PANDIT DEENDAYAL ENERGY UNIVERSITY, GANDHINAGAR
SCHOOL OF TECHNOLOGY

COURSE STRUCTURE FOR B. TECH. IN ELECTRICAL ENGINEERING														
Semester VII			**B. Tech. in Electrical Engineering**											
Sr. No.	**Course/Lab Code**	**Course/Lab Name**	**Teaching Scheme**					**Examination Scheme**						
			L	**T**	**P**	**C**	**Hrs/Wk**	**Theory**			**Practical**		**Total**	
								MS	**ES**	**IA**	**LW**	**LE/Viva**	**Marks**	
1	20EE401T	Electrical Machine Design	4	0	0	4	4	25	50	25	--	--	100	
2	20EE402T	Smart Grid: Technologies and Applications	3	0	0	3	3	25	50	25	--	--	100	
3	20EE403T	Electricity Sector in India: Policies and Regulations	2	0	0	2	2	25	50	25	--	--	100	
4	20EE4XXT	Professional Elective Course – IV	3	0	0	3	3	25	50	25	--	--	100	
5	20EE4XXP	Professional Elective Course - IV Laboratory	0	0	2	1	2	--	--	--	50	50	100	
6	20EE4XXT	Professional Elective Course – V	3	0	0	3	3	25	50	25	--	--	100	
7	20EE4XXP	Professional Elective Course - V Laboratory	0	0	2	1	2	--	--	--	50	50	100	
		Total	**15**	**0**	**04**	**17**	**19**						**700**	

IA- Internal Assessment, MS-Mid Semester; ES – End Semester Exam

The students have to select two theory courses from the following basket for Professional Elective Course – IV & V (Theory). Professional Elective Course – IV & V Laboratory will be offered based on the selected Professional Elective Course – IV & V (Theory).

Subject Code	**Professional Elective Course**		**Professional Elective Course**
20EE404T	FACTS and HVDC Power Transmission	20EE404P	FACTS and HVDC Power Transmission Laboratory
20EE405T	Digital Control	20EE405P	Digital Control Laboratory
20EE406T	Power Quality	20EE406P	Power Quality Laboratory
20EE407T	Modelling and Analysis of Electrical Machines	20EE407P	Modelling and Analysis of Electrical Machines Laboratory
20EE408T	Electric Vehicles Technologies	20EE408P	Electric Vehicles Laboratory

20EE401T					Electrical Machine Design					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
4	0	0	4	4	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the design concepts, design factors, materials used in the electrical machines, temperature rise and duties/ratings of electrical machines
2. To understand the specifications, and procedure of design of induction machines and synchronous machines
3. To understand the procedure of design of Transformers
4. To introduce the students with the concept of CAD of electrical machines

UNIT I: BASIC CONSIDERATIONS IN ELECTRICAL MACHINES DESIGN **08 Hrs**

Introduction, Design factors, Limitations in design, Modern trends in design of electric machines, Conducting materials, Magnetic materials, Insulating materials and its classification. Temperature rise, Expression for temperature rise, heating and cooling time constants, Types of duties and ratings, Selection of motor capacity.

UNIT II: INDUCTION MACHINES DESIGN **18 Hrs**

Introduction, Choice of specific electric and magnetic loadings, Output equation, Separation of D & L.

Design of Stator: Turns per phase, Stator conductors, Shape of stator slots, Number of stator slots, Area of stator slots, Length of mean turn, Stator teeth, Stator core, Length of air gap. **Squirrel Cage Rotor Design:** Number of rotor slots, Harmonic torques and its Reduction, Design of rotor bars & slots, Design of end rings, **Wound Rotor Design:** Number of rotor slots, number of rotor turns, area of rotor conductors, design of rotor core. Estimation of operating characteristics- No load and S.C. current, leakage reactance calculation, Circle diagram, Dispersion coefficient and its effects, Performance calculation.

Design of single phase induction motor: Output equation, Choice of specific loadings, Main dimensions, Design of stator and rotor, Air gap length, Operating characteristic and parameters, Design of starting winding.**A.C. Armature Winding**: Number of phases and phase spread, classification and design of ac windings.

UNIT III: SYNCHRONOUS MACHINES DESIGN **12 Hrs**

Introduction, Choice of specific electric and magnetic loadings, Design of Salient pole machines: Output equation, Main dimensions, Short Circuit Ratio, Effect of SCR on machine performance, Length of air gap and shape of pole face.

Armature Design: Number of armature slots, Coil span, Turns per phase, Conductor section, Slots dimension, Stator Core, Elimination of harmonics, Armature resistance and Leakage reactance, Estimation of air gap length, **Design of rotor**, Height of pole, Design of damper winding, Height of pole shoe, Pole profile drawing, Design of magnetic circuit, Design of field winding, **Design Of Turbo Alternators**: Main dimensions, Length of air gap, Stator and Rotor design.

