Intellectual Property".
5. S K Roy Chaudhary & H K Saharay, "The Law of Trademarks, Copyright, Patents"
6. T. Ramappa "Intellectual Property Rights under WTO", S. Chand.
7. Manual of Patent Office Practice and Procedure
8. WIPO : WIPO Guide To Using Patent Information
9. Halbert, "Resisting Intellectual Property" ,Taylor & Francis
10. Mayall, "Industrial Design", Mc Graw Hill
11. Niebel , "Product Design", Mc Graw Hill

[MLC-2] Effective Technical Communication

Teaching Scheme:	**Examination Scheme:**
Self-study: 1hr / week	Continuous evaluation Assignments/Presentation/Quiz/Test

Course Outcomes:

After successful completion of this course, students will be able to:

1. produce effective dialogue for business related situations.
2. use listening, speaking, reading and writing skills for communication purposes and attempt tasks by using functional grammar and vocabulary effectively.

3. analyze critically different concepts / principles of communication skills.
4. demonstrate productive skills and have a knack for structured conversations.
5. appreciate, analyze, evaluate business reports and research papers.

Course Content:

Fundamentals of Communication: 7 Cs of communication, common errors in English, enriching vocabulary, styles, and registers

Aural-Oral Communication: The art of listening, stress and intonation, group discussion, oral presentation skills.

Reading and Writing: Types of reading, effective writing, business correspondence, interpretation of technical reports and research papers

References:

1. Raman Sharma, "Technical Communication", Oxford University Press.
2. Raymond Murphy "Essential English Grammar" (Elementary & Intermediate) Cambridge University Press.
3. Mark Hancock "English Pronunciation in Use" Cambridge University Press.
4. Shirley Taylor, "Model Business Letters, Emails and Other Business Documents" (seventh edition), Prentise Hall
5. Thomas Huckin, Leslie Olsen "Technical writing and Professional Communications for Non-native speakers of English", McGraw Hill.

[PCC-1] Advanced Control Systems

Teaching Scheme	**Examination Scheme:**
Lectures: 3 hrs/week	T1, T2 – 20 marks each,
Self study: 1hr/hrs	End-Sem Exam – 60

Course Outcomes:

After successful completion of this course, students will be able to:

1. Analyse linear control system using state space approach.
2. Design linear control system using state space to achieve desired system performance.
3. Determine optimal control signal to extremize the given performance criterion.
4. Identify and analyse the non- linear systems.
5. Obtain discrete representation of LTI systems.

Course Contents:

Linear System analysis in state space: State variable description, state space model, Eigen value and Eigen vector of a matrix, diagonalization, solution of state equation, Controllability, Observability and Stability, Luapunov stability analysis of SISO and MIMO linear systems. Minimal realizations and co-prime fractions.

Control Design: State feedback controller by pole placement and design of observer for linear systems.
Optimal Control: Formulation of optimal control problem, linear quadratic regulator (LQR)
Non-linear Systems: Introduction to nonlinear systems, phase plane and describing function methods for analysis of linear systems and linearization.
Digital Control System: Discrete time systems, discretization, sampling, aliasing, choice of sampling frequency, ZOH equivalent

References:

1. Chi-Tsong Chen, "Linear System Theory and Design", Oxford University Press.
2. John S. Bay, "Linear System Theory".
3. Thomas Kailath," Linear System", Prentice Hall, 1990
4. Gillette, "Computer Oriented Operation Research", Mc-Graw Hill Publications.
5. K. Hoffman and R. Kunze, "Linear Algebra", Prentice-Hall (India), 1986.
6. G.H. Golub and C.F. Van Loan, "Matrix Computations", North Oxford Academic, 1983.
7. H. K. Khalil, "Nonlinear Systems", Prentice Hall, 2001.
8. K. Ogata,"Discrete Time Control Systems", Prentice hall, 1995.

[PCC-2] Advanced Power Electronics

Teaching Scheme:
Lectures:3 hrs/week
Self study: 1 hr/week

Examination Scheme:
T1,T2 – 20 marks each
End-Sem Exam - 60

Course Outcomes:

After successful completion of this course, students will be able to:

1. Describe the characteristics of switching devices and use them in practical systems.
2. Model and evaluate the performance of different types of power converters.
3. Design, implement, and analyze the performance of power converter with controllers.
4. Analyze the performance of power converters with protection circuit of devices and converter.

Course Contents:

Solid-State Devices: MOSFET, GTO, IGBT, GTO, SIT, SITH, MCT, their operating characteristics; Heat sink design. DC-DC Converters: Power factor improvement techniques, Switch mode power converter, Buck, boost, buck-boost, Cuk, Fly-back, Forward Converters, operation, modeling, and design of DC-DC converters, Different control strategies of DC-DC converters. Voltage mode and current mode control methods. Inverters: Review of three-phase voltage source inverters, voltage and frequency control;

Harmonic reduction techniques, PWM inverters, Space Vector Modulation; Multi-level inverters, Current source inverter, commutation circuits, transient voltage suppressing techniques, operation and control, AC-AC Converters: Three-phase ac regulators, cyclo-converters; Matrix converters, output voltage control techniques, commutation methods.

