PG Program [M. Tech.]

POWER ELECTRONICS AND MACHINE DRIVES

Curriculum Structure

w.e.f. AY 2019-20 and applicable for batches admitted from AY 2019-20 to 2022-23

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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%
DEC	Department Elective Course	3	9	13.2%
MLC	Mandatory Learning Course	2	0	0%
PCC	Program Core Course	6	22	32.4%
LC	Laboratory Course	2	2	2.9%
IOC	Interdisciplinary Open Course	1	3	4.4%
LLC	Liberal Learning Course	1	1	1.5%
SLC	Self Learning Course	2	6	8.8%
SBC	Skill Based Course	2	18	26.5%

Semester I

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	PSMC	PEMD-19001	Mathematical Modeling of Electrical Machines	3	--	--	3
2.	PSBC	PEMD-19002	Electrical Machines and Drives/ Embedded Systems	3	--	--	3
3.	DEC-I	PEMD (DE)- a)19001 b)19002 c)19003 d)19004 e)19013	a. Wind and Solar Power b. Engineering Optimization c. Computational Electromagnetics d. Embedded C e. Automotive Electronics: Product Development (Hella India Elective-I) f. Any other course approved by BOS	3	--	--	3
4.	MLC	ML-19011	Research Methodology and Intellectual Property Rights	2	--	--	--
5.	MLC	ML-19012	Effective Technical Communication	1	--	--	--
6.	PCC	PEMD-19004	Advanced Control Theory	3	--	--	3
7.	PCC	PEMD-19005	Advanced Power Electronics	3	--	--	3
8.	PCC	PEMD-19006	DSP Applications to Power Electronics and Drives	3	--	--	3
9.	LC	PEMD-19007	Electrical Machines and Drives Lab/Embedded Systems Lab	--	--	4	2
10.	LC	PEMD-19009	Advanced Power Electronics Lab	--	--	4	2
			Total	**21**	**--**	**8**	**22**

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.

Semester II

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	IOC	PEMD-19010	Engineering Optimization	3	--	--	3
2.	DEC-II	PEMDE (DE)- a).19005 b).19006 c).19007 d)19008	a. Grid Interface of Energy Sources b. Machine Learning c. Condition Monitoring of Electrical Apparatus d. Automotive Electronics: Hardware Development (Hella India Elective-II) e. Any course approved by BOS	3	--	--	3
3.	DEC-III	PEMD (DE)- a).19009 b).19010 c).19011 d).19012	a. Energy Storage Systems b. Power Quality Issues and Mitigation c. Smart Grid Technologies d. Automotive Electronics: Software Development (Hella India Elective-III) e. Any other course approved by BOS	3	--	--	3
4.	LLC	LL-19001	Liberal Learning Course	1	--	--	1
5.	PCC	PEMD-19011	Advanced Electric Drives	3	--	--	3
6.	PCC	PEMD-19012	Special Electrical Machines	3	--	--	3
7.	PCC	PEMD-19013	Electric Mobility	3	--	--	3
8.	LC	PEMD-19014	DSP Application Lab	1	--	2	2
9.	LC	PEMD-19015	HIL Lab	--	--	2	1
			Total	20	--	4	**22**

Semester-III

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	SBC	PEMD-20001	Dissertation Phase – I	--	--	18	9
2.	SLC	PEMD-20002	Project and Finance Management	3	--	--	3
			Total	3	--	18	**12**

Semester-IV

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme			Credits
				L	T	P	
1.	SBC	PEMD-20003	Dissertation Phase – II	--	--	18	9
2.	SLC	PEMD-20004	Design of Internet of Things	3	--	--	3
			Total	3	--	18	**12**

SEMESTER-I

[PSMC] PEMD-19001: Mathematical Modeling of Electric Machines

Teaching Scheme:
Lectures: 3 Hrs/week

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

Course Outcomes:

Upon successful completion of this course, the 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

Syllabus Contents:

Principle of unified machine theory, generalized torque equation, performance evaluation of DC machine and speed control, three phase induction motor- transformation methods, stationary, rotor and synchronous frames and corresponding equivalent circuits, three phase synchronous motor: representation, Park transformation, drives, various control techniques, concept of space vector, field oriented control and direct torque control of IM, permanent magnet synchronous motors- machine model(d-q) and control methods, reluctance machines models.