UNIT IV: DESIGN OF TRANSFORMERS **16 Hrs**

Specification, Output equation of transformer, Relation between EMF per turn and transformer rating, Stacking factor, Choice of design parameters: flux density, current density and window space factor, Design of core, window dimensions, Design of yoke, Overall dimensions, Types of transformer windings, Design of high voltage and low voltage winding, Estimation of operating characteristics: resistance, Leakage reactance of windings, Regulation, Mechanical forces, No load current calculation, Temperature rise of transformer, Design of tank, **Concept of CAD of Electrical Machines:** Advantages and Limitations of CAD**.** Different approaches for CAD**.** Selection of Optimal Design, lowest cost and significance of Kg/kVA. Flowchart for the CAD of transformer, induction machines.

TOTAL HOURS **54 Hrs**

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand the basic design concepts/factors, thermal loading and ratings of electrical machines

CO2 – Classify and select proper material for the design of electrical machines

CO3 – Acquire knowledge to carry out a detailed design of induction and synchronous machines

CO4 – Acquire knowledge to carry out a detailed design of transformers

CO5 – Estimate and analyze the various performance parameters of Induction and synchronous machines and transformers

CO6 – Understand the concept ofcomputeraided design (CAD) of electrical machines and optimization

TEXT/REFERENCE BOOKS

1. A. K. Sawhney and A. Chakrabarti, “***A course in Electrical machine design***”, Dhanpat Rai and Co.
2. V. N. Mittal and A. Mittal, “***Design of electrical machines***”, Standard Publishers distributors.
3. M. G. Say, “***The performance and design of alternating current machines***”, CBS Publishers and Distributors.
4. K M Vishnu Murthy, “***Computer Aided design of electrical machines***”, B S Publication..

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 4 Questions, one from each unit, each carrying 15 marks 60 Marks

Part B/Question: 4 Questions , 2 from unit II, 1 from unit III and 1 form unit IV, carrying 10 marks 40 Marks

20EE402T					Smart Grid: Technologies and Applications					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the concept of smart grid and micro Grid
2. To introduce communication technologies for smart grid
3. To acquire knowledge about smart substations and operation of energy management systems

UNIT I: SG AND SMART ENERGY RESOURCES **08 HRS**

Evolution of smart grid, Need for SG, SG Definitions, characteristic of SG, SG technology framework **Smart Energy Recourses:** Renewable power generation; Energy Storage; Electric Vehicle; Microgrid (MG) and its drivers, MG benefits, challenges for MG development, types of MG, building blocks of MG, DC microgrid, Energy Resources Integration standards and their grid impacts

UNIT II: COMMUNICATION TECHNOLOGIES FOR SMART GRID **12 Hrs**

Communication Technologies for SG: Review on communication channels, Wired Communication, Optical Fibre, Radio Communication, Layered Architecture and Protocol, IEEE 802 standards for sub-networks, Ethernet LAN, wireless LAN, Bluetooth, Zigbee, 6LoWPAN, Standards for information exchange, Evolution of smart metering and its key components and hardware; Communication Infrastructure and Protocol for Smart Metering, HAN, NAN, Data Concentrators and protocols for communication, PMU and WAMS.

UNIT III: SMART SUBSTATIONS **08 Hrs**

Sub-station automation equipment, IED for protection, measurement and recording, sensors, RTUs, one-line diagram of smart sub-station, station-bay-process level; **SCADA:** Master Station/Energy Management Systems (EMS), structure of EMS, Data flow architecture, RTU data flow architecture, Server-based substation control system architecture, Smart substations in the smart grid architecture, **Interoperability and IEC 61850:** Interfaces within a substation automation system, Engineering approach in IEC 61850

UNIT IV: DEMAND SIDE MANAGEMENT **12 Hrs**

Demand Side Management (DS): DS planning, key definitions, DS requirement, issues in DS planning, hierarchy of planning objectives, load shape objectives, residential demand-side technology alternatives; implementation of demand side integration (DSI), price-based and incentive-based DSI, hardware support for DSI; Fault location, isolation and restoration; Power flow analysis using forward/backward sweep algorithm; Volt/var Control with optimization approach.

TOTAL HOURS **40 Hrs**

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand concept and significance of smart grids and microgrid
CO2 – Understand the communication technologies for smart grid
CO3 – Understand the smart metering, communication networks and WAMS technology
CO4 – Implement SCADA system for smart sub stations
CO5 – Implement demand side management to efficiently operate distribution network
CO6 – Manage distribution network and take corrective action for its performance improvement

TEXT/REFERENCE BOOKS

1. Ekanayake, J. B et al, "Smart grid : technology and applications", John Wiley & Sons, Ltd, 2012
2. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press.
3. Stuart Borlase, "Smart Grids: Infrastructure, Technology, and Solutions", CRC Press, 2013
4. James A.Momoh, "**Smart grid: fundamentals of design and analysis**". Vol. 63. John Wiley & Sons, 2012.
5. Stephen F. Bush, "**Smart grid: Communication-enabled intelligence for the electric power grid**". John Wiley & sons, 2014

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 4 Questions, one from each unit, each carrying 15 marks 60 Marks
Part B/Question: 4 Questions, one from each unit, each carrying 10 marks 40 Marks

21EE403T					Electricity Sector in India: Policies and Regulations					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
2	-	-	2	2	25	50	25	--	--	100

COURSE OBJECTIVES

1. To impart knowledge on the electricity sector institutional framework in India.
2. To understand overall policy and regulatory framework of the electricity sector in India.
3. To gather knowledge on recent amendments and introductions with regard to upgradation in the electricity sector.
4. To be familiar with the acts and policies related to electricity sector in India.