References:

1. Mohan N., Undeland T.M. and Robbins W.P., "Power Electronics: Converter, Applications and Design", 3rd Ed. John Wiley and Sons, India 1989.
2. Rashid M.H., "Power Electronics-Circuits, Devices and Applications", Pearson Education 1990.
3. B.K. Bose, "Power Electronics and variable frequency Drives-Technology and Applications", IEEE Press, Standard Publisher Distributer.
4. Christophe P. Basso, "Switch mode Power Supplies-Spice Simulations and Practical Designs", Mc Graw Hill.
5. Erickson Robert W. Dragan Maksimović, "Fundamentals of Power Electronics", Springer publication.
6. https://archive.nptel.ac.in/courses/108/107/108107128/

[PCC-3] DSP Applications to Power Electronics and Drives

Teaching Scheme:	**Examination Scheme:**
Lectures:3 hrs/week	T1, T2 – 20 marks each
Self study 1hr/week	End-Sem Exam - 60

Course Outcomes:

After successful completion of this course, students will be able to:

1. Describe addressing modes, interrupt for digital signal processor
2. Demonstrate the use of DSP for power electronics and drives applications.
3. Implement DSP based control system for speed control of electric machines.
4. Write and implement DSP based control algorithm to various real time systems.

Course Contents:

Review of digital signal processors, architecture, peripheral modules. Typical processors for control implementation: memory Organization, CPU details, addressing modes, interrupt structure, hardware multiplier, pipelining.; Fixed- and floating-point data representations.; Typical structure of timer-interrupt driven programs. Implementing digital processor-based control systems for power electronics: Reference frame transformations, PLL implementations, machine models, harmonic and reactive power compensation, space vector PWM. Speed Control of Induction, Synchronous, Synchronous reluctance, Switched Reluctance, Stepper motor, PMSM, BLDC (few of these).

References:

1. K Ogata, "Discrete-Time Control Systems", second edition, Pearson Education Asia.
2. N. Mohan, "Power Electronics", third edition, John Wiley and Sons.
3. Bose B.K., "Power Electronics and Variable Frequency Drives Technology and Applications", IEEE Press, Standard Publisher distributers 2001.
4. Venkataramani, M. Bhaskar"Digital Signal Processors: Architecture, Programming and Applications", Second Edition, Tata McGraw Hill, 2011.

Embedded System Lab

Teaching Scheme: **Examination Scheme:**

Lab:4 hrs/week

Continuous Evaluation: 50 Marks
End-Sem Exam –50 marks

Course Outcomes:

After successful completion of this course, students will be able to:

1. Perceive what is microcontroller, microcomputer, embedded system.
2. Compile different components of microcontroller and their interactions.
3. Become familiar with programming environment used to develop embedded system.
4. Experiment with key concepts of embedded systems like I/O, timers, interrupts.
5. Learn debugging techniques for an embedded system.

Lab Contents:

Experiments based on above objectives such as PID control, LED interface, timers, counters, ADC, DAC, PWM and Design of energy meter etc.

References:

1. Steve Heath, "Embedded Systems Design", Publisher Butterworth-Heinemann.
2. Wyne Woff "Principles of Embedded computing system design", Morgan Koffman publication 2000
3. Rajkamal, "Embedded Systems- Architecture, Programming and Design", 2007- TMH.
4. Qing Li, "Real Time Concepts for Embedded Systems", Elsevier, 2011.
5. Shibu K.V, "Introduction to Embedded Systems", Mc Graw Hill.
6. Frank Vahid, Tony Givargis, "Embedded System Design", John Wiley.
7. Lyla "Embedded Systems", Pearson, 2013.

[LC-2] Advanced Power Electronics Lab

Teaching Scheme: **Examination Scheme:**

Lab:4 hrs/week

Continuous Evaluation: 50 Marks
End-Sem Exam –50 marks

Course Outcomes:

At the end of the course the student will be able to

1. Design and simulate the various converters.
2. Implement various converters in experiment and analyze their performance.
3. Design and simulate various control strategies used for converters.
4. Design and simulate various inverters.

Lab Contents:

1. Modeling and Simulation of Buck, Boost and Buck Boost Converters.
2. Study of Basic Buck Converter- Lab experiment.
3. Study of Basic Boost Converter- Lab experiment.
4. Study of Basic Buck/Boost Converter- Lab experiment.
5. Modeling and Simulation of Isolated DC/DC Converters (Flyback & Forward Converters).
6. Study of Phase Controlled Rectifiers and PWM Rectifiers.
7. Study of Single-Phase Inverters and Modulation Techniques.
8. Study of 3-Phase Inverters and Modulation Techniques.
9. Study of Multilevel Inverters and their Modulation Techniques.
10. Study of matrix converter and its control.

Semester II

[OE-01] Engineering Optimization

Teaching Scheme:
Lectures: 3 Hrs/week
Self Study: 1 hr/week

Examination Scheme:
T1, T2 – 20 marks each
End-Sem Exam: 60 Marks

Course Outcomes:

After successful completion of this course the students will be able to,

1. Explain and use the basic theoretical principles of optimization and various optimization techniques.
2. Develop and select appropriate models corresponding to problem descriptions in engineering and solve them correctly.
3. Solve and analyze complex optimization problems in various engineering pplications.
4. Implement various optimization software tools to solve engineering problems.