References:

1. P. C. Krause, “Analysis of Electric Machinery”, McGraw Hill, New York, 1987.
2. Chee Mun Ong, “Dynamic simulation of Electrical Machinery using Matlab/Simulink” Prentice Hall PTR, 1997.
3. P. Vas, “Vector Control of A.C. Machines”, Clarendon Press, Oxford 1990.
4. J .M. D. Murphy and F.G. Turnbull, “Power Electronic Control of AC motors”, Pergamum Press, 1988.
5. W. Leonhard, “Control of Electrical Drives”, Springer Verlag, 1985.

[PSBC] PEMD-19002: Electrical Machines and Drives

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

Upon successful completion of this course, students will be able to;

1. Differentiate basic concepts, operation principles in dc and ac machine drives.
2. Formulate and solve power flow problems, analyze performance of dc and ac machines.
3. Select suitable motor and drive according to the application.
4. Test and analyze the parameters and performance of the motors.

Course Contents:

Electromechanical energy conversion, field energy, co energy, mechanical forces in electromagnetic system; dc machines, construction, windings, types, dc motor and generators, commutation process, Interpoles; Induction (Asynchronous) motors, construction, rotating magnetic field, squirrel cage and slip ring motors, equivalent circuit, power flow, starting, speed control, single phase induction motors; Synchronous motor and generator construction, equivalent circuit, power and torque equations, power factor control, BLDC and SRM; Basics of electrical drives and control, dynamics of electrical drives, dc motor drives, induction motor drives.

References:

1. P. C. Sen, "Principles of electric machines and power electronics", John Wiley and Sons, Second edition, 1997.
2. G. K. Dubey, "Fundamentals of electrical drives", Second edition, (sixth reprint), Narosa Publishing house, 2001.
3. D. P. Kothari, I. J. Nagrath, 'Electric Machines', Tata McGraw Hill Publication, Fourth edition, reprint 2012.
4. B. K. Bose, "Modern power electronics and ac drives", Pearson Education, Asia, 2003.

[PSBC] PEMD-19003: Embedded Systems

Teaching Scheme:
Lectures: 3 Hrs/week

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

Course Outcomes:

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

1. Explain the embedded system concepts and architecture of embedded systems
2. Deploy low end applications using low and high level languages on microcontroller platform.
3. Test and debug peripherals in embedded system.
4. Identify, design and implement applications on embedded platform.

Syllabus 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. Various elements include OPAMPs, Comparators, Instrumentation OP AMPs, ADCs, DACs, DC-DC Converters, Isolators, Level Shifters, ESD Protection Devices. 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", Publisher Butterworth-Heinemann.
2. WyneWoff “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.

[DEC] Department Elective-I

[DEC-I] PEMD(DE)-19001: Wind and Solar Power

Teaching Scheme:
Lectures: 3 Hrs/week

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

Course Outcomes:

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

1. Demonstrate the importance of energy security and sustenance
2. Design standalone solar PV system and solar thermal system for various applications
3. Design standalone wind energy system
4. Design the grid connected solar PV and wind energy system

Syllabus Contents:

Historical development and current status, characteristics of wind power generation, network integration issues, generators and power electronics for wind turbines, power quality standards for wind turbines, technical regulations for interconnections of wind farm with power systems, isolated wind systems, reactive power and voltage control, economic aspects, impacts on power system dynamics, power system interconnection experience in the world, introduction of solar systems, merits and demerits, concentrators, various applications, solar thermal power generation, PV power generation, cost effectiveness.

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. Mukund Patel, "Wind and Solar Power Systems", CRC Press, 1999.
5. Gilbert M. Master, "Renewable and efficient electric power systems" John Wiley and Sons, 2004.

[DEC-I] PEMD(DE)-19002: Engineering Optimization

Teaching Scheme:
Lectures: 3 Hrs/week

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

Course Outcomes:

Upon 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. Implement various optimization software tools to solve power system/ control system/ machine drive problems and develop algorithms to solve electrical 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, advanced 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.Durga Das Basu, "Introduction to the Constitution of India" Prentice Hall EEE, 19th/20th Edn., 2001. (Students Edn.)