UNIT I INTRODUCTION TO THE ELECTRICITY SECTOR OF INDIA **05 Hrs.**

Indian Power sector at a glance, Policy formulation in India, Power sector administration, Power trading with foreign, Power infrastructure funding, Reforms in Power Sector (as per latest 5-year plan): Capacity addition, Green energy corridor, Integrated Power Development Scheme (IPDS), Rural Electrification in India, Private sector in India. Issues/Barriers with the Indian Power Sector.

UNIT II POWER SECTOR POLICIES **05 Hrs.**

Indian Electricity Act, 1910 and Electricity (Supply) Act, 1948, Electricity Regulatory Commissions Act, 1998, Electricity Act (EA) 2003, Policies Under the EA 2003: Rural Electrification Policy, National Tariff Policy, National Electricity Policy, National Electricity Plan. National Renewable Energy Policy, New Government Policies and Programmes, 24x7' Power for All'

UNIT III TRANSMISSION LINES STANDARDS **09 Hrs.**

CEA (Technical Standards for Electric Lines) Regulations, 2010: Technical standards; Lines (66kV and above) and Lines (33kV and below): Electrical design parameters, line construction: clearance from ground, clearance from other infrastructure, routing of lines, Lighting Protection. **CEA Grid Standards Regulation, 2010:** Standards for operation and maintenance of transmission lines, Operation and Maintenance planning, Categorization of grid incidents and grid disturbance based on severity of tripping.

UNIT IV REGULATIONS FOR GRID CONNECTIVITY **09 Hrs.**

Technical Standards for Connectivity to the Grid Regulations, 2007: Objectives, Conditions for connectivity, Standards for connectivity to the grid: Codes of Practice, Sub-station grounding, Basic insulation, Coordinated Protection system. Grid connectivity standards for: new and existing generating plants; Transmission lines and substation; Distribution Systems and Bulk Consumers. Notified amendments. Indian Electricity Grid Code Regulations, 2010 and amendments, **Technical Standards for Connectivity of the Distributed Generation Resources, 2013**: Codes of Practice, Protection to sense abnormal conditions, Notified amendments.

28 Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to:

CO1 - Gather knowledge on the power sector administration and institutional framework in India.
CO2 - Understand the power sector policies of India.
CO3 - Analyze the Indian electricity grid connectivity standards and regulations.
CO4 - Gather knowledge about the Technical Standards for Electric Lines of India.
CO5 - Understand Grid Standards Regulation for India.
CO6 - Analyze the Technical Standards for Connectivity of the Distributed Generation Resources.

RESOURCES

1. MoP, Policies and Regulation, Ministry of Power, Government of India. <LINK>.
2. CEA, Notified Regulations, Central Electricity Authority, Government of India.
   Metering Regulations: https://cea.nic.in/regulations-category/metering-regulations/?lang=en.
   Technical Standards for Electric power lines: https://cea.nic.in/regulations-category/construction-standards/?lang=en.
   Technical Standards for Connectivity to the Grid Regulations: https://cea.nic.in/regulations-category/grid-connectivity-regulations/?lang=en
3. Harish, V. S. K. V., & Kumar, A. (2014). Demand side management in India: action plan, policies and regulations. *Renewable and Sustainable Energy Reviews*, *33*, 613-624, 10.1016/j.rser.2014.02.021.
4. Kumar, A., & Chatterjee, S. (2012). Electricity sector in India: policy and regulation. *OUP Catalogue*, 10.1093/acprof:oso/9780198082279.001.0001

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 4 Questions, one from each unit, each carrying 15 marks 60 Marks
Part B/Question: 2 Questions , one each from unit III and IV, each carrying 20 marks 40 Marks

20EE404T					FACTS and HVDC Power Transmission					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the characteristics of ac transmission and the effect of shunt and series reactive compensation.
2. To acquire knowledge about flexible power transmission system.
3. To acquire the knowledge about HVDC system: concept, components and operating characteristics.
4. To acquire the knowledge about FACTS Controllers: concept, components and operating characteristics.

UNIT I: FLEXIBLE TRANSMISSION SYSTEM **08 Hrs**

Basics of AC Transmission, Comparison of AC and DC Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission. **HVDC System**: Introduction, Types of HVDC Systems: Monopolar Link, Bipolar Link, Homopolarlink. **FACTS**: Compensation of Transmission lines, Basic types: SVC, STATCOM, TSSC, TCSC, SSSC, UPFC, IPFC. Flexible Systems Vs Conventional transmissions Systems.