Course Contents:

Introduction to optimization, Classical Optimization: Single variable optimization, Multivariable optimization with no constraints, Multivariable optimization with equality constraints, Multivariable optimization with inequality constraints. Linear Programming: Simplex Method, Duality, Transportation problems. Nonlinear Programming: One dimensional minimization methods, unconstrained and constrained optimization.
Dynamic Programming: Development of dynamic programming, Principle of optimality. Practical Aspects of Optimization: Reduced basic techniques, Sensitivity of optimum solution to problem parameters, evolutionary optimization techniques, applications of optimization techniques to various engineering applications.

References:

1. R. Fletcher, “Practical Optimization”, Second edition, John Wiley and Sons, New

York, 1987.
2. S. S. Rao, "Engineering Optimization-Theory and practice", fourth edition, Wiley Easter Publications, January 2009.
3. K. V. Mital and C. Mohan, "Optimization Methods in Operations Research and System Analysis", New age International Publishers, Third edition, 1996.
4. Bazaraa M. S., Sherali H.D. and Shetty C. "Nonlinear Programming Theory and Algorithms", John Wiley and Sons, New York 1993.
5. Bertsekas D. P., "Constrained Optimization and Lagrange Multiplier Methods", Academic Press, New York, 1982.Durga Das Basu, "Introduction to the Constitution of India" Prentice Hall EEE, 19th/20th Edn., 2001. (Students Edn.)

[PEC-2] Grid Interface of Energy Sources

Teaching Scheme:
Lectures:3 hrs/week
Self study:1 hr/week

Examination Scheme:
T1, T2 – 20 marks each
End-Sem Exam - 60

Course Outcomes:

After successful completion of this course, students will be able to:

1. Understand the applications of power converters in renewable energy systems.
2. Describe the operation and control of photovoltaic and wind energy systems with the help of power converters.
3. Select and design the power electronic converters suitable for the solar, wind energy sources.
4. Design and configure the interface with grid for various renewable sources.
5. Analyze the power quality issues for grid connected renewable sources.

Course Contents:

Introduction to renewable sources: world energy scenario, Wind, solar, hydro, geothermal, availability and power extraction. Requirements for solar and wind power generation from the grid. Solar Power – PV system configurations, Solar cell technologies, Maximum power point tracking. Photovoltaic standalone systems, grid interface, storage, AC-DC loads. Power converters for solar, bidirectional converters; Inverters: 1ph, 3ph inverters with & w/o transformers, Heric, H6, Multilevel inverters, Control schemes: unipolar, bipolar, PLL and synchronization, power balancing / bypass, Parallel power processing; Grid connection issues: leakage current, Islanding, harmonics, active/reactive power feeding, unbalance. Introduction to wind energy: P-V, I-V characteristic, wind power system: turbine-generator-inverter, mechanical control, ratings; Power extraction (MPP) and MPPT schemes. Generators for wind: DC generator with DC to AC converters;

Induction generator with & w/o converter; Synchronous generator with back to back controlled/ uncontrolled converter; Doubly fed induction generator with rotor side converter topologies; permanent magnet based generators. Battery: Types, charging discharging. Introduction to AC and DC microgrids.

References:

1. Sudipta Chakraborty, Marcelo G. Sim303265es, and William E. Kramer. Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control and Integration. Springer Science & Business, 2013.
2. Nicola Femia, Giovanni Petrone, Giovanni Spagnuolo, Massimo Vitelli, Power Electronics and control for maximum Energy Harvesting in Photovoltaic Systems,CRC Press,2013.
3. Chetan Singh Solanki, Solar Photovoltaics: fundamentals, Technologies and Applications, Prentice Hall of India, 2011.
4. N. Mohan, T.M. Undeland & W.P. Robbins, Power Electronics: Converter, Applications & Design, John Wiley & Sons, 1989
5. Muhammad H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education India, 2004
6. E. Guba, P. Sanchis, A. Ursa, J. Lpez, and L. Marroyo, 302223Ground currents in single-phase transformerless photovoltaic systems,302224 Progress in Photovoltaics: Research and Applications, vol. 15, no. 7, pp. 629302226650, 2007.
7. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley and Sons, Ltd., 2011.
8. Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, Wiley-IEEE Press, 2011.ix

[PEC-2] Artificial Intelligence and Machine Learning

Teaching Scheme:	**Examination Scheme:**
Lectures:3 hrs/week	T1, T2 – 20 marks each
Self study:1 hr/week	End-Sem Exam - 60

Course Outcomes:

After successful completion of this course, students will be able to:

1. Identify problems where artificial intelligence techniques are applicable.
2. Select appropriate technologies for a given problem and anticipate the design implication.
3. Understand the fundamental issues and challenges of machine learning algorithms.

4. Design and Apply the machine learning algorithms to real world problems.
5. Analyze the machine learning algorithms applied to real world problems.

