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

NEP 2020 Compliant

Proposed Curriculum Structure

M. Tech.
Electrical – Power Electronics and Power Systems

(Effective from: A.Y. 2025-26)

W.e.f AY 2025-26

List of Abbreviations

Abbreviation	Title	No of courses	Credits	% of Credits
PSMC	Program Specific Mathematics Course	1	4	5%
PSBC	Program Specific Bridge Course	1	3	3.75%
PCC	Program Core Course	8	24	30%
PEC	Program Specific Elective Course	3	9	11.25%
RM	Research Methodology	1	3	3.75%
OE	Open Elective	1	3	3.75%
SLC	Self-Learning Course	2	6	7.5%
AEC	Technical Communication Skills	1	2	2.5%
LLC	Liberal Learning Course	1	1	1.25%
OJT	Internship	1	3	3.75%
Project	Dissertation Phase – I and II	2	22	27.5%
	Total	**22**	**80**	**100%**

PG Program [M. Tech. Electrical – Power Electronics and Power Systems]
Proposed Curriculum Structure

Semester I

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme					Evaluation Scheme				
				L	T	P	S	Cr	Theory			Laboratory	
									MSE	TA	ESE	ISE	ESE
1.	PSMC	PEPS-23001	Mathematical Modeling of Electric Machines	3	1	--	1	4	30	20	50	--	--
2.	PSBC	PEPS-23002	Embedded Systems	2	--	2	3	3	30	20	50	50	50
3.	PCC	PEPS-23003	Advanced Control Theory	3	1	--	1	4	30	20	50	--	--
4.	PCC	PEPS-23004	Advanced Power Electronics	3	--	--	1	3	30	20	50	--	--
5.	PCC	PEPS-23005	Power System Analysis	3	--	--	1	3	30	20	50	--	--
6.	PCC	PSPS-23006	Simulation Laboratory	--	--	4	--	2	--	--	--	50	50
7.	PEC-1	PEPS (PE)-23001 PEPS (PE)-23002 PEPS (PE)-23003 PEPS(PE)-25001	a. Wind and Solar Power b. Engineering Optimization c. c. EHVAC Transmission d. Automotive Embedded Product Development e. Any other course offered by faculty	3	--	--	1	3	30	20	50	--	--
8.	RM	SET25001	Research Methodology	3	--	--	1	3	30	20	50	--	--
Total Credits								**25**					

Legends:
L-Lecture, T-Tutorial, P-Practical, S-Self Study, Cr-Credits
ISE-In-Semester-Evaluation, ESE-End-Semester-Evaluation, MSE-Mid-Semester-Evaluation, TA-Teachers'

PG Program [M. Tech. Electrical – Power Electronics and Power Systems] Proposed Curriculum Structure

Semester II

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme					Evaluation Scheme (Weightages in %)				
				L	T	P	S	Cr	Theory			Laboratory	
									MSE	ISE	ESE	ISE	ESE
1.	OE	OEC-25013	Engineering Optimization	3	--	--	1	3	30	20	50	--	--
2.	PCC	PEPS-23008	Power Systems Dynamics and Stability	3	--	--	1	3	30	20	50	--	--
3.	PCC	PEPS-23009	HVDC and FACTS	3	--	--	1	3	30	20	50	--	--
4.	PCC	PEPS-23010	Digital Protection	3	--	2	1	4	30	20	50	50	50
5.	PEC-2	PEPS(PE)-23007	Power System Transients	3	--	--	1	3	30	20	50	--	--
		PEPS(PE)-23008	Machine Learning										
		PEPS(PE)-23009	Electrical Power Distribution Systems										
		PEPS(PE)-23010	Restructured Power Systems										
		PEPS(PE)-25002	Automotive Electronics Hardware Development										
			Any other course offered by faculty										
6.	PEC-3	PEPS(PE)-23004	Energy Storage Systems	3	--	--	1	3	30	20	50	--	--
		PEPS(PE)-23005	Power Quality Issues and Mitigation										
		PEPS(PE)-23006	Smart Grid Technologies										
		PEPS(PE)-25003	Automotive Electronics Software Development										
			Any other course offered by faculty										
7.	PCC	PEPS-23012	HIL Lab	--	--	4	--	2	--	--	--	50	50
8.	AEC	SET-25002	Technical Communication skills	1	--	2	1	2	50	50	--	100	--
8.	LLC	CCA	Liberal Learning Course	--	--	2	2	1	--	--	--	100	--
Total Credits								**24**					