UNIT II: HVDC SYSTEM **14 Hrs**

Components of HVDC systems: Smoothing Reactors, Reactive Power Sources and Filters in LCC HVDC systems DC line: Corona Effects. Insulators, Transient Over-voltages. DC breakers. Monopolar Operation. Ground Electrodes. **Line Commutated Converters (LCCs):** Six pulse converter, Analysis neglecting commutation overlap, harmonics, Twelve Pulse Converters. Inverter Operation. Effect of Commutation Overlap. Expressions for average dc voltage, AC current and reactive power absorbed by the converters. Effect of Commutation Failure, Misfire and Current Extinction in LCC links, DC line faults in LCC systems. **Voltage Source Converters (VSCs)**: Two and Three-level VSCs. PWM schemes: Selective Harmonic Elimination, Sinusoidal Pulse Width Modulation. Analysis of a six pulse converter. Equations in the rotating frame. Real and Reactive power control using a VSC, DC line faults in VSC systems

UNIT III: FACTS CONTROLLERS **14 Hrs**

Thyristor-based Flexible AC Transmission Controllers: Description and Characteristics of Thyristor-based FACTS devices: Static VAR Compensator (SVC), Thyristor Controlled Series Capacitor (TCSC), Thyristor Controlled Braking Resistor and Single Pole Single Throw (SPST) Switch. Configurations/Modes of Operation, Harmonics and control of SVC and TCSC. Fault Current Limiter. **Voltage Source Converter based FACTS controllers:** Voltage Source Converters (VSC): Six Pulse VSC, Multi-pulse and Multi-level Converters, Pulse-Width Modulation for VSCs. Selective Harmonic Elimination, Sinusoidal PWM and Space Vector Modulation. STATCOM: Principle of Operation, Reactive Power Control: Type I and Type II controllers, Static Synchronous Series Compensator (SSSC) and Unified Power Flow Controller (UPFC): Principle of Operation and Control. Working principle of Interphase Power Flow Controller. Other Devices: GTO Controlled Series Compensator, Fault Current Limiter.

UNIT IV: FLEXIBLE TRANSMISSION FOR SMART GRIDS **04 Hrs**

DC Microgrid configuration, Synchro-Phasor Measurement Technology: PMUs, Future Developments and Challenges.

TOTAL HOURS **40 Hrs**

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Distinguish between DC and AC power transmission system
CO2 – Understand the operation of Line Commutated Converters and Voltage Source Converters for HVDC system
CO3 – Understand the working principles of HVDC devices and their operating characteristics
CO4 – Analyse the application of flexible transmission for futuristic power grid
CO5 – Analyse operation of thyristor-based and voltage source converter based FACTS controllers
CO6 – Understand the working principles of FACTS devices and their operating characteristics

TEXT/REFERENCE BOOKS

1. Kundur, Prabha, Neal J. Balu, and Mark G. Lauby. ***"Power system stability and control"***. Vol. 7. New York: McGraw-hill.
2. Hingorani, N. G., Gyugyi, L. ***"Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems"***, Wiley-IEEE Press, ISBN: 978-0-780-33455-7,Dec 1999.
3. Sood, Vijay K. ***HVDC and FACTS controllers: applications of static converters in power systems***. Springer Science & Business Media, 2006.
4. Surjit Singh, **"Electrical Estimating and Costing"**, Dhanpat Rai and Co.
5. Acha, E., Roncero-Sánchez, P., de la Villa-Jaen, A., Castro, L. M., & Kazemtabrizi, B. (2019). ***VSC-FACTS-HVDC: Analysis, Modelling and Simulation in Power Grids***. John Wiley & Sons.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 4 Questions, one from each unit, each carrying 15 marks 60 Marks
Part B/Question: 2 Questions , one each from unit II and III, each carrying 20 marks 40 Marks

20EE404P					FACTS and HVDC Power Transmission Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To understand simulation studies and mathematical models of HVDC and FACTS system.
2. To vary the control and design inputs and analyse operation for HVDC and FACTS system
3. To gather knowledge about the computation tools and simulation software that can be used for transmission system

LIST OF EXPERIMENTS

1. To develop simulation models for cables and transmission Lines.
2. To develop a 6-pulse bridge circuit model and analyse its operation without commutation overlap feeding an inductive load.
3. To develop a 6-pulse bridge circuit model and analyse its operation with commutation overlap less than 60 degfeeding an inductive load.
4. To analyse PWM Pattern Generation Techniques.
5. To develop a Voltage-Source Converter (VSC) inverter feeding an inductive load from a dc supply and analyse the currents and voltages in *pu*.
6. To develop a Voltage-Source Converter (VSC) inverter model with AC current PWM control.
7. To develop a model for unipolar HVDC system and analyse DC current and voltages of the line.
8. To develop a model for bipolar HVDC system and analyse DC current and voltages of the line
9. To develop a model for homopolar HVDC system and analyse DC current and voltages of the line
10. To analyse a HVDC system with DC line fault in terms of current and voltages.
11. Design power system with using PSCAD
12. To develop simulation model of a SVC for power system studies
13. To develop simulation model of a TCSC for power system studies