Course Contents:

Introduction to Artificial Intelligence: Artificial Intelligence problems, foundation of AI and history of AI intelligent agents: Agents and Environments, the concept of rationality, the nature of environments, structure of agents, problem solving agents, problem formulation. Searching- Searching for solutions, uniformed search strategies – Breadth first search, depth first Search. Search with partial information (Heuristic search).
Introduction to Machine Learning: Basic definitions, types of learning, designing a learning system, perspectives and issues, hypothesis space and inductive bias, evaluation, cross-validation. Linear regression, Decision trees, Splitting Criteria, Issues in decision tree learning, overfitting and evaluation, nearest neighbor methods. Neural network: Perceptron, multilayer network, backpropagation, introduction to deep neural network. Dimensionality Reduction: Feature reduction, Principal Component Analysis, Fischer's Discriminant Analysis. Probability and Bayes learning, Naive Bayes Model, Logistic Regression, Reinforcement learning. Support Vector Machine, Kernel function and Kernel SVM, Clustering: partitioning, k-means clustering, hierarchical clustering, and Case studies.

Reference Books:

1. S. Russel and P. Norvig, "Artificial Intelligence – A Modern Approach", Fourth Edition, Pearson Education
2. David Poole, Alan Mackworth, Randy Goebel," Computational Intelligence: a logical approach", Oxford University Press.
3. Ethem Alpaydin, Introduction to Machine Learning, Second Edition, The MIT Press, 2010.
4. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.
5. Stephen Marsland, Machine Learning: An Algorithmic Perspective, CRC Press, 2009.
6. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.
7. https://archive.nptel.ac.in/courses/106/105/106105152/

[PEC-2] Condition Monitoring of Electrical Apparatus

Teaching Scheme:
Lectures:3 hrs/week
Self study:1 hr/week

Examination Scheme:
T1, T2 – 20 marks each
End-Sem Exam - 60

Course Outcomes:

After successful completion of this course, students will be able to:

1. Understand the necessity of condition monitoring and reliability.
2. Have knowledge about the conventional and modern methodologies/techniques.
3. Develop basic functional models for condition monitoring system to different kind of
4. power apparatus.
5. Determine life expectancy of the equipment.

Course Contents:

Basic definitions, terminologies, symbolic representation, Necessity from technical social, financial aspect, types of faults in electrical equipments {Electrical equipments such as transformer, CT/PT and rotating electrical machines, CBs, etc.}, maintenance strategies, breakdown maintenance, planned, preventative and condition-based maintenance. Measurement of insulation resistance, Diagnostic Testing: Routine tests, type tests, special tests, offline tests, Causes of failure and remedies. Recent methods (offline), Dissolved Gas Analysis (DGA), Dissipation Factor (tan δ), Sweep 55 Frequency Response Analysis (SFRA), Partial Discharge (PD), Time Domain Dielectric Response (TDDR), Frequency Domain Spectroscopy (FDS), Chemical analysis. Image processing techniques. Recent methods (online), vibration, chemical and temperature monitoring, sensor and data acquisition system, Modern algorithms, GA, and signal processing techniques. Application to various equipment such as transformers and electric machines. Discrete time Fourier series and its convergence, discrete time Fourier Transform, its properties, frequency response. Introduction to DFT in time domain and frequency domain, Decimation-in-time FFT Algorithm, Decimation In Frequency FFT Algorithm, Wavelet transform, Lab view platform. Comparison of DIT AND DIF algorithms. Introduction to FIR and IIR Filter Design. Calculation of Power Equipment Reliability for Condition-based Maintenance Decision- making, Optimum Reliability- Centered Maintenance, Cost Related Reliability Measures for Power System Equipment, Reliability based replacement refurbishment/planning.

References:

1. P. Vas, "Parameter estimation, condition monitoring and diagnosis of electrical machines", Clarendon Press Oxford, 1993.

2. P. Tavner, Li Ran, J. Penman and H. Sedding, "Condition monitoring of rotating electrical machines", IET press, 2008.
3. Xose M Lo´pez, Ferna´ndez, H Bu˙lent Ertan, J Turowski, "Transformers analysis, design, and measurement", CRC Press, 2012
4. S.V. Kulkarni and S. A. Khaparde, "Transformer Engineering: Design, Technology and Diagnostics", Second edition, CRC Press, 2013
5. R. Billinton and R. N. Allan, "Reliability Evaluation of Power Systems, 2nd ed. New York", NY, USA: Plenum, 1996.
6. Videos on Transformer condition evaluation with ABBs Mature Transformer Management Program
7. Induction motor condition monitoring with ABBs, Siemens, General

[PEC-2]: Automotive Electronics

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/week	T1 and T2: 20 Marks each
Self study:1 hr/week	End-Sem Exam: 60 Marks

Course Outcomes:

After successful completion of this course the students will be able to,

1. Apply hardware design skills to automotive specific applications.
2. Describe concept such as DFM, DFT, EMC, DFMEA.
3. Design gate driver circuits for power electronics switches.
4. Understand the requirement of electromagnetic compatibility for automotive electronics.

