IPS Academy, Institute of Engineering & Science
(A UGC Autonomous Institute, Affiliated to RGPV, Bhopal)
Scheme Based on AICTE Flexible Curricula **(B. Tech)**
Electrical and Electronics Engineering Department

VII Semester

w.e.f. July 2022

S. No.	Subject Code	Category	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours/ Week			Total Credits
				Theory			Practical						
				End Sem	Mid Sem Exam	Quiz/ Assignment	End Sem	Term Work Lab Work & Sessional		L	T	P	
1	**PCC - EEE701**	**PCC**	Power System Protection	70	20	10	60	40	200	**3**	**0**	**2**	**4**
2	**PCC - EEE702**	**PCC**	Hybrid & Electrical Vehicles	70	20	10	-	-	100	**3**	**0**	**0**	**3**
3	**PEC - EEE701**	**PEC**	Professional Elective-III	70	20	10	-	-	100	**3**	**0**	**0**	**3**
4	**OEC - EEE701**	**OEC**	Open Elective-III	70	20	10	-	-	100	**3**	**0**	**0**	**3**
5	**PROJ - EEE701**	**PROJ**	Evaluation of Internship				-	100	100	**0**	**0**	**4**	**2**
6	**PROJ - EEE702**	**PROJ**	Project Phase-I				60	40	100	**0**	**0**	**12**	**6**
			Total	**280**	**80**	**40**	**120**	**180**	**700**	**12**	**0**	**18**	**21**

Professional Elective-III (PEC-EEE701)	**Open Elective-III (OEC-EEE701)**
(A) HVDC & FACTS	(A) Intellectual Property Right
(B) Power Electronics Converters for Renewable Energy	(B) Data Structure
(C) Smart Grid Technology	(C) Operation Research
(D) Advance Control System	

1 Hr. Lecture	1 Hr. Tutorial	2 Hr. Practical
1 Credit	1 Credit	1 Credit

IPS Academy

INSTITUTE OF ENGINEERING & SCIENCE

(A UGC Autonomous Institute affiliated to RGPV)

Electrical and Electronics Engineering Department

PCC-EEE701	**Power System Protection**	**4L:2H:2P**	**4Credits**

Course Objective: To understand the need of protection of electric equipment and their protection schemes.

Module -1: (10 Hours)
Fault Analysis Faults in power systems, single line diagram, equivalent impedance diagram, per unit reactance. Analysis (using matrices) of power systems by symmetrical components under: (a) Three phase short circuit. (b) Line to line fault. (c) Line to ground fault. (d) Double line to ground fault. Sequence networks and their inter connections for different types of faults, effects of fault impedance. Current Limiting Reactors: Applications, types, construction and location of current limiting reactors, short circuit calculation using reactors.

Module -2: (10 Hours)
Relays: General considerations, sensing of faults, construction of electro-magnetic attraction and induction types relays, Buchholz and negative sequence relay, concept of reset, pick up, inverse time and definite time characteristics, over current , over voltage, directional, differential and distance relays on R-X diagram. Static Relays: Introduction, advantage and limitation of static relays, static over current, directional, distance and differential relays.

Module -3: (10 Hours)
Protection Types & detection of faults and their effects, alternator protection scheme (stator, rotor, reverse power protection etc.). Power transformer protection (external and internal faults protection), generator-transformer unit protection scheme, bus bar protection. Transmission line protection (current/time grading, distance), Pilot relaying schemes, power line carrier protection.

Module -4: (8 Hours)
Switchgear Theory of current interruption- energy balance and recovery rate theory, arc quenching, recovery and restriking voltages. Types of circuit breakers, bulk oil and minimum oil, air break and air blast, sulphurh exafluride (SF6) and vacuum circuit breakers. Rating selection and testing of circuit breakers/operating mechanisms. LT switchgear, HRC fuses, types construction and applications..

Module -5: (7 Hours)
Modern Trends In Protection Electronic relays, static relays functional circuits: comparators, level detectors, logic and training circuits, microprocessor and computer based protection schemes, software development for protection, security &reliability**,** High voltage testing:

Testing of insulators and bushings, testing of isolators and circuit breakers Testing of cables, testing of transformers - testing of surge diverters - radio interference measurements - design, planning and layout of high voltage laboratory.