[DEC-I] PEMD(DE)-19003: Computational Electromagnetics

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

1. Develop computational skills in applied electromagnetic and related disciplines
2. Use and apply electromagnetic concepts to a electromagnetic problem
3. Solve the problem analytically and analyze using simulation
4. Solve real world modern Electromagnetic problem computational problems with FEA software

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.

[DEC-I] PEMD(DE)-19004: Embedded C

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

1. Apply the fundamentals of embedded systems
2. Select suitable microprocessor / controller/PIC for given application
3. Select suitable programming language platform C / C++ as per application
4. Programme the I/O and timers/counter programming

Course Contents:

Introduction to embedded system, embedded system architecture, classifications of embedded systems, challenges and design issues in embedded systems, fundamentals of embedded processor and microcontrollers. Concepts of C programming C concepts and programming- data types, advanced data types- register, constants, IO operations, operators, operator precedence and associatively, Conditional statements & loops, arrays, single and double dimensional arrays, stings and string operations. PIC Architecture Introduction to PIC microcontrollers, PIC architecture, comparison of PIC with other CISC and RISC based systems and microprocessors, memory mapping, assembly language programming, addressing modes, instruction set. I/O Programming PIC I/O ports, I/O bit manipulation programming, timers/counters, programming to generate delay and wave form generation, I/O programming, LEDs, 7segment led's, LCD and Keypad interfacing

References:

1. C in Depth by S.K. Srivastava and Deepali Srivastava, BPB Publications.
2. 'Embedded C", Micheel J. Pont, Pearson Education Ltd, 2002.
3. C Programming for Embedded Systems, Kirk Zurell, R and D books, 2000.
4. Embedded C programming, Mark Siengemund, First edition, Elsevier, 2014.

[DEC-I] PEMD(DE)- 19013: Automotive Embedded Product Development

HELLA –COEP Automotive Electronics Program (Elective-1)

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/week	T1 and T2: 20 Marks each
Complimentary lab sessions will be organized to ensure hands-on learning	End-Sem Exam: 60 Marks

Course Outcomes:

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

1. Acquire automotive product development understanding
2. Learn Project Management concept
3. Apply processes, methods and tools to demonstrate learning

Syllabus Contents:

- **Automotive system overview & product development:** Major Automotive trends (e-mobility, Autonomous Driving, Comfort & Connected Cars), Vehicle EE architecture, product. Integration of Mechanical, Software, Hardware domains and their interdependences, Design for x Abilities (manufacturability, testability, serviceability, maintainability, Overview of Design guidelines.
- **Process, methods & tools:** Requirement Engineering and version control tools: DOORs, PTC, V model, Product Engineering Process, Automotive spice, TS 16949, Key Performance Indicators for development.
- **Product reliability, safety & quality:** DFMEA, PFMEA, Warranty, Design Validations, Process Validations, Customer Line Return, Non Quality Expenses, First Pass Yield, Statistical tools, ASIL levels, Safety Goals, Safety Measures, HARA, FMEDA,ISO 26262.
- **Project Management & Organization:** Matrix Organization, Line responsibilities, Functional responsibility, Team work, Leadership, Scope management, Scheduling, Cost, Monitoring & Tracking, Engineering Change Management, Milestones.

[MLC-] ML-19011: Research Methodology and Intellectual Property Rights

Teaching Scheme:
Lectures: 2 hrs/week

Examination Scheme:
Continuous evaluation
Assignments/Presentation/Quiz/Test

Course Outcomes (COs):

Upon 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

Syllabus Contents:

Unit 1: **[5Hrs]**
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.

Unit 2: **[5Hrs]**
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

Unit 3: **[5Hrs]**
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

Unit 4 : **[4Hrs]**
Introduction to the concepts Property and Intellectual Property, Nature and Importance of Intellectual Property Rights, Objectives and Importance of understanding Intellectual Property Rights

Unit 5 : **[7Hrs]**

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

Unit 6 : [4Hrs]

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. Intellectual Property Rights under WTO by T. Ramappa, S. Chand.
7. Manual of Patent Office Practice and Procedure
8. WIPO : WIPO Guide To Using Patent Information
9. Resisting Intellectual Property by Halbert ,Taylor & Francis
10. Industrial Design by Mayall, Mc Graw Hill
11. Product Design by Niebel, Mc Graw Hill
12. Introduction to Design by Asimov, Prentice Hall
13. Intellectual Property in New Technological Age by Robert P. Merges, Peter S. Menell, Mark A. Lemley