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Operate simulation software to analyze performance of power transmission systems
CO2 – Develop HVDC transmission line models and analyze their performance characteristics
CO3 – Develop converter models for HVDC transmission system
CO4 – Conduct current and voltage based operation analysis for different HVDC and FACTS models
CO5 – Develop FACTS controller models using simulation software
CO6 – Analyze and compare current and voltage waveforms for different HVDC links

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100

Continuous evaluation 50 marks
End semester examination and Viva-voce 50 marks

<table>
<tr><td colspan="5">20EE405T</td><td colspan="6">Digital Control</td></tr>
<tr><td colspan="5">Teaching Scheme</td><td colspan="6">Examination Scheme</td></tr>
<tr><td rowspan="2">L</td><td rowspan="2">T</td><td rowspan="2">P</td><td rowspan="2">C</td><td rowspan="2">Hrs/Week</td><td colspan="3">Theory</td><td colspan="2">Practical</td><td rowspan="2">Total Marks</td></tr>
<tr><td>MS</td><td>ES</td><td>IA</td><td>LW</td><td>LE/Viva</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>3</td><td>3</td><td>25</td><td>50</td><td>25</td><td>--</td><td>--</td><td>100</td></tr>
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COURSE OBJECTIVES

1. To represent the discrete time system in discrete transfer function and discrete state space model.
2. To analyse the stability of discrete control system.
3. To learn the discrete control system design and state observers.
4. To learn the modern control strategies.

UNIT I: INTRODUCTION TO DISCRETE TIME SYSTEMS **10 Hrs.**

Introduction to the representation of discrete time systems, Properties and uses of the z- transform for discrete time signals and systems. Sampling and reconstruction of continuous time signals, ZOH equivalent, Relationship between s-plane (continuous-time) and z-plane (discrete time), Bilinear transformation, Pulse transfer function, Stability analysis and stability tests for discrete-time systems, Jury's stability criterion.

UNIT II: DISCRETE STATE SPACE MODELS **10 Hrs.**

Introduction to discrete state space models, canonical models, Conversion of continuous to discrete state space model, state transition matrix, solution of state difference equation, Controllability, observability, reachability, constructability of discrete state space models, effect of sampling on stability, controllability and observability.

UNIT III: DIGITAL CONTROLLER DESIGN **10 Hrs.**

Digital controller design via classical techniques, Discrete PID control, Position and velocity algorithms for PID controller implementations, Deadbeat control, State feedback control, discrete pole placement control, Design of full order State observers and estimators.

UNIT IV: MODERN CONTROL TECHNIQUES **10 Hrs.**

Introduction to optimal control, discrete linear regulator problem, Performance indices, Linear Quadratic Regulator (LQR) design, Riccati equation, Model Predictive Controller, Problem formulation, Objective functions, Receding horizon control.

Max Hrs: 40

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Interpret discrete time systems under the z-domain transfer functions and discrete state-space models.
CO2 – Analyze stability and transient response of linear discrete-time systems, analytically.
CO3 – Design digital control systems using transform techniques and state-space methods.
CO4 – Test the controllability and observability of linear discrete systems.
CO5 – Understand the concepts of optimal control
CO6 – Understand the working and formulation of Model Predictive Control.

TEXT/REFERENCE BOOKS

1. K. Ogata, Discrete Time Control Systems, Pearson Education/PHI, 2nd Edition, 2003.
2. M. Gopal, Digital Control and State Variable Methods, Tata McGraw Hill, 3/e, 2008.
3. K. M. Moudgalya, Digital Control, Wiley-Interscience; 1/e , 2008
4. G. F. Franklin, J. D. Powell and M. L. Workman, Digital Control of Dynamic Systems, Pearson Education, Asia, 3/e, 2000.
5. K. J. Astroms and B. Wittenmark, Computer Controlled Systems - Theory and Design, Prentice Hall, 3/e, 1997.
6. E. F. Camacho and A. C. Bordons, Model Predictive Control, 2/e, Springer, 2007

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 4 Questions, one from each unit, each carrying 15 marks — 60 Marks
Part B/Question: 4 Questions, one from each unit, each carrying 10 marks — 40 Marks

20EE405P					Digital Control Laboratory					
Teaching Scheme					**Examination Scheme**					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To gain practical knowledge of discrete systems
2. To learn the identification of discrete control relevant models of physical processes.
3. To develop the simulation skills prior to the design of a controller
4. To learn and implement discrete control strategies
5. To verify the concepts of controllability and observability using simulations