List of Experiments (Expandable):

1. Determination of drop out factor of an instantaneous over current relay.
2. Determination of operating characteristic of IDMT relay.
3. Study of operating characteristic of differential relay.
4. Study of gas actuated protective relay (Buchholz Relay).
5. Study and operation of static over current relay.
6. Determination of transmission line parameters using MATLAB.
7. Analysis of power system faults (Symmetrical & Asymmetrical) using MATLAB.
8. Study of SF6 circuit breaker.
9. Protectional simulation study of Generator, Transformer protection.
10. Comparative study of different generation of relays

Course Outcomes: After successful completion of course students will be able to

CO1: Ability to find sequence network and their interconnection for different types of fault.
CO2: To find desirable qualities and requirement of protective relays.
CO3: Student will understand working and types of circuit breaker.
CO4: Student will understand the system protection and protection of transformer.
CO5: Student will understand the surge protection & insulation co-ordination.

Textbooks/References:

1. Van A. R & Warrington C., "Protective Relays: Their Theory and Practice", Vol 1 &2, Chapman and Hall.
2. Badriram, B.H. Vishwakarma, "Power System Protection and Switchgear" New Age International Pvt. Ltd. Publishers, Second Edition 2011.
3. Masson R.J., Art & Science of Protective Relaying.
4. J & P Switchgear handbook Ravindra Nath B., and Chandar M., Power systems protection and switchgear
5. Rao Sunil S, Switchgear and protection.
6. C.L Wadhwa, "Electrical Power System", 6th Edition New Age International Pvt Ltd Publishers, Second Edition 2010.

PCC – EEE702	**Hybrid & Electrical Vehicles**	**3L : 0T : 0P (3 hrs.)**	**3 credits**

Course Objective: The objective of this course is to provide fundamental knowledge in dynamics and control of Electric vehicles. The course justify the selection of Drives for various applications of Electric vehicles and familiarize the various energy storage and Energy Management Strategies.

Pre Requisite: should have the knowledge of Electrical Machines and Power Electronics and IC engines .

Module 1 (5 hrs.)
Introduction Conventional Vehicles: -History, Components of Electric Vehicle (EV), Comparison with Internal combustion Engine Technology, Benefits and Challenges, EV classification and their electrification Levels. EV Terminology Introduction and History of hybrid and Electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive trains on energy supplies.

Module 2 (8 hrs.)
Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis. Electric Trains Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis.

Module 3 (7 hrs.)
Electric Propulsion: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control Of Switch Reluctance Motor drives, drive system efficiency.

Module 4 (10 hrs.)
Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Module 5 (8 hrs.)

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies.

Course Outcomes: After successful completion of course students will be able to

CO1: Describe about working principle and importance of hybrid and electric vehicles.

CO2: Explain the construction and working principle of various electric drive trains used in electric vehicles.

CO3: Describe the different types and working principle of hybrid vehicles.

CO4: Describe the different types of Energy Storage Requirements in Hybrid and Electric Vehicles

CO5: Illustrate the Management various types Energy Strategies in Hybrid and Electric Vehicles.

Text/ Reference books

1. C. Mi, M. A. Masrur and D. W. Gao, "Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives", John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2015.
3. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
4. T. Denton, "Electric and Hybrid Vehicles", Routledge, 2016.

PEC-EEE701(A)	**Program Elective Course III (HVDC& FACTS)**	**3L: 0T : 0P(5 hrs.)**	**3 Credits**

Course Objective: HVDC and FACTS course is give unified treatment of protection and System Control in HVDC, FACTS Concept & Unified Power Flow Controller.

Module 1(10hrs.)
Introduction to HVDC Transmission: Comparison with EHV AC power transmission, HVDC system configuration and classification HVDC systems elements: Converter transformers, D.C. smoothing reactors, Thyristor valves, Earth electrodes & Earth return, etc. HVDC-AC interactions: SCR, Problems with low ESCR system, Solutions to problems associated with weak system.

Module 2(10hrs.)
Protection and System Control in HVDC: Response to D.C. and A.C. system faults, D.C. line fault, A.C. system fault, Converter fault, Protection issues in HVDC, D.C. Circuit Breakers, Basic mechanism of HVDC system control, Power reversal, Power control, Constant ignition angle, constant current, constant extinction angle control, High level controllers. Converter mal-operations - misfire, arc through, commutation failure, Frequency Control of A.C. system, Stabilization & damping of A.C. networks.

