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Bachelor of Technology (B.Tech.) VII Semester (Electrical Engineering)

w.e.f. July 2023

S.No.	Subject Code	Category Code	Subject Name	Maximum Marks Allotted					Total Marks	Contact Hours Per Week			Total Credits
				Theory			Practical			L	T	P	
				End. Sem.	Mid Sem. Exam.	Quiz/ Assignment	End Sem.	Lab Work					
1	EE71	PEC	Professional Elective Course-III	70	20	10	-	-	100	3	1	-	4
2	EE72	OEC	Open Elective Course-II	70	20	10	-	-	100	3	1	-	4
3	EE73	PCC	High Voltage Engineering	70	20	10	30	20	150	3	-	2	4
4	EE74	PCC	Electrical Drives	70	20	10	30	20	150	3	-	2	4
5	EE75	PCC	Switchgear & Protection	70	20	10	30	20	150	3	-	2	4
6	EE76	MC	Industrial Training Evaluation	-	-	-	60	40	100	-	-	4	2
			Total	**350**	**100**	**50**	**150**	**100**	**750**	**15**	2	**10**	**22**
7	EE77	DLC	Self-Learning Presentation (SWAYAM/NPTEL/MOOC)	-	-	-	-	-	-	-	-	-	8
8	EE78	MC	NSS/NCC/Swatchhata Abhiyan/Rural Outreach	Qualifier									
Additional Course for Honours or Minor Specialization				Permitted to opt for maximum 8 credits against additional MOOC courses in subject code EE77 for the award of Honours (Minor Specialization).									

Note: 01. Departmental BOS will decide list of three/four elective subjects for each PEC and OEC.
02. MOOC/NPTEL subjects shall be taken with permission of HOD/Coordinator
03. Industrial training presentation & viva shall take place in VII Sem. which students have already done in VI Sem.

Professional Elective Course-III

S.No.	Subject Code	Subject Name
1	EE71A	Power Quality
2	✱ EE71B	Digital Image Processing
3	EE71C	Elements of Smart Grid

Open Elective Course-II

S.No.	Subject Code	Subject Name
1	✱ EE72A	Electrical and Hybrid Vehicles
2	EE72B	AI & Machine Learning
3	✱ EE72C	Computer Networks

1 hour lecture (L) = 1 credit | 1 hour Tutorial (T) = 1 credit | 2 hour Practical (P) = 1 credit

PEC: Professional Elective Course, OEC: Open Elective Course, PCC: Professional Core Course, DLC: Distance Learning Course, MC: Mandatory Course

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		Theory			Practical		Total Marks	L	T	P	
		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE71A	Power Quality	70	20	10	-	-	100	3	1	-	4

POWER QUALITY

Module-I:
Introduction power quality: voltage quality, power quality evaluation Procedure, term anddefinition, general classes of power quality problem, causes & effect of power quality disturbance.

Module-II:
Voltage sags and interruption: sources of sags and interruption, estimating voltage sag performance, fundamental principles of protection monitoring sags.

Module-III:
Transients over voltages: sources of transients over voltages, principles of over voltage protection, utility capacitor switching transients, fundamentals of harmonicsand harmonics distortion, harmonic sources from commercial load and from industrial loads.

Module-IV:
Applied harmonics: harmonics distortion evaluations, principles for controlling harmonics,studies devices for controlling harmonic distortion, filters, and passive input filter standards of harmonics

Module-V:
Electromagnetic compatibility, constant frequency control, constant tolerance band control,variable tolerance band control, discontinuous current control

Text Books:
1. Roger C. Duggan, Mark F. McGranaghan, Surya Santoso, "Electrical Power System Quality", Third edition.
2. Jos Arrillaga, "Power System Harmonics",Wiley, Second Edition.

Reference Books:
1. Derek A. Paice, "Power Electronics Converter Harmonics", First Edition.
2. Angelo Baggini, "Handbook of Power Quality", Wiley, Third Edition.