[MLC] ML-19012: Effective Technical Communication

Teaching Scheme:
Lectures: 1hr / week

Evaluation Scheme:
100M: 4 Assignments
(25 Marks each)

Course Outcomes:

Upon successful completion of this course, the 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

Syllabus Contents:

Unit 1: Fundamentals of Communication **[4 Hrs]**
7 Cs of communication, common errors in English, enriching vocabulary, styles and registers

Unit 2: Aural-Oral Communication **[4 Hrs]**
The art of listening, stress and intonation, group discussion, oral presentation skills

Unit 3: Reading and Writing **[4 Hrs]**
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] PEMD-19004: Advanced Control Theory

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

1. Analyze linear control system using vector spaces.
2. Design linear control system using state space to achieve desired system performance
3. Design Linear quadratic regulator to achieve desired system performance
4. Analyze non- linear systems
5. Obtain discrete representation of LTI systems

Syllabus Contents:

Review of Linear Algebra : Vector space, linear combination, linear independence, bases of a vector space, representation of any vector on different basis, matrix representation of a linear operator, change of basis, rank, nullity, range space and null space of a matrix, Eigen value and Eigen vector of a matrix, similarity transform, Diagonalization.

Linear System analysis in state space: 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, Design of PI/PID controller

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] PEMD-19005: Advanced Power Electronics

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

1. Plot characteristics of switching devices and use them in practical systems.
2. Design and model different types of power converters.
3. Design controller and implement them in simulation.
4. Design power circuit and protection circuit of devices and converter.

Syllabus 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. N. Mohan, T. M. Undeland and W. P. Robbins, "Power Electronics: Converter, Applications and Design", John Wiley and Sons, 1989.
2. M.H. Rashid, "Power Electronics", Prentice Hall of India, 1994.
3. B. K .Bose, "Power Electronics and A.C. Drives", Prentice Hall, 1986.
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.

[PCC] PEMD-19006: DSP Applications to Power Electronics and Drives

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

1. Implement PWM or SVPWM inverter control
2. Use DSP for power electronics and drives applications.
3. Implement DSP based PLL.
4. Implement open loop and closed loop control for PMSM, BLDC motors.

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 Education Private Limited, 2011.

[LC] PEMD-19007: Electrical Machines and Drives Lab

Teaching Scheme:
Lab: 6 hrs/week

Examination Scheme:
Continuous Evaluation: 50marks
End-Sem Exam: 50 Marks

Laboratory Outcomes:

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

1. Differentiate between various dc and ac motors.
2. Obtain the equivalent circuit parameters of dc motor, induction motor and transformer.
3. Test a dc and induction motor to estimate its efficiency at any load condition.
4. Analyze different steady state speed control methods for Induction motors and understand the closed loop block diagrams for different methods.
5. Select ac and dc motors and drives for industrial application.

Laboratory Contents:

The list of practical to be performed as the part of the course:

1. Evaluate a performance of a dc motor by load test.
2. Obtain open circuit and load characteristics of a separately excited dc generator.
3. Determination of equivalent circuit parameters of an induction motor by no load and blocked rotor test.
4. Practical realization of the behavior of a synchronous motor by excitation variation and control of power factor.
5. Perform a load test on a synchronous motor to estimate its efficiency.
6. Perform a load test on a synchronous generator to evaluate its voltage regulation.
7. Parallel operation of two synchronous generators and control of load sharing among them.
8. Load test on a single phase transformer to evaluate efficiency.
9. Study of commercial AC and DC drives.