Module 3 (10hrs.)
FACTS Concept: Fundamentals of A.C. power transmission and reactive power control, Principal of reactive power compensation. Flow of power in AC parallel and meshed system Introduction to FACTS: Need for FACTS in emerging power systems, Types of FACTS, Co-ordination of FACTS with HVDC.

Module 4 (8hrs.)
Static Shunt and Series Compensation – Principles of shunt compensation : Variable Impedance type & switching converter type , methods of controllable VAR Static VAr Compensator (SVC) Static synchronous compensator (STATCOM) configuration, Characteristics, Principles of static series compensation, TCSC, TSSC, Static Synchronous Series Compensator (SSSC), GCSC.

Module 5 (8hrs.)
Unified Power Flow Controller (UPFC) – Principle of operation - modes of operation – applications of UPFC for power flow studies. Interline power flow controller (IPFC), FACTs Controller interactions – SVC–SVC interaction - co-ordination of multiple controllers using linear control techniques – Quantitative treatment of control coordination.

Course Outcomes: After successful completion of course students will be able to

CO1: To understand the significance of HVDC systems over EHVAC systems.
CO2: To explain different converters for AC to DC & DC to AC conversion.
CO3: To analyze the performance of power flow in A.C. transmission system and reactive power control.
CO4: To understand the principle of compensation, and importance of controllable parameters.
CO5: To acquire the knowledge of FACTS controllers interaction and their co-ordination.

Text/ Reference books

1. Padiyar, K.R., 'HVDC transmission systems', Wiley Eastern Ltd., 2010.
2. Kimbark, E.W., 'Direct Current Transmission-vol.1', Wiley Inter science, New York, 1971.
3. Padiyar K.R., 'FACTS controllers for Transmission and Distribution systems' New Age International Publishers, 1st Edition, 2007.
4. Mohan Mathur, R., Rajiv. K. Varma, "Thyristor – Based Facts Controllers for Electrical Transmission Systems", IEEE press and John Wiley & Sons, Inc.
5. Hingorani,L.Gyugyi, 'Concepts and Technology of Flexible AC Transmission System', IEEE Press New York, 2000 ISBN –078033 4588.
6. 1 Song, Y.H. and Allan T. Johns, 'Flexible AC Transmission Systems (FACTS)', Institution of Electrical Engineers Press, London, 1999.
7. Arrilaga, J., 'High Voltage Direct Current Transmission', 2nd Edition, Institution of Engineering and Technology, London, 1998.
8. Enrique Acha, Claudio R.Fuerte-Esqivel, Hugo Ambriz-Perez, Cesar AngelesCamacho 'FACTS –Modeling and simulation in Power Networks' John Wiley & Sons, 2002.
9. Kamakshaiah, S and Kamaraju, V, 'HVDC Transmission', 1st Edition, Tata McGraw Hill Education (India), Newdelhi 2011.

PEC - EEE701(B)	**Program Elective Course III (Power Electronics Converters for Renewable Energy)**	**3L: 0T: 0P (3 hrs.)**	**3 Credits**

Course objective: To familiarize the students with the

Prerequisite: Power System, Electrical machines, Instrumentation

Module 1(8 hrs.)
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, shading; Modules, connections, ratings; Power extraction (MPP), tracking and MPPT schemes; standalone systems, grid interface, storage, AC-DC loads.

Module 2(10 hrs.)
Power converters for solar: Micro converter, DC-DC buck/boost/buck-boost /flyback/forward/cuk, bidirectional converters; Inverters: 1ph, 3ph inverters Multilevel Neutral pointclamp, Modular multilevel, CSI; Control schemes: unipolar, bipolar

Module 3(10 hrs.)
Single phase and three-phase back Controllers. Triggering techniques for power factor and harmonic controls. Design and analysis of phase control circuits. Solid state transfer switches. Concept of three-phase to single phase and single phase to three-phase cyclo-converter. Effect of source inductance. Concept of PWM techniques single and multiple pulse form. Working of STATCON, SVC, UPS, SMPS

Module 4(8 hrs.)
Intro to wind energy: P-V, I-V characteristic, wind power system: turbine-generator-inverter, mechanical control, ratings; Power extraction (MPP) and MPPT schemes. PLL and synchronization, power balancing / bypass, Parallel power processing; Grid connection issues: leakage current, Islanding mode, harmonics, Mitigation of harmonics, filters, passive filters, Active filters, active/reactive power feeding, unbalance

Module 5(8 hrs.)
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; Doublyfed

induction generator with rotor side converter topologies; permanent magnet based generators. Battery: Types, charging discharging.