LIST OF EXPERIMENTS

1. Introduction to control system tool box and MATLAB commands for representing discrete systems.
2. Identification of discrete state space model of Single Board Heater System using step response data.
3. Linearization of a non-linear process using Taylor Series Expansion.
4. Simulation of discrete PID controller using MATLAB /Simulink.
5. Discrete PID control of Single Board Heater System: An experimental study
6. Discrete PID control of liquid level interacting System: An experimental study.
7. Effect of sampling time on controllability, observability and stability of a discrete system: A simulation study.
8. Simulation of discrete Pole Placement Control using MATLAB /Simulink.
9. Model Predictive Control of Single Board Heater System: A simulation study.
10. Model Predictive Control of Single Board Heater System: An experimental study.
11. Pole placement control of Inverted Pendulum: A simulation study.
12. Speed control of a DC motor: An experimental study.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Translate the discrete system in discrete state space and transfer function model.

CO2 – Model the physical process into control relevant state space/transfer function model

CO3 – Simulate and control the linear process using MATLAB simulation environment.

CO4 – Perform Hands-on experiment to implement the discrete PID controller

CO5 – Understand the effect of sampling time on stability, controllability and observability.

CO6 – Implement Model Predictive Controller strategy using MATLAB simulation environment.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100

Continuous evaluation	50 marks
End semester examination and Viva-voce	50 marks

20EE406T					Power Quality					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the basic concepts, terminologies and standard related to Power Quality
2. To gain knowhow about the significance of Power Quality, its impact, monitoring and the related analysing instruments
3. To get a fair knowledge about the operational analysis, applications, features of different custom power devices

UNIT I: INTRODUCTION TO POWER QUALITY **08 Hrs**

IEEE Standards 519:2014,Terms and definitions of transients, Long Duration Voltage Variations: under Voltage, Under Voltage and Sustained Interruptions; Short Duration Voltage Variations: interruption, Sag, Swell; Voltage Imbalance; Notching, D C offset,; waveform distortion; voltage fluctuation; power frequency variations. Electromagnetic Interference

UNIT II: POWER QUALITY ISSUES **14 Hrs**

Voltage Sag & Swell: Sources of voltage sag & swell, motor starting, arc furnace, fault clearing etc; estimating voltage sag &swell, performance and principle of its protection; solutions at end user level- Isolation Transformer, Voltage Regulator, Static UPS, Rotary UPS, Active Series Compensator. **Electrical Transients:** Sources of Transient Over voltages- Atmospheric and switching transients- motor starting transients, PF correction capacitor switching transients, ups switching transients, neutral voltage swing etc; devices for over voltage protection. **Harmonics:** Causes of harmonics, current and voltage harmonics: measurement of harmonics; effects of harmonics on – Transformers, AC Motors, Capacitor Banks, Cables, and Protection Devices, Energy Metering, Communication Lines etc. harmonic mitigation techniques

UNIT III: POWER QUALITY MONITORING **06 Hrs**

Power quality measurement devices - Harmonic Analyzer, Transient Disturbance Analyzer, wiring and grounding tester, Flicker Meter, Oscilloscope, Multimeteretc.

UNIT IV: INTRODUCTION TO CUSTOM POWR DEVICES **12 Hrs**

Passive Filters (Types/ Analysis/ Design/ Issues), Introduction to custom power devices and their Applications in power system; Load compensation and voltage regulation using DSTATCOM; protecting sensitive loads using DVR; Unified power Quality Conditioner (UPQC).

TOTAL HOURS **40 Hrs**

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Define the basic concepts, terminology used in power quality assessment and know various standards related to power quality

CO2 – Understand various power frequency disturbance issues & working principles of passive, hybrid and active power filter

CO3 – Comprehend the power quality monitoring equipments

CO4 – Analyze different power quality issues from the information gathered with the help of various instruments and equipment

CO5 – Evaluate variety of power quality improvement solutions suitable to particular situation/application

CO6 – Design &develop specific solution in terms of harmonic filters/ custom power device for power quality improvement

TEXT/REFERENCE BOOKS

1. R. C. Dugan, McGrahan, Santoso&Beaty, "***Electrical Power System Quality***", McGraw Hill.
2. Arinthom Ghosh and Gerard Ledwich, Kluwer,"***Power Quality Enhancement Using Custom Power Devices***", Academic Publishers.
3. C. Sankaran, "***Power Quality***", CRC Press.
4. Bhim Singh, Ambrish Chandra, Kamal Al-Haddad, "Power Quality: Problems and Mitigation Techniques", Wiley.
5. Hirofumi Akagi, Edson HirokazuWatanable and Mauricio Aredes, **"Instantaneous Power Theory and Applications to Power Conditioning (IEEE Press Series on Power Engineering)",** Wiley-Interscience A John Wiley and Sons Publication-2007.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 4 Questions, one from each unit, each carrying 15 marks 60 Marks

Part B/Question: 2 Questions, one from unit II and one form unit IV, each carrying 10 marks 40 Marks