[LC] PEMD-19008: Embedded Systems Lab

Teaching Scheme:
Lectures: 4 hrs/week

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

Course Outcomes:

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

1. Explain the architecture of microcontroller, microcomputer, embedded system.
2. Demonstrate interactions of different components of a micro-controller.
3. Become familiar with programming environment used to develop embedded systems
4. Demonstrate key concepts of embedded systems like I/O, timers, interrupts, interaction with peripheral devices
5. Apply debugging techniques for an embedded system

Syllabus Contents:

After understanding of MSP 430 architecture inclusive of Memory, I/O, Pipeline, Lab assignments will be based on use of instruction set, ISS, Communication/Display/User Interface Peripherals/Serial/PWM to solve specific embedded problems, power, foot print, interrupt latency, real time response, introduction to Real time operating system concepts. Experiments based on above objectives such as PID control, LED Interface, timers, Design of Energymeter 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.
8. MSP 430 Guide

[LC] PEMD-19009: Advanced Power Electronics Lab

Teaching Scheme:
Lab: 6 hrs/week

Examination Scheme:
Continuous Evaluation: 50marks
End-Sem Exam: 50 Marks

Laboratory Outcomes:

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

1. Design and simulate 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.

Laboratory Contents:

1. The list of practical to be performed as the part of the course:
2. Modeling and Simulation of Buck, Boost and Buck Boost Converters.
3. Study of Basic Buck Converter- Lab experiment.
4. Study of Basic Boost Converter- Lab experiment.
5. Study of Basic Buck/Boost Converter- Lab experiment.
6. Modeling and Simulation of Isolated DC/DC Converters (Flyback & Forward Converters).
7. Study of Phase Controlled Rectifiers and PWM Rectifiers.
8. Study of Single Phase Inverters and Modulation Techniques.
9. Study of 3-Phase Inverters and Modulation Techniques.
10. Study of Multilevel Inverters and their Modulation Techniques.
11. Study of matrix converter and its control.

SEMESTER-II

[IOC] PEMD-19010: Engineering Optimization

Teaching Scheme:
Lectures: 3 Hrs/week

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

Course Outcomes:

Upon 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 domains
4. Implement various optimization software tools to solve real time problems and develop relevant algorithms.

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, advanced optimization techniques, applications of optimization techniques to solve various real time problems

References:

1. 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.)

[DEC] Department Elective-II

[DEC-II] PEMD(DE)1905: Grid Interface of Energy Sources

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

1. Select power electronic converters suitable for the solar, wind energy sources
2. Design and configure the interface with grid for various renewable sources
3. Analyze the power quality issues
4. Solve the problems and analyze the performance of the power converters

Course Contents:

Introduction to renewable sources: world energy scenario, Wind, solar, hydro, geothermal, availability and power extraction. Introduction to solar energy: Photovoltaic effect, basics of power generation, P-V & I-V characteristics, effect of insolation, temperature, diurnal variation, shading; Modules, connections, ratings; Power extraction (MPP), tracking and MPPT schemes; standalone systems, grid interface, storage, AC-DC loads. Power converters for solar: Micro converter, DC-DC buck/boost/buck-boost /flyback /forward/cuk, bidirectional converters; Inverters: 1ph, 3ph inverters with & w/o transformers, Heric, H6, Multilevel Neutral point clamp, Modular multilevel, CSI; 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. Intro 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.

[DEC-II] PEMD(DE) 1906: Machine Learning

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

1. Explain the basic concepts of machine learning
2. Demonstrate fundamental issues and challenges of machine learning algorithms
3. Comparevarious popular MachineLearning approaches.
4. Appreciate the underlying mathematical relationships within and across Machine Learning algorithms.
5. Design and Apply machine learning algorithms to real world problems

Syllabus Contents:

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, over-fitting and evaluation, nearest neighbor methods. Neural network: Perceptron, multilayer network, back propagation, 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

References:

1. Ethem Alpaydin, Introduction to Machine Learning, Second Edition, The MIT Press, 2010.
2. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.
3. Stephen Marsland, Machine Learning: An Algorithmic Perspective, CRC Press, 2009.
4. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.