- Exit option to qualify for **PG Diploma in Power Electronics and Power Systems**:

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

PG Program [M. Tech. Electrical – Power Electronics and Power Systems]
Proposed Curriculum Structure

Semester-III

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme					Evaluation Scheme (Weightages in %)				
				L	T	P	S	Cr	Theory			Laboratory	
									MSE	ISE	ESE	ISE	ESE
1.	SLC		Massive Open Online Course –I	3	--	--	1	3	--	--	100	--	--
2.	SLC		Massive Open Online Course –II	3	--	--	1	3	--	--	100	--	--
3.	OJT	PEPS-250011	Internship	--	--	--	--	3	--	--	100	--	--
4.	Project	PEPS-24001	Dissertation Phase–I	--	--	22	12	11	--	--	--	70	30
			Total Credits					20					

Semester-IV

Sr. No.	Course Type	Course Code	Course Name	Teaching Scheme					Evaluation Scheme (Weightages in %)				
				L	T	P	S	Cr	Theory			Laboratory	
									MSE	ISE	ESE	ISE	ESE
1.	Project	PEPS-24003	Dissertation Phase–II	--	--	22	12	11	--	--	--	70	30
			Total Credits					11					

Legends:
L-Lecture, T-Tutorial, P-Practical, S-Self Study, Cr-Credits
ISE-In-Semester-Evaluation, ESE-End-Semester-Evaluation, MSE-Mid-Semester-Evaluation, TA-Teachers'

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SEMESTER-I

[PEPS-23001] Mathematical Modeling of Electric Machines

Teaching Scheme:
Lectures: 3 Hrs/week
Self Study: 1 Hr/week
Tutorial: 1 Hr/week

Examination Scheme:
MSE: 30 Marks
TA: 20 Marks
End-Sem Exam: 50 Marks

Course Outcomes:

After 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

Course 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.

[PEPS-23002] Embedded Systems

Teaching Scheme:
Lectures: 2 Hrs/week
Practicals: 2 Hr/week
Self Study: 3 Hrs/week

Examination Scheme:
MSE: 30 Marks
TA: 20 Marks
End-Sem Exam: 50 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 "Princ|ples of Embedded computing system design", Morgan Koffman publication 2000
3. Rajkamal, Systems- Architecture, Programming and Design", 2007- TMH.
4. Qing Li, Time Concepts for Embedded Elsevier, 2011.
5. Shibu to Embedded Mc Graw Hill.

[PEPS-23003] Advanced Control Theory

Teaching Scheme	**Examination Scheme:**
Lectures: 3 Hrs/week	MSE: 30 Marks
Self Study: 1 Hr/week	TA: 20 Marks
Tutorial: 1 Hr/week	End-Sem Exam: 50 Marks

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-
2. John S
3.
4. -Graw Hill Publications.
5. -Hall (India), 1986.
6. G.H. Golub and C.F. V
   1983.
7.
8.

[PEPS23004] Advanced Power Electronics

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

Examination Scheme:
MSE: 30 Marks
TA: 20 Marks
End-Sem Exam: 50 Marks

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: Converters, Applications and Design*, 3rd Edition, John Wiley & Sons, India.
2. Rashid, M.H., *Power Electronics: Circuits, Devices and Applications*, Pearson Education.
3. Bose, B.K., *Power Electronics and Variable Frequency Drives: Applications*, IEEE Press, Standard Publishers Distributors.
4. Basso, P., *Switch Mode Power Supply: Technology and Spice Simulations with Practical Designs*, McGraw Hill.
5. Erickson, R.W., and Maksimović, D., *Fundamentals of Power Electronics*, Springer Publication.