Course Outcomes: After successful completion of course students will be able to:

CO1. Understanding renewable energy sources and optimization of Solar Energy tapping in PV systems
CO2. Understanding of different power converter for Solar (PV Systems)
CO3. Application of single phase and three phase controller with different controlling techniques.
CO4. Understanding of wind energy generators and their synchronization with grid network.
CO5. Understanding of different topology of wind generators.

References:

1. Sudipta Chakraborty, Marcelo G. Sim303265es, and William E. Kramer. Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Chetan Singh Solanki, Solar Photovoltaics: fundamentals, Technologies and Applications, Prentice Hall of India, 2011.
2. N. Mohan, T.M. Undeland& W.P. Robbins, Power Electronics: Converter, Applications & Design, John Wiley & Sons, 1989
3. Muhammad H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education India, 2004.
4. Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley and Sons, Ltd., 2011

PEC - EEE701(C)	**Program Elective Course III (Smart Grid Technology)**	**3L: 0T: 0P (3 hrs.)**	**3 Credits**

Course objective: To equip the students with the fundamental knowledge on the smart grid

Prerequisite: Power System, Electrical machines, Instrumentation

Module 1(8 hrs.)

Introduction to Smart Grid: Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and Benefits .Difference between conventional & Smart Grid, Concept of Resilient & Self-Healing Grid, Present development & International policies in Smart Grid, Diverse perspectives from experts and global Smart Grid initiatives.

Module 2(10 hrs.)
Smart Grid Technologies: Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation , Transmission systems: EMS, FACTS and HVDC, Wide area monitoring.

Module 3 (10 hrs.)
Protection and Control, Distribution Systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV).

Module 4(8 hrs.)
Smart Meters and Advanced Metering Infrastructure: Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement, Unit (PMU), Intelligent Electronic Devices (IED) & their application for monitoring & protection

Module 5 (8 hrs.)
Power Quality Management in Smart Grid: Power Quality & EMC in Smart Grid, Power Quality issues of Grid connected Renewable Energy Sources, Power Quality Conditioners for Smart Grid, Web based Power Quality monitoring, Power Quality Audit.

Course Outcomes: After successful completion of course students will be able to

CO1 Students can understand Present development & International policies in Smart Grid
CO2 Students may familiar with Smart Grid Technologies and its protection
CO3 Students may familiar with Smart Grid protection and control
CO4 Understand about the Advanced Metering system.
CO5 Students can understand the importance of power quality management.

Reference Books/Text Books

1. Stuart Borlase: Smart Grid-Infrastructure, Technology and Solutions, CRC Press
2. D. P. Kothari and I. J. Nagrath, "Modern Power System Analysis", Tata McGraw Hill 2011.
3. A. J. Wood and B. F. Wollenberg, "Power generation, operation and control", second edition John Wiley and Sons 1996.
4. N. G. Hingorani and L. Gyugyi, "Understanding facts: Concepts and Technology of flexible AC transmission systems", Wiley Press 2000.

Reference

1. Vehbi C. Güngör, Dilan Sahin, Taskin Kocak, Salih Ergüt, Concettina Buccella, Carlo Cecati, and Gerhard P. Hancke: Smart Grid Technologies- Communication Technologies and Standards IEEE Transactions on Industrial Informatics, Vol. 7, No.4, November 2011.
2. Xi Fang, Satyajayant Misra, Guoliang Xue, and Dejun Yang: Smart Grid – The New and Improved Power Grid- A Survey, IEEE Transaction on Smart Grids,2011

PEC-EEE701(D)	Program Elective Course III (Advanced Control Systems)	3L :0T : 0P (3 hrs.)	3 Credits

Course Objective:-

This subject deals with state space, describing function, phase plane and stability analysis including controllability and observability. It also deals with modern control and optimal control systems, Nonlinear control, Variable Structure Control