20EE406P					Power Quality Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To understand the basic concepts, terminologies and standard related to Power Quality
2. To gain knowhow about power quality analysis of linear and nonlinear loads
3. To get a fair knowledge about harmonic analysis with the help of FFT analysis

LIST OF EXPERIMENTS

1. Generation of voltage Sag and Swell.
2. Generation of voltage interruption, voltage flicker and voltage unbalance.
3. Generation of voltage notching & power frequency voltage variation.
4. Power Quality analysis of linear and non-linear load.
5. Harmonic analysis using FFT and Power GUI block in MATLAB.
6. Impact of harmonics and unbalanced voltage on induction motor.
7. Measurement of power factor of a load.
8. Measurement of displacement factor, distortion factor and power factor for linear load.
9. Measurement of displacement factor, distortion factor and power factor for nonlinear load.
10. Measurement of power quality parameters using power analyzer.
11. Experimental study on power quality analysis for linear and nonlinear loads.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand the basic concepts, terminology used in power quality assessment and know various standards related to power quality analysis
CO2 – Generate various power frequency disturbances on simulation platform
CO3 – Carry out harmonic analysis using FFT and Power GUI tool in MATLAB
CO4 – Measure various power quality factor of linear and non-linear load
CO5 – Evaluate impact of poor power quality on performance of electrical equipments
CO6 – Measure power quality parameters experimentally for linear and non-linear load

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100
Continuous evaluation 50 marks
End semester examination and Viva-voce 50 marks

20EE407T					Modelling and Analysis of Electrical Machines					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	--	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To understand the concept of magnetic circuits and electromechanical energy conversion.
2. To get a knowledge of basic machine modelling and various kind of reference frames.
3. To acquire the knowledge of various equations used for modelling and analysis of electrical machine.
4. To analyse the dynamic performance of electrical machines.

UNIT I: FUNDAMENTALS OF ELECTRIC MACHINERY **05 Hrs.**

Introduction, Basics of Magnetic Circuit, Magnetically Coupled Circuits, Analysis of Singly Excited Electromechanical System, Energy and Co-Energy Principles in Linear and Non-Linear Magnetics, Analysis of Doubly Excited Electromechanical System, Machine Winding and Air Gap MMF, Winding Inductances and Voltage Equations.

UNIT II: REFERENCE-FRAME THEORY **10 Hrs.**

Introduction, Equations of Transformation, Stationary Circuit Transformed to Arbitrary Reference Frame, Balanced Steady-State Phasor Relationships, Commonly Used Reference Frames, Transformations Between Reference Frames, Reference Frames Power Invariance, Transformations of Balanced Set, Balanced Steady State Phasor Relationship, Balanced Steady State Voltage Equations.

UNIT III: MODELLING OF THREE PHASE AC MACHINE **15 Hrs.**

Induction Machine Analysis: Equivalent Circuit, Steady State Performance and its Equations, Dynamic Modelling of Induction Machine, Three Phase to Two Phase Conversion, Generalized Model, Analysis of Induction Machine - Synchronous Reference Frame - With Currents as Variables - With Rotor Flux as Variables, Equation of Flux Linkages, Per Unit Model, Basis for Vector Control, Small Signal Modelling of Induction Machine**Synchronous Machines Analysis:** Steady State and Transient Equations, Derivation of Cylindrical and Salient Rotor Machine Phasor Diagram, Concept of Synchronous Machine Reactance, Analysis of Equivalent Circuit of Synchronous Machine, Voltage and Torque Equation, Analysis of Steady State Operation, Dynamic Performance During Sudden Change in Load Torque, Dynamic Performance During Three Phase Short Circuitat Machine Terminals and Various Time Constants.

UNIT IV: BRUSHLESS DC MACHINE & DRIVES FOR BLDC **10 Hrs.**

Introduction and Concept of Brushless DC machines, Voltage and Torque Equations in Machine Variables, Voltage and Torque Equations in Rotor Reference Frame Variables, Analysis of Steady State Operations, Dynamic Performance of BLDC.Voltage Source Inverter Drives, Equivalence of VSI Schemes, Average-Value Analysis of VSI Drives, Steady State Performance of VSI Drives, Transient and Dynamic performance of VSI drives, Steady State Harmonics, Case Studies Related with BLDC Drives.