[PEPS-23005] Power System Analysis

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

Examination Scheme:
MSE: 30 Marks
TA: 20 Marks
End-Sem Exam: 50 Marks

Course Outcomes:

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

1. Analyze power systems using basic concepts and principles.
2. Formulate and solve power flow problems, economic and environmental dispatch problems.
3. Evaluate the voltage stability and power system security of given power system
4. Solve a practical system both under steady state and fault conditions
5. Analyze power system stability problems

Course Contents:

Algorithms for formation of bus admittance and impedance matrices, power flow solutions: Gauss Seidal, Newton-Raphson, Fast decoupled load flow, optimal power flow, sparsity exploitation in power system studies, Z - matrix for short circuit studies, concept security state and security analysis, contingency studies, unit commitment, state estimation, Weighted least squares state estimation, optimal hydro-thermal scheduling, voltage stability: Definition and classification, mechanism of voltage collapse, analytical concept of voltage stability for a two bus system, Artificial Intelligence applications to power system analysis, renewable generation for power flow analysis.

References:

1. G. W. Stagg and A. h. El-h

2 hall, 1986.

3. I. J. Nagrath and D. P. Koth hill, 1980.

4 hn Wiley, 1984.

[PEPS-23006] Simulation Laboratory

Teaching Scheme:
Self Study: 4 hrs/week

Examination Scheme:
Lab ISE - 50 Marks
Lab ESE 50 Marks

Course Outcomes:

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

1. Model electrical power system under steady state and transient conditions.
2. Use MATLAB and ATP/PSCAD for power system studies.
3. Determine the reactive power requirement of lines and compute VAR compensation required from voltage profile along the line.
4. Compute the Y-bus matrix, perform load flow studies and interpret the results.
5. Use Maxwell software for analysis of electric machines.
6. Use PSIM, PSPICE for power electronic circuit simulation.
7. Use ETAP for power system analysis

Course Contents:

This lab will cover simulation experiments/assignments on the platform like MATLAB, ATP/EMTP, PSCAD, MAXWELL, LABVIEW, PSIM, PSPICE, DigSILENT, etc. The problems will be related to the core subjects and electives.

References: Manuals of respective software.

[PEPS (PE)-23001] Wind and Solar Energy Systems

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

Examination Scheme:
MSE: 30 Marks
TA: 20 Marks
End-Sem Exam: 50 Marks

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. Explain and classify wind turbines, instruments for measuring solar radiation, solar collectors, solar cell and solar MPPT techniques
4. Analyze different types of wind generators, solar cell and solar collectors
5. 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.
ltd.2005.
2.
and sons ltd., 2006.
3.
Edition, 1996.

[PEPS(PE)-23002] Engineering Optimization

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

Examination Scheme:
MSE: 30 Marks
TA: 20 Marks
End-Sem Exam: 50 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.

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 power system/control systems/power electronics and machine drives.

References:

1. R. Fletcher, , Second edition, John Wiley and Sons, New York, 1987.
2. S. S. Rao, Optimization-Theory and fourth edition, Wiley Easter Publications, January 2009.
3. K. V. Mital and C. Mohan, Methods in Operations Research and System Ana New age International Publishers, Third edition, 1996.
4. John Wiley and Sons, New York 199h.