Pre Requisite: - Should have knowledge of mathematics, differential equations and difference equation, Laplace transform, matrices and vectors

Module 1 (11 hrs.)
STATE SPACE ANALYSIS: Review of Linear Control System, introduction to modern control system , State space method of description, State Space Representation using Phase Variable and Canonical Variables, , Solution of State Equation, State Transition Matrix and its Properties, Eigen Values, Eigen Vectors, Canonical Forms –Controllable Canonical Form, Observable Canonical Form, Jordan Canonical Form., Diagonalization, Concepts of Controllability Observability & Stability, Discretization of continuous-time State space model

Module 2 (08 hrs.)
Pole Placement Design and State Observers: Introduction, Stability Improvements by State Feedback, Necessary and Sufficient Conditions for Arbitrary Pole Placement,. State Regulator Problem and State Regulator Design, Evaluation of State Feedback Gain Matrix K, Selection of Location of Desired Closed Loop Poles, State Observer Design, Full Order/Reduced Order Observer Design, Observer Based State Feedback Control,

Module 3 (07 hrs)
Non-linear systems Analysis: Introduction, Common Nonlinear System Behaviors, Common Nonlinearities in Control Systems, Fundamentals, Describing Functions of Common Nonlinearities, Stability Analysis by Describing Function Method, Concept of Phase Plane Analysis, , Singular points, Stability of Nonlinear System, Construction of Phase Trajectories, Lyapunov Stability Definitions, Lyapunov Stability Theorems, Lyapunov Functions for Nonlinear Systems.

Module 4 (07 hrs.)

Optimal Control: Introduction to Optimal Control, Parameter Optimization Calculus of variation, Euler-Lagrange equations, Boundary conditions, Transversality condition, Bolza problem, Pontryagin's maximum principle.

Module 5 (07 hrs.).

Variable Structure Control: Variable Structure Control and its applications. Examples on variable structure control

Course Outcomes: After successful completion of course students will be able to

CO1 Analyze control system by classical control method and advanced control method.

CO2 Analyze Pole placement problem.

CO3 Analyze non-linear control systems by different methods

CO4 Analyze optimum control by different methods in terms of performance indices.

CO5 Analyze to Variable Structure Control

Text/ Reference books:

1. B. C. Kuo, "Automatic Control Systems", eight editions, Wiley India 2009.
2. K. Ogata, "Modern Control Engineering", fifth edition, Prentice-Hall 2010.
3. B. C. Kuo, "Digital Control Systems", Oxford University Press 1992.
4. K. Ogata, "Discrete-Time Control Systems", second edition, Pearson Education 2005.
5. Andrew P. Sage, "Optimum System Control", Pearson Education Canada, 1977.
6. M. Gopal Modern Control System Theory New Age International, 1993.

OEC-EEE701 (A)	Intellectual Property Rights	3L: 0T: 0P (3Hrs)	03 Credits

Pre requisite(s): Nil

Course Objective:
1. To be familiar with the concept of intellectual property.
2. To be familiar with Purpose and function of trademarks.
3. To be familiar with Fundamental of copy right law.
4. To clear idea of the trade Secrete.
5. To be familiar with latest development in the field of intellectual property.

Module 1 (08 Hrs)
Introduction to Intellectual Property: Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

Module 2 (08 Hrs)
Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

Module 3 (10 Hrs)
Law Of Copyrights: Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer.

Module 4 (08 Hrs)
Trade-Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation. Unfair competition: Misappropriation right of publicity, false advertising.

Module 5 (08 Hrs)
New Development In Intellectual Property: new developments in trade mark law; copy right law, patent law, intellectual property audits. International overview on intellectual property,

international – trade mark law, copy right law, international patent law, and international development in trade secrets law.

Course Outcomes: After successful completion of course students will be able to

CO 1. Understand the concept of intellectual property.
CO 2. Understand what is trademark and its importance.
CO 3. Understand the law of copyright.
CO 4. Understand how trade secrete help in competitive market
CO 5. Understand the latest trends in intellectual property.

Text Books & References:

1. Intellectual property right, Deborah. E. Bouchoux, Cengage learning.
2. Intellectual property right – Unleashing the knowledge economy, prabuddha ganguli, Tata McGraw Hill Publishing company ltd.,