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Course Code : EE71A
Course Category: PEC
Course Name : Power Quality

At the end of this course students will be able to:

CO-1: Understand the major power quality problems.

CO-2: Understand and analyze harmonics in power systems.

CO-3: Use equipment that is required to measure the quality of power.

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		Theory			Practical		Total Marks	L	T	P	
		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE71B	Digital Image Processing	70	20	10	-	-	100	3	1	-	4

DIGITAL IMAGE PROCESSING

Module -I:
Digital Image Fundamentals: Steps in Digital Image Processing – Components – Elements of Visual Perception–Image Sensing and Acquisition–Image Sampling and Quantization – Relationships between pixels – Color image fundamentals – RGB, HSI models, Two-dimensional mathematical preliminaries, 2D transforms – DFT, DCT.

Module-II:
Image Enhancement: Spatial Domain: Gray level transformations – Histogram processing , Basics of Spatial Filtering, Smoothing and Sharpening Spatial Filtering, Frequency Domain: Introduction to Fourier Transform– Smoothing and Sharpening frequency domain filters , Ideal, Butterworth and Gaussian filters, Homomorphic filtering, Color image enhancement.

Module-III:
Image Restoration: Image Restoration ,degradation model, Properties, Noise models , Mean Filters, Order Statistics , Adaptive filters , Band reject Filters, Band pass Filters , Notch Filters , Optimum Notch Filtering , Inverse Filtering , Wiener filtering.

Module-IV:
Image Segmentation: Edge detection, Edge linking via Hough transform , Thresholding , Region based segmentation , Region growing , Region splitting and merging , Morphological processing, erosion and dilation, Segmentation by morphological watersheds , basic concepts,Dam construction, Watershed segmentation algorithm.

Module-V:
Image Compression and Recognition: Need for data compression, Huffman, Run Length Encoding, Shift codes, Arithmetic coding, JPEG standard, MPEG. Boundary representation, Boundary description, Fourier Descriptor, Regional Descriptors, Topological feature, Texture, Patterns and Pattern classes, Recognition based on matching.

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Text books:

1. R.C.Gonzalez and Richard E Woods, "Digital Image Processing", Pearson Education, Fourth edition.
2. Anil.K.Jain, "Fundamentals of Digital Image Processing" Pearson Education,First Edition.

Reference Book:

1. B.Chanda and D. Dutta Majumdar, "Digital Image Processing and Analysis",PHI India, Second Edition.

Course Code : EE71B
Course Category : PEC
Course Name : Digital Image Processing

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

CO-1: Understand the basics of digital image processing. (Blooms cognitive level 1, 2)

CO-2: Operate on images using the techniques of smoothing, sharpening and enhancement. (Blooms cognitive level 3)

CO-3: Implement and Analyze the Images using various algorithms. (Blooms Cognitive level 3,4)

CO-4: Design adaptive algorithm suitable for image restoration, segmentation, compression, recognition etc. (Blooms cognitive level 6)

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Subject Code	Subject Name	Maximum Marks Allotted						Hours/ Week			Total Credits
		Theory			Practical		Total Marks	L	T	P	
		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE71C	Elements of Smart Grid	70	20	10	-	-	100	3	1	-	4

ELEMENTS OF SMART GRID SYSTEM

Module-I:
Introduction to Smart Grid
Basics of power systems, definition of smart grid, need for smart grid, smart grid domain, enablers of smart grid, smart grid priority areas, regulatory challenges, Smart grid activities in India.

Module-II:
Smart Grid Architecture
Smart grid architecture, standards-policies, smart-grid control layer and elements, network architectures, IP-based systems, power line communications, supervisory control and data acquisition system, advanced metering infrastructure. The fundamental components of Smart Grid designs, Transmission Automation, Distribution Automation,Renewable Integration

Module-III:
Tools and Techniques for Smart Grid
Computational Techniques- Static and Dynamic Optimization Techniques for power applications such as Economic load dispatch-Computational Intelligence Techniques-Evolutionary Algorithms in power system - Artificial Intelligence techniques and applications in power system.