[PEPS(PE)-23003] EHV AC Transmission

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

Examination Scheme:
MSE: 30 Marks
TA: 20 Marks
End-Sem Exam: 50 Marks

Course Outcomes:

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

1. Appreciate the necessity, merits and demerits of EHVAC transmission and mechanical aspects
2. Evaluate the Inductance and capacitance of two conductor and multi conductor lines
3. Analyze the effect of corona, electrostatic field of EHVAC lines
4. Analyze the surface gradient on two conductor and bundle with more than h sub conductors
5. Select EHVAC transmission system components, protection and insulation level for overvoltages

Course Contents:

Introduction: Engineering aspect and growth of EHVAC Transmission line trends and preliminaries, power transferability, transient stability and surge impedance loading. Calculation of line and ground parameters: Resistance, power loss, temperature rise properties of bundled conductors, inductance and capacitance of EHV lines, positive, negative and zero sequence impedance and line parameters for modes of propagations. Voltage gradients of conductor: Charge potential relations for multi-conductor lines, surface voltage gradients on the conductor line, distribution of voltage gradients on sub conductors of bundle. Corona in EHV lines Corona loss formulae- attenuation of travelling waves due to Corona Audio noise due to Corona, its generation, characteristic and limits. Measurements of audio noise radio interference due to Corona properties of radio noise frequency spectrum of RI fields Measurements of RI and RIV. Theory of the Travelling and standing waves, Lighting and lighting protection, Over voltage in EHV system covered By switching operations, Power frequency voltage control and over voltage, Insulation Coordination, Design of EHV - AC lines

References:

h New Academic Science Ltd; 4 edition, 2011 rd

HV -AC & HVDC transmission system engin hanna Publication,3 edition

[PEPS(PE)-23001] Automotive Embedded Product Development

(Course content will be provided by the concerned industry)

[SET-25001] Research Methodology

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

Examination Scheme:
MSE: 30 Marks
TA: 20 Marks
End-Sem Exam: 50 Marks

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.

References:

1.
2.
3.
4.
5. S K Roy Chaudhary & H K Saharay, "The Law of Trademarks, Copyright, Patents

SEMESTER-II

[OEC-25013] Engineering Optimization

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

Examination Scheme:
Mid-Sem Exam -30 marks
T. A. - 20 marks
End-Sem Exam –50 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 applications.
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, Second edition, John Wiley and Sons, New York, 1987.
2. S. S. Rao, Optimization-Theory and fourth edition, Wiley Easter Publications, January 2009.
3. K. V. Mital and C. Mohan, Methods in Operations Research and System New age International Publishers, Third edition, 1996.
4. Bazaraa M. S., Sherali H
   John Wiley and Sons, New York 199h.
5. Academic
   Constituti Hall EEE, 19th/20th Edn., 2001. (Students Edn.)

[PEPS-23008] Power Systems Dynamics and Stability

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

Examination Scheme:
MSE: 30 Marks
ISE: 20 Marks
End-Sem Exam: 50 Marks

Course Outcomes:

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

1. Comprehend concepts in the dynamic phenomena and stability of power systems
2. Model power system components, such as synchronous machines, excitation systems and governors
3. Analyze dynamic and oscillatory behavior of power systems and to alleviate the same.
4. Interpret results of system stability studies.

Course Contents:

Basic concepts of dynamical systems and stability, modelling of power system components for stability studies: generators, transmission lines, excitation and prime mover controllers, analysis of single machine and multi-machine systems, small signal angle instability (low frequency oscillations): damping and synchronizing torque analysis, Eigen value analysis, mitigation using power system stabilizers, PSS design for multi-machine systems, small signal angle instability (sub-synchronous frequency oscillations): analysis and counter-measures, transient instability: analysis using digital simulation and energy function method, transient stability controllers.

References:

hers,
Bangalore,1996.
1 hill Inc, New York, 1995.
3 hall, 1997.

[PEPS-23009] HVDC and FACTS

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

Examination Scheme:
MSE: 30 Marks
ISE: 20 Marks
End-Sem Exam: 50 Marks

Course Outcomes:

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

1. Identify the need for hVDC systems.
2. Identify converters for hVDC application
3. Appreciate the use of filters for hVDC systems
4. Explain the operation of various FACTS devices.
5. Model FACTS devices to improve steady and dynamic performance of power system.