Course Contents:

Low Power Domain: 16/32 bit controllers, Hardware-Software Interfaces, communication interfacesCAN, LIN, SPI, wireless interfaces- Bluetooth, ISM band applications, I/O interfaces –digital, analog signal conditioning, switches, relays, high side, low side drivers, Introduction to design tools (Microcap, Cadence Concept HDL and Allegro).

High Power Domain: Selection of power switching devices- MOSFETs/IGBTs/SiC/ GaNFETs, Gate driver design, power loss calculations, thermal management, Design consideration For High Voltage applications.

Embedded C: Concepts of C (structure, union, pointer, bitwise operator), Logic building according to requirement, MISRA C guidelines.

Electromagnetic Compatibility: Introduction to various regulatory requirements and International electrical and EMC standards, Understanding origin of pulses, disturbances, circuit and PCB layout design techniques to meet EMC.
Design for Manufacturability and Testability: PCB layout consideration, manufacturing interfaces and process flow, ICT, AOI and EOL testing.

References:

1. The 8051 Microcontroller: A System Approach by Muhammad A. Mazidi, 1st Ed., PHI, 2012.
2. Venkataramani, M. Bhaskar"Digital Signal Processors: Architecture, Programming and Applications", Second Edition, Tata McGraw Hill Education Private Limited, 2011.
3. Behrouz A. Forouzan, "Data Communications and Networking", McGraw Hill, 5th edition
4. N. Mohan, "Power Electronics", third edition, John Wiley and Sons.
5. Kim Fowler," Electronic Instrument Design" Oxford university press.
6. Robert J. Herrick, "Printed Circuit board design Techniques for EMC Compliance", Second edition, IEEE press.

[PEC-3] Energy Storage Systems

Teaching Scheme:
Lectures:3 hrs/week
Self study:1 hr/week

Examination Scheme:
T1, T2 – 20 marks each
End-Sem Exam - 60

Course Outcomes:

After successful completion of this course, students will be able to:

1. Understand the emerging needs of Electrical Energy Storage Systems.
2. Analyze the performance of various Electrical Energy Storage Systems.
3. Assess the markets for the Electrical Energy Storage Systems.
4. Design the battery management system.

Course Contents:

Energy storage systems overview, Energy storage in the power and transportation sectors. Importance of energy storage systems in electric vehicles. Types of Electrical Energy Storage Systems, Classification, Thermal, Mechanical, Chemical, Electromagnetic, Electrochemical Energy Storage systems: (a)Batteries-Working principle of battery, primary and secondary (flow) batteries, battery performance evaluation methods, major battery chemistries and their voltages- Li-ion battery& Metal hydride battery vs lead-acid battery. (b) Supercapacitors- Working principle of supercapacitor, types of supercapacitors, cycling and performance characteristics, difference between battery and supercapacitors, (c) Fuel cell: Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems.

Battery design for transportation, Mechanical Design and Packaging of Battery Packs for Electric Vehicles, Advanced Battery-Assisted Quick Charger for Electric Vehicles, Charging Optimization Methods for Lithium-Ion Batteries, Thermal run-away for battery systems, Thermal management of battery systems, State of Charge and State of Health Estimation Over the Battery Lifespan, Recycling of Batteries from Electric Vehicles., Standards and Safety involved.

References:

1. IEC White paper on Electrical Energy Systems: www.iec.ch/whitepaper/pdf/iecWP
2. Energy Storage Systems, Volume I and II, EOLSS, www.eolssunesco@gmail.com
3. Frank S. Barnes and Jonah G. Levine, Large Energy Storage Systems Handbook (Mechanical and Aerospace Engineering Series), CRC press (2011)
4. Ralph Zito, Energy storage: A new approach, Wiley (2010)
5. A.G.Ter-Gazarian, Energy Storage for Power Systems, Institution of Engineering and Technology, 2011.

[PEC-3] Power Quality Issues and Mitigation

Teaching Scheme:
Lectures:3 hrs/week
Self study:1 hr/week

Examination Scheme:
T1, T2 – 20 marks each
End-Sem Exam – 60

Course Outcomes:

After successful completion of this course, students should be able to,

1. Assess power quality of the power system.
2. Suggest mitigating equipment for power quality issues.
3. Identify different power quality improvement techniques.
4. Select and use power quality monitoring meters.

5. Design harmonic filters.

Course Contents:

Terms and definitions, voltage sags and interruptions: sources of sags and interruptions, end user issues, transient over voltages: sources of transient overvoltage, devices for overvoltage protection, load switching transient problems, harmonics: harmonic distortion, total harmonic distortion, triplet harmonics, effects of harmonic distortion, locating sources of harmonics, modeling harmonic sources, computer tools for harmonic analysis, long duration voltage variations: devices for voltage regulation, capacitors for voltage regulations, regulating utility voltages with dispersed sources, monitoring and measurement of power quality, Mitigation equipment, filter design.

References:

1. Roger Dugan, H. Wayne, "Electrical power systems quality". MacGraw Hill, 2002
2. Alexander Kusko and Marc T. Thompson, "Power quality in electrical systems".
3. Arindam Ghosh, Gerard Ledwich, "Power Quality Enhancement using Custom Power Device.
4. Math. J. Bolen, "Understanding Power Quality Problems", IEEE power series for power Engineering.
5. Walkileh George J., "Power system harmonics, Fundamentals, Analysis and filter Design", Springer.