Module-IV:
Distribution Generation Technologies
Introduction to Distribution Energy Sources, Renewable Energy Technologies-Micro grids-Storage Technologies- Electric Vehicles and plug- in hybrids- Environmental impact and Climate Change- Economic Issues.

Module-V:
Communication Technologies in Smart Grid
Introduction to Communication Technology, Two Way Digital Communications Paradigm, Synchro-Phasor Measurement Units (PMUs) — Wide Area Measurement Systems (WAMS)- Introduction to Internet of things (IoT)- Applications of IoT in Smart Grid

Text Book:

1. S. Borlase, "Smart Grids, Infrastructure, Technology and Solutions", CRC Press, First Edition.

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Reference Books:

1. G. Masters, "Renewable and Efficient Electric Power System", Wiley—IEEE Press, Second Edition.
2. A.G. Phadke and J.S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer, Second Edition.
3. T. Ackermann, "Wind Power in Power Systems", Hoboken, N J, USA, John Wiley, Second Edition.

Course Code : EE71C
Course Category: PEC
Course Name : Elements of Smart Grid

After successful completion of the course, student will be able to-

CO-1: Understand the features of Smart Grid.

CO-2: Assess the role of automation and digitization in the Transmission and Distribution

CO-3: Analyze Smart grids and Distributed energy resources (DER) with evolutionary algorithms.

CO-4: Understand the operation and importance of data acquisition devices and their location in Voltage and Frequency control

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Subject Code	Subject Name	Maximum Marks Allotted						Hours/ Week			Total Credits
		Theory			Practical		Total Marks	L	T	P	
		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE72A	Electrical and Hybrid Vehicles	70	20	10	-	-	100	3	1	-	4

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ELECTRICAL AND HYBRID VEHICLES

Module-I:
Introduction to electric cars: Comparison different drive-trains: (Internal combustion engine vehicles, Hybrid electric vehicles, Plug in hybrid electric vehicles, Full Electric vehicles, Hydrogen fuel cell vehicles), constructional features, working, motors (dc motor, BLDC, PMSM, Induction motor) and their effect on dynamics.

Module-II:
Electrical propulsion system: Various drives based system configurations, mathematical modelling and analysis of the driveline (Power train, chassis & wheels, engine, suspension system).

Module-III:
Energy storage (Li-ion): battery losses, battery packs and battery management systems, Charging requirements: DC-DC converters for battery charging, AC charging such as type 1,2,3 and DC charging and Chademo, Tesla and CCS.

Module-IV:
Automotive Communication protocols: ICT and communication protocols required to implement EV charging and smart charging, Concept of wireless and on-road charging of EVs, microgrids for EV charging, using renewable energy sources.

Module-V:
Control & Performance analysis of an electric vehicle: Control algorithms -classical and modern control methods, observer design, and electric vehicle control using DSP.

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Text Book:

1. Ali Emadi, "Handbook of Automotive power Electronics and Motor Drives", CRC Press.

Reference Books:

1. M. Wang, R. Zhang and X. Sheng, "Mobile Electric Vehicle, Online Charging & Discharging" Springer, 2015.
2. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel CellVehicles, Fundamentals, Theory, and Design," CRC Press, London.
3. N.Patel, A.K. Bhoi, S. Padmanaban, J.B. Holm-Nielsen, "Electric Vehicles, Modern Technologies and Trends," Springer, 2021.

Course Code : EE72A
Course Category : OEC
Course Name : Electrical and Hybrid Vehicles

After completion of this course students will be able to-

CO1: Differentiate the constructional features of electric vehicles and hybrid electric vehicles.