Course Contents:

HVDC: Introduction, various possible HVDC configurations, components of HVDC system, operation of 6-pulse and 12-pulse converter, Effect of source inductance, Generation of harmonics, Design of AC filters and DC filters, hVDC light and hVDC PLUS Series and Parallel operation of converters, Introduction to distribution FACTs devices.

The concept of flexible AC transmission reactive power control in electrical power transmission lines, uncompensated transmission line, Introduction to FACTS devices and its importance in transmission Network, Introduction to basic types of FACTS controllers, Shunt Compensation: Methods of Var generation: Thyristor controlled reactor (TCR), Thyristor switched capacitor (TSC), Fixed capacitor- Thyristor controlled reactor (FC-TCR), STATCOM; Series Compensation : Thyristor Switched Series Capacitor (TSSC), Thyristor Controlled Series Capacitor (TCSC). Static Synchronous Series Compensator (SSSC), modes of operation, Voltage regulator and Phase Angle Regulator (PAR), Multi functional FACTS controller: The Unified Power Flow Compensator (UPFC); circuit and steady-state characteristic; effect on transmission line compensation; Interline Power Flow Controller (IPFC); circuit and steady-state characteristic;

References:

h hi
, First Edition1990.
hn Wiley and Sons,
New York ,1982.
3. N.G.h nderstanding FACTS :Concepts and Tech IEEE Press,2000.
International (P) Ltd. 2007.
5. high Voltage Direct Current Transmission 3.

[PEPS-23010] Digital Protection

Teaching Scheme
Lectures: 3 Hrs/week
Self Study: 1 Hr/week
Practicals: 2 Hr/week

Examination Scheme:
MSE: 30 Marks
TA: 20 Marks
End-Sem Exam: 50 Marks

Course Outcomes:

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

1. Select various components (like CT, CVT, and numerical relay) for protection purpose.
2. Apply least squares, DFT, FFT phasor estimation algorithms for numerical protection.
3. Design and simulate over current, distance and differential protection schemes for power systems.
4. Develop the advanced schemes for power system protection using new technologies such as synchronized measurements, PMUs, GPS, fiber optics.

Course Contents:

Review of principles of power system protection: over current, directional, differential and distance protection, travelling wave based protection, review of sequence networks and short circuit analysis, relay coordination: over current and distance relay coordination, Current transformer and potential transformer, standards, effect on relaying philosophy, introduction to computer aided relaying, motivation, basic hardware, , estimation of phasors and frequency, algorithms for transmission line protection, out-of-step relaying, introduction to adaptive relaying and wide area measurements(WAM), transformer, generator and bus bar protection

References:

Bombay.
1. A. G. Phadke, J. S. Th h
studies press ltd.England, John Wiley and sons inc., New York.
2.
3. Y. G. Paithankar, S. R.
hall, India.

[PEPS(PE)-23007] Power System Transients

Teaching Scheme

Examination Scheme:

Lectures: 3 Hrs/week
Self Study: 1 Hr/week

MSE: 30 Marks
ISE: 20 Marks
End-Sem Exam: 50 Marks

Course Outcomes:

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

1. Understand the transient phenomena in power system.
2. Analyze transient phenomena and develop the strategies to mitigate associated problems.
3. Evaluate the transient process due to lightning
4. Use of different software tools to study the transient phenomenon

Course Contents:

Sources of electrical transients, basic concepts, definitions, causes, effects, basic mathematical concepts for transient analysis, representation of transient wave shap, modelling power apparatus for transient analysis, capacitor switching, reactor switching, magnetizing inrush and ferroresonance, transmission lines, the wave equation, and line terminations, travelling wave attenuation and distortion, transients due to faults, electromagnetic induction, magnetic flux, and currents, transient electromagnetic phenomena, lightning induced transients, computation of lightning events, lightning protection using shielding and surge arresters, transient voltages and grounding practices, numerical simulation of electrical transients, simulation tools, international standards.