[PEC-3] Smart Grid Technologies

Teaching Scheme:	**Examination Scheme:**
Lectures:3 hrs/week	T1, T2 – 20 marks each
Self study:1 hr/week	End-Sem Exam – 60

Course Outcomes:

After successful completion of this course, students will be able to:

1. Express the need and specify the components of smart grid ~~and smart communication~~.
2. Understand the various smart grid technologies.
3. Identify the need of micro grid, smart metering, smart storage
4. Understand the role of smart sensors, smart communication for development of Smart cities and Smart substation

Course Contents:

Introduction to smart grid, smart grid vision and road map in India, Concept of Resilient and self-Healing Grid, Present international developments, smart cities, RTU, IED, PMU, smart substations, feeder automation, PHEV, V2G, G2V, CAES, real time prizing, AMR, OMS, smart sensors, Home and building automation, GIS, Concept of microgrid, architecture, DC micro grid, issues, integration of renewable energy sources, cyber controlled smart grid, Power quality and EMC in micro grid, web based PQ monitoring, smart grid communication architecture, WAMS, HAN, NAN, WAN, Bluetooth, ZigBee, GPS, Wi-Fi Max based communication, wireless network, cloud computing, cyber security, BPL, IP based protocols.

References:

1. Ali Keyhani, Mohammad N. Marwali, Min Dai, "Integration of green and renewable energy in electric power systems, John Wiley.
2. Clark W. Gellings, 'Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press.
3. Stuart Borlase, "Smart Grids-Infrastructures, Technology and Soluations", CRC Press, Taylor and Francis group.
4. Janaka Ekanayake, Kithsiri Liyanage, J. Wu and Akihiko Yokoyama, 'Smart Grid-Technology and Applications, John Wiley.

[PEC-4] High Frequency Magnetics for power Converters

Teaching Scheme:	**Examination Scheme:**
Lectures:3 hrs/week	T1, T2 – 20 marks each
Self study:1 hr/week	End-Sem Exam – 60

Course Outcomes:

After successful completion of this course, students will be able to:

1. Demonstrate principle of magnetic components.
2. Design and optimize the high frequency inductors and transformers for a given application.
3. Analyze and model losses in magnetic components and understand design trade-offs.
4. Estimate the parasitic in the magnetic circuits.

Course Contents:

Magnetic concepts – Faradays', Lenz's and Ampere's laws, magnetic circuits and electrical equivalent circuits, multi-winding magnetics, flux and flux density, magnetic losses, Winding ac resistance – skin and proximity effects, Dowell's equation, conduction losses with PWM waveforms, resistance matrix, air-gap fringing and its effects on Rac, Litz wire – basic principle and design, Leakage inductance – Analytical estimation of leakage inductance, interleaving to reduce leakage and ac resistance in transformers and its limitations. Winding capacitances – Inter and intra-winding capacitances – genesis and their impacts on circuit operation, techniques to reduce them, analytical estimation, Core loss – origin, Steinmetz equation and improvements, core loss measurement techniques, choice of core material, core shapes.

Design of Magnetics for high frequency inductor- Energy storage, area product, window area, selection of core, design of inductor for dc-dc converters.

Design of magnetics for high frequency transformer- Operating principle, turns ratio, leakage flux linkage, equivalent circuit, area product, transformer design for dc-dc converters,

Text/References

1. R. W. Erickson, D. Maksimovic, "Fundamentals of Power Electronics", Springer, 2nd Edition, 2001.
2. L. Umanand, "Power Electronics- Essentials and Applications" Wiley,1st Edition 2009.
3. M. Kazimierczuk, "High-Frequency Magnetic Components", Wiley, 2nd Edition, 2014.
4. W.G. Hurley, W.H. Wölfle, "Transformers and Inductors for Power Electronics: Theory, Design and Applications", Wiley, 2013.
5. Lloyd H. Dixon, Jr/Texas Instruments, "Magnetics Design Handbook", 2001.
6. W. T. Mclyman, "Transformer and Inductor Design Handbook", CRC Press, 2017.
7. Relevant IEEE papers.

[CCA-01] Liberal Learning Course

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 hrs/week	T1 and T2: 20 Marks each
	End-Sem Exam: 60 Marks

Course Outcomes:

After successful completion of this course the students will be able to,

1. Survey new topics from various disciplines and Select various sources and avenues to harvest/gather information.

2. Explain qualitative attributes of a good learner.
3. Demonstrate quantitative measurements of learning approaches and learning styles.
4. Appreciate openness to diversity.

Course Contents:

Topic selected by the student from areas displayed by the institute. The sample list is below.
Agriculture (Landscaping, Farming, etc.), Business (Management, Entrepreneurship, etc.), Defense (Study about functioning of Armed Forces), Education (Education system, Policies, Importance, etc.), FineArts (Painting, Sculpting, Sketching, etc.), Linguistics, Medicine and health (Diseases, Remedies, Nutrition, Dietetics, etc.), Performing Arts (Music, Dance, Instruments, Drama,etc.), Philosophy, Social Sciences (history, PoliticalSc., Archeology, Geography, Civics, Economics, etc.)