CO2: Describe their working & Select the different drive trains and motors based on the application.

CO3: Recognize the various charging schemes for EV's, & elucidate the need of battery management system in electric vehicles.

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Subject Code	Subject Name	Maximum Marks Allotted						Hours/ Week			Total Credits
		Theory			Practical		Total Marks	L	T	P	
		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE72B	Artificial Intelligence and Machine Learning	70	20	10	-	-	100	3	1	-	4

ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

Module-I:
Introduction to Pattern Recognition:
Problems, applications, design cycle, learning and adaptation, examples, Probability Distributions, Parametric Learning-Maximum likelihood and Bayesian Decision Theory-Bayes rule discriminantfunctions, loss functions and Bayesian error analysis.

Module-II:
Representation of Knowledge:
Knowledge Representation, Problems in representing knowledge, knowledge representation using propositional and predicate logic, comparison of propositional and predicate logic, Resolution, refutation, deduction, theorem proving, inferencing, monotonic and no monotonic reasoning.

Module-III:
Neural Network:
Perceptron, Multi-layer perceptron, back-propagation algorithm, error surfaces, practical techniques for improving back-propagation, additional networks and training methods, Adaboost, Deep Learning.

Module-IV:
Supervised Learning:
Classification, Linear Regression, Linear Regression of One Variable using Gradient Descent Algorithm, Linear Regressions of Multiple Variables using Gradient Descent Algorithm. Logistic Regression, Decision Trees, Ensemble Learning – Boosting – Bagging, Naive Bayes Classifier, k- Nearest Neighbors Classifier, Support Vector Machine

Module-V:
Unsupervised Learning:
Hierarchical Clustering, k-Means Clustering, Mixture Models, Density-Based Spatial Clustering of Applications with Noise (DBSCAN), Ordering Points to Identify the Clustering Structure (OPTICS)

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Introduction to Neural Network:

Perceptron, Basic Neural Network Structure, Forward Propagation, Cost Functions, Error Backpropagation Algorithm, Training by Gradient Descent.

Text Book:

1. C. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

Reference Books:

1. Richard O Duda, Peter E. Hart, David G. Stork, "Pattern Classification", JohnWiley and Sons, Second Edition.
2. Trevor Hastie, Robert Tibshirani, Jerome H. Friedman, "The Elements of Statistical ModelCurriculum of Engineering & Technology PG Courses [Volume 11] [332] Learning", Second Edition.

Course Code : EE72B
Course Category: OEC
Course Name : Artificial Intelligence and Machine Learning

After completion of this course students will be able to-

CO-1: Study the parametric and linear models for classification.

CO2-: Design neural network and SVM for classification.

CO3-: Develop machine independent and unsupervised learning techniques.

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		Theory			Practical		Total Marks	L	T	P	
		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE72C	Computer Networks	70	20	10	-	-	100	3	1	-	4

COMPUTER NETWORKS

Module-I

Introduction: Network applications, network hardware, network software, reference models: OSI, TCP/IP, Internet, Connection oriented network - X.25, frame relay. THE PHYSICAL LAYER: Theoretical basis for communication, guided transmission media, wireless transmission, the public switched telephone networks, mobile telephone system.

Module-II

The Data Link Layer: Design issues, error detection and correction, elementary data link protocols, sliding window protocols, example data link protocols - HDLC, the data link layer in the internet. **The Medium Access Sublayer**: Channel allocations problem, multiple access protocols, Ethernet, Data Link Layer switching, Wireless LAN, Broadband Wireless, Bluetooth

Module-III

The Network Layer: Network layer design issues, routing algorithms, Congestion control algorithms, Internet working, the network layer in the internet (IPv4 and IPv6), Quality of Service.

Module-IV

The Transport Layer: Transport service, elements of transport protocol, Simple Transport Protocol, Internet transport layer protocols: UDP and TCP.