References:

1. Pritindra Chaudh hI.
-hill, 2010.
h -Interscience, 1991.

5. J.A. Martinez-
Press, 2009.
7. h. W. Dommell, EMTP Theory Book.
8. Alternate Transients Program Rule Book.

[PEPS(PE)-23008] Machine Learning

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

Examination Scheme:
MSE: 30 Marks
ISE: 20 Marks

End-Sem Exam: 50 Marks

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. Pearson Education
2.
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/

[PEPS(PE)-23009] Electrical Power Distribution Systems

Teaching Scheme **Examination Scheme:**

Lectures: 3 Hrs/week
Self Study: 1 Hr/week

MSE: 30 Marks
ISE: 20 Marks
End-Sem Exam: 50 Marks

Course Outcomes:

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

1. Calculate load necessary for planning of new distribution systems
2. Design primary and secondary distribution systems.
h. Analyze unbalanced distribution systems and explain impact of integration of DGs.
4. Address the protection and reliability issues in distribution systems.
5. Design active network management

Course Contents:

Overview of power distribution systems, objectives and goals, physical layout, standards and requirements, Distribution network planning, distribution transformers, grounding and protection, Medium and long term load forecasting, three phase network modelling, analysis of unbalance networks, Distribution load flow, Distribution state estimation, Distribution losses, Reliability considerations and bench marking, Distributed generation (DG), distribution planning in presence of DGs, grid integration of DG, protection

issues with DG, Electric vehicles, impact on forecasts, planning for charging networks, Battery storage systems sizing and location, Design of active networks, economic considerations of power distribution, microgrid and hybrid systems

References:

4. W. h h
Edition, 2017
3

[PEPS(PE)-23010] Restructured Power Systems

Teaching Scheme

Examination Scheme:

Lectures: 3 Hrs/week
Self Study: 1 Hr/week

MSE: 30 Marks
ISE: 20 Marks
End-Sem Exam: 50 Marks

Course Outcomes:

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

1. Understand the need for restructuring of power system and identify various market models
2. Study various ancillary services and management
3. Analyze transmission open access pricing issues and congestion management
4. Investigate effects of FACTS devices and distributed generation on restructured power systems

Course Contents:

Overview of Indian Power System: past and present status, Centralized and De-centralized dispatch philosophies, Introduction to Ancillary Services: Types and Classification, Ancillary Service Management, Transmission Congestion Management, Transmission Pricing Methods, Loss Allocation Algorithms, Locational Marginal Price (LMP) calculation and properties, Financial Transmission Rights (FTR), Transmission Expansion Planning, Role of FACTS devices in competitive power market, Distributed Generation in Restructured market, Working of International Power Markets, Restructured issues in Indian Power Sector.

References:

1. Lorrin Philipson, h - esigning markets for hn Wiley and Sons, 2002.
2. Kankar Bhattacharya, Jaap E. Daadler, Math H
3. Mohammad Shahidehpour, Muwaffaq Alomoush,

[PEPS(PE)-25002] Automotive Embedded Hardware Development

(Course contents will be provided by the concerned industry)

[PEPS(PE)-23004] Energy Storage Systems

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

Examination Scheme:
MSE: 30 Marks
ISE: 20 Marks
End-Sem Exam: 50 Marks

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.

[PEPS(PE)-23005] Power Quality Issues and Mitigation

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

Examination Scheme:
MSE: 30 Marks
ISE: 20 Marks
End-Sem Exam: 50 Marks

Course Outcomes:

After 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. Identify different power quality improvement techniques.
4. Select and use power quality monitoring meters
5. Design harmonic filter

Course 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 hill, 2002
2. Alexander Kusko and Marc T. Th
3. Arindam Ghosh, Gerard Ledwich hancement using Custom Power
4. Math h ries on Power Engineering.
5. Wakileh harmonics, Fundamentals, Analysis and Filter

[PEPS(PE)-23006] Smart Grid Technologies

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

Examination Scheme:
MSE: 30 Marks
ISE: 20 Marks
End-Sem Exam: 50 Marks

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.
energy in electric power systems, John Weily.
2.
Press.
3. -
Taylor and Francis group.
4. -
Technology and Applications, John Wily.