[DEC-II] PEMD(DE)-19007: Condition Monitoring of Electrical Apparatus

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

1. Configure reliable condition monitoring system for a plant
2. Use Mathematical conventional and modern methodologies/techniques in analysis.
3. Develop basic functional models for condition monitoring system to different kind of power apparatus.
4. 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 . Cables, Transformers, Induction motor, Capacitor banks, conventional methods, 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 equipments such as transformer, induction motor, synchronous generator and motor, DC motor, CT and PT, case studies. Discrete time Fourier series and its convergence, discrete time Fourier Transform, its properties, frequency response. Introduction to DFT in time domain and frequency domain, Derivation of DFT from DTFT, Inverse DFT, Convolution using DFT, Computational Complexity of the DFT, 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

[DEC-II] PEMD(DE)-19008: Automotive Electronics: Hardware Development

HELLA –COEP Automotive Electronics Program (Elective: 2)

Teaching Scheme:
Lectures: 3 Hrs/week
Complimentary lab sessions will be organized to ensure hands-on learning

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

Course Outcomes:

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

1. Acquire automotive specific hardware design skills.
2. Apply concept such as DFM, DFT, EMC, DFMEA.
3. Apply processes, methods and tools to demonstrate learning

Syllabus Contents:

- **Low Power Domain:** 16/32 bit controllers, Hardware-Software Interfaces, communication interfaces- CAN, 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.
- **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.

[DEC] Department Elective-III

[DEC-III] PEMD(DE)-19009: Energy Storage Systems

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

1. Identify the emerging needs of Electrical Energy Storage Systems.
2. Discuss the scientific principles underpinning the operation of energy storage systems
3. Model various electrical energy storage systems and analyze their performance.
4. Assess the global markets for the Electrical Energy Storage Systems.

Syllabus Contents:

The Role of Electrical Energy Storage Technologies in Electricity use, emerging needs of Electrical Energy Storage (EES), The roles of EES, Types of Electrical Energy Storage Systems, Classification, Mechanical, Electrochemical, Chemical, Electrical, Thermal Energy Storage systems, Standards and Safety involved, Areas of applications of EES, Markets and forecast for EES.

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. A. G. Ter-Gazarian, ”Energy Storage for Power Systems”, Institution of Engineering and Technology, 2011.
4. James M. Eyer, Joseph J. Iannucci and Garth P. Corey, “Energy Storage Benefits and Market Analysis”, Sandia National Laboratories, 2004.

[DEC-III] PEMD(DE)-19010: Power Quality Issues and Mitigation

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

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

Syllabus Contents:

Terms and definitions, voltage sags and interruptions: sources of sags and interruptions, end user issues, transient over voltages: sources of transient overvoltages, devices for overvoltage protection, load switching transient problems, harmonics: harmonic distortion, total harmonic distortion, triplen harmonics, effects of harmonic distortion, locating sources of harmonics, modelling 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”. McGraw 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 Devices”.
4. Math H. J. Bolen, “Understanding Power Quality Problems”, IEEE power series on Power Engineering.
5. Wakileh, George J.,” Power system harmonics, Fundamentals, Analysis and Filter Design”, Springer

[DEC-III] PEMD(DE)-19011: Smart Grid Technologies

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

1. Differentiate conventional and smart grid, identify the need of smart grid, micro grid, smart metering, smart storage, hybrid vehicles, home automation, smart communication,
2. Express the need and specify the components of smart grid and smart communication.
3. Select suitable sensors for smart grid
4. Select suitable communication protocol

Syllabus 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, i-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 renuable energy in electric power systems, John Weily.
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 Wily.

[DEC-III] PEMD(DE)-19012: Automotive Electronics: Software Development

HELLA –COEP Automotive Electronics Program (Elective: 3)

Teaching Scheme:
Lectures: 3 Hrs/week
Complimentary lab sessions will be organized to ensure hands-on learning

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

Course Outcomes:

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

1. Acquire automotive specific software design skills.
2. Apply concepts such as AUTOSAR, MATLAB, and Communication Protocol.
3. Apply processes, methods and tools to demonstrate design skills

Syllabus Contents:

Software Architecture: Classical architecture, Layered Architecture (AUTOSAR), All layer information (e.g. RTE, BSW, Application) Tool: Davinci developer, configurator, Raphsody.
Communication Protocols: Communication Protocol, CAN, LIN, Automotive Ethernet, RF, Bluetooth, Wi-Fi, Diagnostic Protocol: UDS, Tools: CANoe, Vehicle spy, CAPEL ,TAE scripting.
Model Based Development: Model Based Development: Algorithm/application development using Simulink, stateflow, code generator.
Embedded C: Concepts of C (structure, union, pointer, bitwise operator), Logic building according to requirement, MISRA C guidelines.
Software Testing: Unit testing, Model in loop(MIL) testing, module testing, integration testing, software in loop(SIL) testing, Hardware in Loop (HIL) testing,. Tools: Tessy, PolySpace, TPT, Winidea, QAC, HIL Test Setup.