Module-V

The Application Layer: Domain name system, electronic mail, World Wide Web: architectural overview, dynamic web document and http.

Application Layer Protocols: Simple Network Management Protocol, File Transfer Protocol, Simple Mail Transfer Protocol, Telnet.

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Text Book:

1. A.S. Tanenbaum, "Computer Networks", Pearson Education, Fourth Edition.

Reference Books:

1. Behrouz A. Forouzan, "Data communications and Networking, McGraw-Hill India, Fourth Edition,
2. James F. Kurose Keith W. Ross, "Computer Networking: A top down approach", Pearson Education, India, Sixth Edition.

Course Code : EE72C
Course Category: OEC
Course Name : Computer Networks

After completion of this course student will be able to-

CO-1: Identify different process dynamics in process industries and their control schemes.

CO-2: Analyze and Design different types of mechanical, optical sensor and actuators.

CO-3: Differentiate process controller's their stability and tuning.

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		Theory			Practical		Total Marks	L	T	P	
		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE73	High Voltage Engineering	70	20	10	30	20	150	3	-	2	4

HIGH VOLTAGE ENGINEERING

Module-I:
Breakdown mechanism in gases: ionization, ionization processes, Townsend's mechanism, time lag for breakdown, Streamer theory, Paschen's law, effect of temperature on B.D. Voltage, Desirable properties of a gaseous insulation, SF6 as an insulator, vacuum as a dielectric.

Module-II:
Breakdown of gases in uniform and non-uniform fields : factors affecting time lag for BD, BD in a uniform AC field, BD under impulse voltage, volt time characteristics, B.D. in non-uniform field, degree of non-uniformity, effect of polarity of electrodes on B.D. voltage, Corona, corona loss on conductor at DC voltage, corona loss on conductor at AC voltage.

Module-III:
Breakdown in liquid and solids: Break down in liquids, classification of liquids, B.D. in pure liquids, B.D. in commercial liquids, different theories of B.D. In liquids, different theories of B.D. in solids, intrinsic B.D. electromechanical B.D. thermal B.D. mechanism of B.D. occurring after prolonged operation, B.D. of composite dialectics, Application of Insulating Materials.

Module-IV:
Generation of High Voltage: Impulse voltage, impulse voltage generation, single stage IG circuits-their analysis, multistage IG, constructional details of IG. Power transformer impulse testing, measurement of impulse voltage by sphere gap

Module-V:
Generation of High AC voltage: Cascaded transformer, series resonant transformer, tesla coil, generation of high DC voltage- half and full wave rectifier, voltage doublex circuit, measurement of AC, DC high voltage, sphere gap, voltage dividers. Testing of Insulators, bushing, isolators and circuit breakers

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Text Books:

1. M.S. naidu and V.Kamaraju, "High Voltage Engineering", Tata Mc Graw Hill, Fifth Edition.
2. D.V. Razevig "High Voltage Engineering", translated by Dr. M.P. Chourasia Khanna Pub, Second Edition.

Refrence Books:

1. E. Kuffel & W.S. Zingal, "High Voltage Engineering", Newres publication, Second Edition.
2. Kuffel & Abdulah, "High Voltage Engineering", First Edition.
3. C.L. Wadhana, "High Voltage Engineering", new age International Publication, Third Edition.

List of Experiments:

1. To determine the breakdown characteristics of sphere- sphere gap
2. To determine the breakdown characteristics of Rod-Rod gap
3. To determine the breakdown characteristics of needle-needle gap
4. To determine the breakdown characteristics of needle plane gap
5. To determine the breakdown voltage of Transformer oil sample.
6. Study of 1.6 million volts Impulse voltage generation

Course Code : EE73
Course Category: PCC
Course Name : High voltage

After completion of this course student will be able to-

CO-1: Understanding of breakdown phenomenon in gaseous dielectric in different field.

CO-2: Understanding of breakdown in liquid and solid dielectrics.