[PEPS(PE)-25003] Automotive Embedded Software Development

(Course contents will provided by the concerned industry)

[PEPS-23012] HIL Lab

Teaching Scheme:
Practicals:4 hrs/week

Examination Scheme:
Lab ISE: 50 Marks
Lab ESE 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. The students will 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.
5. Independently setup HIL experiments using SIMULINK and dSpace virtual HIL software packages.
6. 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. Develop the model and controller, and validate and verify their SIMULINK files according to the predefined requirements.
The learning objectives of the first two lab sessions were 1) Develop and debug the model/controller in MATLAB/SIMULINK, 2) Design MIL tests in order verify and validate the model/controller according to predefined requirements, 3) Generate and debug production code, and performing SIL tests, 4) get hands on experience of V&V tools in MATLAB/SIMULINK

Three labs on dSPACE software package and verifying/validating their developed code with VHIL. The learning objectives of these three lab sessions were 1) Independently setting up VHIL, and recording data using data acquisition tools in dSPACE, 2) Learning to work with dSPACE software packages, 3) Designing and implementing 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.
2. International
3. Manuals of respective devices and software.

[SET-25002] Technical Communication Skills

Teaching Scheme:
Self-study: 1hr / week

Examination Scheme:
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.
2.
Cambridge University Press.
3. Mark Hancock
4.
(seventh edition), Prentise Hall
5.

[CCA] Liberal Learning Course

Teaching Scheme
Practicals: 2 Hrs/week
Self Study: 2 Hr/week

Examination Scheme:
Lab ISE: 100 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.

SEMESTER – III

[SLC-] Massive Open Online Course-I

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

Examination Scheme:
End-Sem Exam: 100 Marks

Approved MOOC course of 12 weeks available on NPTEL/Swayam Portal to be completed

[SLC-] Massive Open Online Course-II

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

Examination Scheme:
End-Sem Exam: 100 Marks

Approved MOOC course of 12 weeks available on NPTEL/Swayam Portal to be completed

[P E P S - 2 5 0 0 1 1] Internship

Teaching Scheme:
Credits: 3

Examination Scheme:
End-Sem Exam: 100 Marks

Course Outcomes:

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

1. apply classroom concepts, theories, and methodologies to real-world industrial or organizational environments.
2. develop hands-on skills related to tools, technologies, or processes used in the specific field
3. enhance the ability to identify, analyze, and solve practical problems using innovative and logical approaches.
4. familiarize with workplace norms, standard operating procedures (SOPs), organizational structure, and professional ethics.
5. improve written, verbal, and interpersonal communication skills through interactions with mentors, team members, and clients.
6. develop skills in planning, organizing, and completing assigned tasks within deadlines.
7. build a sense of responsibility, accountability, and adherence to professional and ethical standards.
8. enable students to document work, prepare internship reports, and present outcomes effectively.
9. work effectively in teams, contribute to group tasks, and coordinate in a multicultural or multidisciplinary environment.
10. get insights into potential career paths, job roles, and industry expectations for better future planning.

[PEPS-24001] Dissertation Phase-I

Teaching Scheme:
Practical:22 hrs/week
Self study: 12 hrs/week

Examination Scheme:
Lab ISE – 70%
Lab ESE– 30%

Course Outcomes:

After 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 Systems, Power electronics, Electrical machines, 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. Use and develop written and oral presentation skills.

Course 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 by the departmental evaluation committee

SEMESTER - IV

[PEPS-24003] Dissertation Phase-II

Teaching Scheme:
Practical:22 hrs/week
Self study: 12 hrs/week

Examination Scheme:
ISE – 70%
ESE– 30%

Course Outcomes:

After 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, analyse and interpret suitable data to enable the research question to be answered.
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.

Course 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 by the departmental evaluation committee and final viva voce will be conducted by the external examiner.