References:

1. Expert(s), Books, Texts, Newspaper, Magazines, Research Papers, Journal, Discussion with peers or faculty.

[PCC-4] Advanced Electric Drives

Teaching Scheme:
Lectures:3 hrs/week
Self study:1 hr/week

Examination Scheme:
T1, T2 – 20 marks each
End-Sem Exam – 60 Marks

Course Outcomes:

After successful completion of this course, students will be able to:

1. Comprehend state of the art technology of dc and ac advanced drives.
2. Solve problems; analyze performance of dc and ac drives.
3. Select suitable drives according to the application.
4. Design the advanced drive and compare the performance with the existing one.

Course Contents:

Review of drive fundamentals, dynamics of electric drives, selection of motor power rating. Review of fundamentals of DC Drives and Induction motor drives. Converter topologies for low, medium and high power drives. Frequency controlled, vector controlled, and Direct torque controlled for induction motor drives. Sensor and Senseless control, Ripple minimization techniques for DTC. PMSM and BLDC drives, Synchronous Reluctance and Switched Reluctance motor drives. Stepper motor drives. Drives for the slip ring induction machine, DFIG and its four-quadrant control.

References:

1. R. Krishnan, 'Switched Reluctance Motor Drives – Modeling, Simulation, Analysis, Design and Application', CRC Press, New York, 2001.
2. T. Kenjo and S. Nagamori, 'Permanent Magnet and Brushless DC Motors', Clarendon Press, London, 1988.
3. M.H. Rashid "Power Electronics", 3rd Ed, PHI Pub. 2004.
4. G. K. Dubey , "Fundamentals of Electrical Drives", Narosa Publishing house.
5. B. K. Bose, "Modern Power Electronics and AC Drives", Pearson Education, Asia, 2003.

[PCC-5] Special electric machine

Teaching Scheme:	**Examination Scheme:**
Lectures:3 hrs/week	T1, T2 – 20 marks each
Self study:1 hr/week	End-Sem Exam – 60 Marks

Course Outcomes:

After successful completion of this course, students will be able to:

1. Discriminate and able to select proper machines for the given application
2. Represent and analyze the modern machines
3. Model and propose a control to PMSM, SRM, BLDC and stepper motors

Course Contents:

Permanent Magnet Brushless D.C. Motors : Fundamental equations – EMF and Torque equations – Torque speed characteristics – Rotor position sensing – Sensorless motors – Motion control . Permanent Magnet Synchronous Motors : Construction - Principle of operation – EMF and torque equations – Starting – Rotor configurations – Dynamic model . Synchronous Reluctance Motors: Constructional features – axial and radial flux motors – operating principle – characteristics , Switched Reluctance Motors: Constructional features – principle of operation – torque production – characteristics – power controllers . Stepping Motors: Features – fundamental equations – PM stepping motors – Reluctance stepping motors – Hybrid stepping motors – Torque and voltage equations – characteristics.

Reference Books:

1. Miller, T. J. E., Brushless Permanent Magnet and Reluctance Motor Drives, Oxford Science Publications, 1989.
2. Kenjo, T., and Sugawara, A., Stepping Motors and their Microprocessor Controls, Oxford Science Publications, 1984. 3. Venkataratnam K., Special Electrical Machines, CRC Press, 2009.
3. Krishnan, R., "Permanent Magnet and BLDC Motor Drives", CRC Press, 2009. 2. Chang-liang, X., "Permanent Magnet Brushless DC Motor Drives and Controls", Jun 2012

[PCC-6] Electric Mobility

Teaching Scheme:	**Examination Scheme:**
Lectures:3 hrs/week	T1, T2 – 20 marks each
Self study:1 hr/week	End-Sem Exam – 60 Marks

Course Outcomes:

After successful completion of this course, students will be able to:

1. Demonstrate the concept of Electric Vehicles, Hybrid Electric Vehicles & Plug in Hybrid Electric Vehicles
2. Evaluate the power electronics & electric machine requirements of EVs & HEVs
3. Adress design issues of EVs & HEVs
4. Model EVs & HEVs

Course Contents:

A brief history of EV & PHV, Basics of EV & HEV, Architectures of EV & HEV, HEV fundamentals. Introduction to PHEVs, PHEV architectures, Power management of PHEVs, Fuel economy of PHEVs, PHEV design & component sizing, Aerodynamic considerations, Consideration of rolling resistance, Transmission efficiency, Consideration of vehicle mass, Electric vehicle chassis & body design, General issues in design. Vehicle-to-grid technology, Battery chargers used in EVs & HEVs, Emerging power electronic devices for EV, challenges in design, Batteries, Ultracapacitors, Fuel Cells Battery management systems, Introduction to modelling, Fundamentals of vehicle system modeling, HEV modeling, Case studies - Rechargeable battery vehicles, Hybrid vehicles, Autonomous Vehicles, smart mobility issues and challenges.