CO-3: Understanding of generation and measurement of high voltages and testing of different equipment.

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		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE74	Electrical Drives	70	20	10	30	20	150	3	-	2	4

ELECTRICAL DRIVES

Module-I:
Basic Concepts of Electric Drives: Elements of drive systems, Requirement of electric drives, Rating & Selection ofdrives, groups and individual drives, Constant power and Constant torque drives.
Motor Mechanism dynamics: Review of Characteristics of AC & DC motors, load characteristic, load-drive speed torque characteristics, quadrant speed torque characteristics. Mechanical Systems Stability of Electric drives, referred moment of inertia and torque of motor load combination, load equalization.

Module-II:
DC Drives: Starting & braking of conventional, Phase controlled and chopper-controlled drives, Transient & Steadystate analysis, Energy recovery systems.

Module-III:
Induction Motor Drives: Conventional method of starting braking and speed control, PWM, (VSI) Voltage sourceInverter and Current Sources (CSI) fed IM drives, cyclo-converter fed drive, Vector control drives.
Slip Controlled IM Drives: Review of Conventional methods & converter controlled-Crammers & Scherbius drives;rotor impedance control.

Module-IV:
Synchronous Motors Drives: VSI and CSI fed; self-controlled-Brush less &. Commutator less dc & ac motor drives

Module-V:
Special Drives: Fundamentals of Switched reluctance motors, Stepper Motors, Permanent Magnet Motor Introductionto vector control; Digital control of drives.
Case Studies Electric traction, steel & cements plants, textile & paper mills, machine tool drive and CNC, electriccars.

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Text Books:

1. Pillai S. K., "A first course on Electrical Drives", Wiley Eastern, Second edition
2. Dubey G. K., "Power Semiconductor Controlled Drives", Prentice-Hall, Englewood Cliffs, First Edition.
3. Dubey G. K., "Fundamentals of Electrical Drives", Narosa Publishing Hous, Second Edition.
4. P.V. Rao, "Power semiconductor Drives", BS Publications, Fourth Edition.

Reference Books:

1. Bose B. K., "Power Electronics and AC Drives", Prentice-Hall, First Edition.
2. Murphy M. D. and Tumbuli F., "Power Electronic Control of AC Motors", Pergamon Press, OxfordUniversity Press, First Edition.

List of Experiments:

1. To perform Speed Torque characteristics of a separately excited DC motor using open and close loop armature voltage control.
2. To perform Speed Torque characteristics of a separately excited DC motor using open and close loop armature field control.
3. To perform four- quadrant Speed Torque characteristics of a separately excited DC motor using open and close loop control.
4. To perform Speed Torque characteristics of single phase Induction motor using open loop controlled V/f method.
5. To perform Speed Torque characteristics of single phase Induction motor using close loop controlled V/f method.
6. To perform Speed Torque characteristics of three phase Induction motor using open loop controlled V/f method.
7. To perform Speed Torque characteristics of three phase Induction motor using close loop controlled V/f method.
8. To perform Speed Torque characteristics of permanent magnet synchronous motor (PMSM) using open loop control.
9. To perform Speed Torque characteristics of permanent magnet Brush less DC motor (PMBLDC) using open loop control.
10. To perform Speed Torque characteristics of permanent magnet Brush less DC motor (PMBLDC) using close loop control.
11. To perform Speed Torque characteristics of Switch Reluctance Motor (SRM) using open loop control.
12. To perform Speed Torque characteristics of Switch Reluctance Motor (SRM) using close loop control.

Course Code : EE74
Course Category: PCC
Course Name : Electrical Drives

After completion of this course student will be able to-

CO-1: Relation between Power Electronic switches and Machines to from a drive.

CO-2: Application of various converter topology in association with Machines.

CO-3: Discussion of special drives and case studies.