[LLC] LL-19001: Liberal Learning Course

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

Upon 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.

Syllabus 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:

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

[PCC] PEMD-19011: Advanced Electric Drives

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

1. Select suitable dc and ac drives.
2. Solve problems and analyze performance of dc and ac drives.
3. Select suitable drive control strategy according to the application.
4. Design advanced drive and compare the performance with the existing one.

Course Contents:

Review of drive fundamentals, various quadrants of electric drives, types of industrial loads, duties of electric motors, heating and cooling, calculations of load on motor. Review of fundamentals of DC Drives and Induction motor drives. Converters topologies for low, medium and high power drives. Direct torque and vector control methods for AC drives. Sensor and Senseless control, Ripple minimization techniques for DTC. Drives for the slip ring induction machine, DFIG and its four quadrant control, Construction and working of BLDC, PMSM, Synchronous Reluctance and Switched Reluctance motors. Speed control of these motors. Stepper motor drives. Construction and working of axial flux and transverse flux reluctance and permanent magnet machines, linear synchronous machines.

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] PEMD-19012: Special Electrical Machines

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

1. Select proper machines for the given application
2. Represent and analyze the modern machines
3. Develop dynamic model and analyze PMSM, BLDC and SRM
4. 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

References:

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] PEMD-19013: Electric Mobility

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

1. Propose a suitable architecture scheme for f Electric Vehicles, Hybrid Electric Vehicles and Plug in Hybrid Electric Vehicles
2. Select energy sources, power electronics and motors required for EVs and HEVs
3. Design EV & HEV system
4. Model EVs & HEVs

Course Contents:

A brief history of EV & PHV, Basics of EV & HEV, Architectures of EV and HEV, HEV fundamentals. Introduction to PHEVs, PHEV architectures, Power management of PHEVs, Fuel economy of PHEVs, PHEV design and component sizing, Vehicle-to-grid technology. Introduction, Principles of power electronics, Rectifiers, Converters, Inverters, Battery chargers used in EVs and HEVs, Emerging power electronic devices. Introduction, Induction motor drives, Permanent magnet motor drives, Brushed & Brushless DC motor, Switched reluctance motors. Batteries, Ultracapacitors, Fuel Cells, Controls, Aerodynamic considerations Consideration of rolling resistance, Transmission efficiency, Consideration of vehicle mass, Electric vehicle chassis & body design, General issues in design. Introduction, Fundamantals of vehicle system modeling, HEV modeling using ADVISOR & PSAT, Case studies - Rechargeable battery vehicles, Hybrid vehicles

References:

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] PEMD-19014: DSP Application Lab

Teaching Scheme:
Lectures: 1 hrs/week
Practicals: 2 hrs/week

Examination Scheme:
Continuous Evaluation: 50 Marks
End-SemExam–50marks

Course Outcomes:

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

1. Analyze and describe the functionality of a real world DSP system.
2. Write low level device drivers/Chip Support Libraries for standard peripherals such as UART/PWM/TimersCreate/debuganddevelopapplicationsinCforembeddedenvironment.
3. Develop various DSP Algorithms using MATLAB Software package.
4. Develop an embedded controller for power electronics and drive applications

Syllabus 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, TMS28335.
2. Website: www.ti.comandwww.DSPguide.com.
3. Marven,C., Ewers, G.A simple approach to DSP TexasInstr.1993.
4. MSP430 Technical Reference Manual

[LC] PEMD-19015: HIL Lab

Teaching Scheme:
Lectures: 2 hrs/week

Examination Scheme:
Continuous Evaluation: 50 Marks
End-Sem Exam: 50 Marks

Course Outcomes:

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

1. Mathematically formalize requirements based on design objectives.
2. Perform analysis and design in the discrete domain using ADC and DAC.
3. Gain knowledge and hands on experience with sensor and actuator calibration, signal amplification, sampling, DAC and ADC, uncertainties and noise, continuous and discrete filters, safety measures for HIL implementations, *etc*.
4. Independently setup HIL experiments using Simulink and dSpace virtual HIL software packages.