Reference Books:

1. Chris Mi, M. AbulMasrur, David WenzhongGao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", 2011, Wiley publication.

2. Allen Fuhs, "Hybrid Vehicles and the future of personal transportation", 2009, CRC Press.
3. James Larminie, John Lowry, "Electric Vehicle Technology Explained", 2003, Wiley publication.

[LC-3] DSP Application Lab

Teaching Scheme:	**Examination Scheme:**
Lab:2 hrs/week	Continuous Evaluation: 50 Marks
Lecture:1 hr/week	End-Sem Exam – 50 marks

Course Outcomes:

After successful completion of this course, students will be able to:

1. Write low level device drivers/Chip Support Libraries for standard peripherals such as UART/PWM/Timers.
2. Create/debug and develop applications in C for embedded environment.
3. Develop an embedded controller for power electronics.
4. Design an embedded controller for drive applications.

Lab Contents:

Experiments on the DSP/Micro- controllers, Interfacing peripherals to DSP/micro-controller, Assembly language programming, Real-time voltage/ current, speed sensing signal and processing, PWM strategies realization through DSP and controlling power electronic converters and Drive Systems.

References:

1. TI User Manuals TMS320C2x, TMS 28335.
2. Website www.ti.com and www.DSPguide.com.
3. Marven, C., Ewers, G. A simple approach to DSP Texas Instr. 1993.
4. MSP 430 Technical Reference Manual.

[LC-4] HIL Lab

Teaching Scheme:	**Examination Scheme:**
Lab:2 hrs/week	Continuous Evaluation: 50 Marks

End-Sem Exam – 50 marks

Course Outcomes:

After successful completion of this course, students will be able to:

1. Mathematically formalize requirements based on design objectives.
2. Trace the design project requirements through modeling and control design.
3. Perform, analysis and design in the discrete domain using ADC and DAC.
4. Independently setup HIL experiments using SIMULINK and dSpace virtual HIL software packages.
5. Creates a virtual real-time environment which contains a model of control system, and an external physical system.

Lab Contents:

Three lab sessions to work with MATLAB/SIMULINK to develop the model and controller and validate and verify their SIMULINK files according to the predefined requirements or predefined plant. Develop and debug the model/controller in MATLAB/SIMULINK, Design model in loop simulation (MIL) and tests in order verify and validate the model/controller according to predefined requirements. Generate and debug production code, and performing software in loop test (SIL). Get hands on experience of V&V tools in MATLAB/SIMULINK

Three labs on dSPACE software package and verifying/validating their developed code with Virtual HIL. Independently setting up VHIL, and recording data using data acquisition tools in dSPACE. Learning to work with dSPACE software packages. Designing and implementing design of experiment (DOE) tests on the VHIL platform.

Two labs to perform HIL simulation using dSpace and implementation of controller on real time system like power converters, electric motors.

References:

1. Martin Schlager, "Hardware-in-the-Loop Simulation" 2014, VDM
2. Adit Joshi, "Automotive Applications of Hardware-in-the-Loop (HIL) Simulation" SAE International
3. Manuals of respective devices and software.

Semester III

[SBC-1] Dissertation Phase – I

Course Outcomes:

After successful completion of this course, students will be able to,

1. Implement innovative ideas in the field of power electronics and machine drives.
2. Prepare precise technical research paper for publishing in internationally recognized journals or conferences.
3. Enhance presentation skills
4. Take up any challenging job in industry.

Work Contents:

The M. Tech. project is aimed at training the students to analyze independently any problem in the field of Electrical Engineering or interdisciplinary. The project may be analytical, computational, experimental or a combination of three. The project report is expected to show clarity of thoughts and expression, critical appreciation of the existing literature and analytical, experimental, computational aptitude. The student progress of the dissertation work will be evaluated in stage I (after semester III) by the departmental evaluation committee.

References:

Various books, research papers on the topic selected for the dissertation.

[SLC-1] Massive Open Online Course-I

Teaching Scheme:	**Examination Scheme:**
Lectures:3 hrs/week	T1, T2 – 20 marks each
Self study:3 hr/week	End-Sem Exam – 60 Marks

Semester IV

[SBC-2] Dissertation Phase – II

Course Outcomes:

After successful completion of this course, students will be able to,

1. Implement innovative ideas in the field of power electronics and machine drives.
2. Prepare good technical project reports for publication in journals and conferences.
3. Enhance presentation skills.
4. Take up any challenging job in industry.

Work Contents:

The M. Tech. project is aimed at training the students to analyze independently any problem in the field of Electrical Engineering or interdisciplinary. The project may be analytical, computational, experimental or a combination of three. The project report is expected to show clarity of thoughts and expression, critical appreciation of the existing literature and analytical, experimental, computational aptitude.

The student progress of the dissertation work will be evaluated in stage II (after semester IV) by the departmental evaluation committee and final viva voce will be conducted by the external examiner.

References:

Various books, research papers on the topic selected for the dissertation.

[SLC-2] Massive Open Online Course-I

Teaching Scheme:	**Examination Scheme:**
Lectures:3 hrs/week	T1, T2 – 20 marks each
Self study:3 hr/week	End-Sem Exam – 60 Marks