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Subject Code	Subject Name	Maximum Marks Allotted						Hours/ Week			Total Credits
		Theory			Practical		Total Marks	L	T	P	
		End Sem	Mid-Sem Exam	Quiz/ Assignment	End Sem	Lab work					
EE75	Switchgear & Protection	70	20	10	30	20	150	3	-	2	4

SWITCHGEAR & PROTECTION

Module-I: Relays:
General consideration, sensing of fault, primary and back up protection, basic requirements of protective relaying, classification of relays, construction of electromagnetic relays, induction type relay principle, inverse time and definite time characteristics, over current, over voltage, directional, distance relays, differential buchholz and negative phase sequence relays.

Module-II: Advance relays:
Static Relays: Classification of static relays, block diagram & components of static relays, cooperators, static over current, static directional, static distance and static differential relays. Microprocessor based relays: General considerations, flow chart and software development for protection, microprocessor based over current relay, directional relay, distance relay, security and reliability. Numerical relays: Principle, characteristics and operation of numerical relay. FPGA based relays

Module- III: Protection:
Types and detection of faults and their effects, alternator protection scheme, power Transformer protection, generation-transformer unit protection scheme, busbar protection, transmission line protection, frame leakage protection, pilot relay scheme.

Module-IV: Switchgear:
Fuse: Characteristics, types of fuses, selection of fuses, construction and application of HRC fuses. Circuit breaker: basic principle of operation, arc phenomenon, initiation and maintenance of arc, arc interruption methods, arc voltage and current waveform in AC circuit break in re-striking and recovery voltage, current chopping, rating of circuit breakers, breaking capacity, making capacity, short time rating, working principle and important features of oil CB, minimum oil CB, air blast CB, Vacuum CB and SF6 CB, auto high-speed re- closing.

Module-V: Over voltage protection and neutral grounding:
Surge over voltages: Causes of over voltages, lightning phenomenon, protection of transmission line against Over voltage, klydonograph and magnetic link, switching surges, surge diverters Peterson coil and insulation coordination. Neutral grounding: Resistance earthling, reactance earthling, resonance earthling,voltage transformer earthling, earthling transformer.

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Text Books:

1. Y.G. Painthankar S.R. Bhide, "Fundamentals of Power System Protection", PHI, Second edition
2. Sunil S.Rao, "Switchgear and Protection", Khanna Pub New Delhi, Fourteenth Edition.
3. C.L. Wadhwa, "Electrical Power Systems", Newage International (P) Ltd, Eight Edition.

References Books:

1. B.Ravindranath and N Chander, "Power System Protection & Switchgear", Wiley Eastern Ltd, Second Edition.
2. Badri Ram Vishwakarma, "Power System Protection and Switchgear", Tata McGravy Hill, Third Edition.
3. T.S. Madhav Rao, "Power System Protection: Static Relays with Microprocessor Application", McGraw Hill Pub., Second Edition.
4. S.R.Bhinde., "Digital Power System Protection", Fourth Edition.

List of experiments:

1. To plot operating characteristics by performing operation of inverse definite minimumtime (IMDT) relay.
2. To check the percentage setting of percentage differential relay by performing operation.
3. To find the pick-up value and reset value of instantaneous relay by performingoperation.
4. To perform operation and plot the directional characteristics of directional over currentrelay on R-X diagram.
5. To perform operation and plot characteristics of over/under voltage microcontroller-based relay.
6. To check the microcontroller based over current relay and plot the curves.
7. To plot the directional characteristics of microprocessor based directional relay byperforming operation.
8. To perform operation and plot characteristics of microprocessor based differential relay.

Course Code : EE75
Course Category: PCC
Course Name : Switchgear & Protection

After completion of this course student will be able to-

CO-1: Categorize various types of relays and their working

CO-2: Explain the types, working and application of circuit breakers.

CO-3: Illustrate Protection of Bus-bar, transmission line, transformers and alternator.

CO-4: Develop and design of various protection schemes.

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