Syllabus Contents:

Experiments on Development and debugging the model/controller in MATLAB/SIMULINK, Design MIL tests in order to verify and validate the model/controller according to predefined requirements, Generate and debug production code, and performing SIL tests, hands on experience of V&V tools in MATLAB/SIMULINK, Learning to work with dSPACE software packages, setting up VHIL, and recording data using data acquisition tools in dSPACE, Designing and implementing DOE tests on the VHIL platform.

References: Help files of relevant software.

SEMESTER-III

[SBC] PEMD-20001: Dissertation Phase – I

Course Outcomes:

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

1. Identify key research and development topics in the field of chosen dissertation area (Power electronics, Electrical machines, electrical drives, Energy systems and any interdisciplinary area)
2. Identify, summarize and critically evaluate relevant literature and write a literature review on the relevant topic.
3. Manage time effectively whilst working on independent research and prepare action plan.
4. Show evidence of clarity of argument, understanding of the chosen topic area, and presentation of technical information
5. develop written and oral presentation skills.

Syllabus 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:

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

[SLC] PEMD-20002: Project and Finance Management

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

1. Demonstrate project management skills.
2. Analyze risk and manage it.
3. Illustrate project financial evaluation
4. Utilize specialized economic evaluation techniques to determine and evaluate project feasibility.

Syllabus Contents:

Project organization and contracts, Construction finance, Public-private partnerships in financing of infrastructure, Private finance initiative, Project finance, How to get involved in private finance, Risk analysis, Risk management, Project financial evaluation, Capital program management, Project control, Project management engineering, procurement and construction, Identifying and covering risks—current trends, Project uncertainty management. Term project presentation

References:

1. Online MOOC course material available in the selected area
2. Shtub, Bard and Globerson, "Project Management: Engineering, Technology, and Implementation", PH Inc.
3. Khan, M.Y & Jain, P.K.: Financial Management; Tata McGraw Hill, New Delhi, 2008
4. Keown, Martin, Petty and Scott (Jr): Financial Management; Principles and Applications; Prentice Hall of India, New Delhi, 2002.

SEMESTER-IV

[SBC] PEMD-20003: Dissertation Phase – II

Course Outcomes:

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

1. Manage time and other resources effectively whilst working on independent research.
2. Identify, analyses and interpret suitable data to enable the research problem to be solved.
3. Model, Simulate/ develop innovative hardware/ develop new algorithms/ emulate/ HIL/ develop prototype for the selected topic.
4. Describe the process of carrying out independent research in written format and report your results and conclusions with reference to existing literature and Analyze and synthesize research findings.
5. Use and develop written and oral presentation skills and prepare good technical project reports for publication in journals and conferences.
6. Take up challenging issues in industry and provide solutions.

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:

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

[SLC] PEMD-20004: Design of Internet of Things

Teaching Scheme:
Lectures: 3 hrs/week

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

Course Outcomes:

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

1. Illustrate the application areas of IOT ·
2. Realize the revolution of Internet in Mobile Devices, Cloud and Sensor Networks ·
3. Demonstrate building blocks of Internet of Things and characteristics.
4. Configure the IoT features to the given system

Syllabus Contents:

Introduction to IoT, Sensing, Actuation, Basics of Networking, Basics of Networking, Communication Protocols, Communication Protocols, Sensor Networks, Sensor Networks, Machine-to-Machine Communications, Interoperability in IoT, Introduction to Arduino Programming, Integration of Sensors and Actuators with Arduino, Introduction to Python programming, Introduction to Raspberry, Implementation of IoT with Raspberry Pi, Introduction to SDN, SDN for IoT, Data Handling and Analytics, Cloud Computing, Cloud Computing, Sensor-Cloud, Fog Computing, Smart Cities and Smart Homes, Connected Vehicles, Smart Grid, Industrial IoT, Industrial IoT, Case Study: Agriculture, Healthcare, Activity Monitoring.

References:

1. Adrian McEwen Hakim Cassimally, “Designing the Internet of Things”, Publisher: JOHN WILEY & SONS INC
2. NPTEL Course on “Design of Internet OF Things” by Prof. T V Prabhakar ,IISC Bangalore.