Max. 40. Hrs.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Relate the machine modelling aspects with basics of electrical machines
CO2 – Apply knowledge of reference frame theories used for transformations required during dynamic analysis of electrical machines
CO3 – Build mathematical model three phase AC machine for steady state and dynamic performance
CO4 – Evaluate steady state, dynamic and transient performance of three phase AC machine during normal conditions
CO5 – Analyse dynamic and transient performance of three phase AC machine during abnormal conditions
CO6 – To evaluate dynamic performance of BLDC machine and electric drives

TEXT/REFERENCE BOOKS

1. A.E Fitzgerald, Charles Kingsley, Stephen .D. Umans, Electric Machinery, 6th Edition, TMH.
2. Paul C. Krause, Oleg Wasynczuk and Scott D. Sudhoff, “Analysis of Electric Machinery and Drive Systems”, John Wiley & Sons, New York, 2004.
3. R. Krishnan, Electric Motor Drives, Modelling, Analysis and Control, Prentice Hall.
4. P S R Murty, Modelling of Power System Components. B S Publication.
5. Dr.P.S.Bimbhra, Generalized Theory of Electrical Machines, Khanna Publishers.
6. Chee-Mun Ong, Dynamic Simulations of Electric Machinery, Prentice Hall.
7. John Nelson Chiasson, Modelling and High Performance Control of Electric Machines, John Willey & Sons.
8. D. P. Sen Gupta & John Williamson Lynn, Electrical Machine dynamics, Macmillan

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 4 Questions, one from each unit, each carrying 16 marks 64 Marks
Part B/Question: 4 Questions, 1 from unit II and IV, and 2 from unit III, each carrying 10 marks 36 Marks

20EE407P					Modelling and Analysis of Electrical Machines Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	2	1	2	-	-	-	50	50	100

COURSE OBJECTIVES

1. To implement the different transformations using reference frame theory
2. To develop mathematical model of electrical machines
3. To analyse the dynamic performance of electrical machines
4. To implement vector control in electrical machines

List of Experiments:

1. To simulate conversion of time varying waveforms of three phase (abc) quantities to two phase (dq0) by different reference frames
2. To simulate the transformation between various reference frames (abc to dq and dq to abc) and its comparison.
3. To develop the mathematical model and simulation of three phase symmetrical induction machines for analysis of its steady state characteristics.
4. To simulate the induction motor model to evaluate its dynamic performance.
5. To simulate single phase induction motor to study its characteristics.
6. To model a three phase synchronous machines to determine the operational characteristics of the generator with parameter variations.
7. To examine the response of synchronous generator operating under fixed rotor speed and fixed excitation voltage to several kinds of electrical faults at its stator terminals.
8. To perform 6 pulse operation for Brushless DC Motor Drive.
9. To perform PWM control for Brushless DC Motor Drive with Speed Feedback.
10. To simulate open loop induction motor drive.
11. To simulate closed loop volts/hertz speed control drive.
12. To simulate current regulated induction motor drive with indirect field oriented control.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Implement the conversation of three phase to two phase and vice-versa
CO2 – Relate the steady state and dynamic performance of electrical machines
CO3 – Develop the model of three phase induction motor and alternator
CO4 – Evaluate the performance of induction machine and synchronous machine with various types of external inputs
CO5 – Analyse the performance of BLDC drive
CO6 – Simulate the vector control in electrical machines

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100

Continuous evaluation 50 marks
End semester examination and Viva-voce 50 marks

20EE408T					Electric Vehicle Technologies					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
3	0	0	3	3	25	50	25	--	--	100

COURSE OBJECTIVES

1. To give exposure to electric vehicle technology and government policies for electric vehicles
2. To gain knowledge about the operation of electric powertrain and charging infrastructure
3. To analyse the application of artificial intelligence, machine learning and embedded systems in electric vehicles

UNIT I:ELECTRIC VEHICLES **09 Hrs**

Concept, Significance, Classification, Components, Vehicle Dynamics, Merits and Demerits, Challenges and Constraints, Power Train, Charging Requirements, V2G and G2V technology, Technical Specifications of Commercial Electric Vehicles, Government Policies on Electric Vehicles

UNIT II: ELECTRIC POWERTRAIN **11Hrs**

Concept, Classification, Power Train Architecture, Components, Propulsion Motors, Permanent Brushless dc Motors, Sensors, Power Converters, Controller, Power and Control Architecture, Battery Management System, Regenerative Braking, Drive Cycle and Testing, 2-Wheeler and 4-Wheeler Electric Vehicle, Design of Electric Propulsion system, Hybrid Electric Vehicle Drive Trains

UNIT III: CHARGING INFRASTRUCTURES **11Hrs**

Energy Storage Elements, Battery, Fuel Cell, Ultracapacitors, Hybrid Energy Storage, Battery Charging, Battery Chargers, Off Board, On Board and Wireless Battery Charging, dc Chargers, Power Converters, Constant Voltage, Constant Current and Boost Charging, Impact of Battery Charging on Grid, Vehicle to Everything (V2X)

UNIT IV: EMERGING TRENDS IN ELECTRIC VEHICLES **09Hrs**

Wide Band Gap Semiconductor Devices, Application of Artificial Neural Networks, Fuzzy Logic, and Machine Learning and IoT in Electric Vehicles, Communication Systems, Integration of Electric Vehicles in Smart Grids, Solar Photovoltaic based Charging of Electric Vehicle.

TOTAL HOURS 40 Hrs

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand the electric vehicle technology, its significance and government initiatives for electric vehicles
CO2 – Classify different types of electric vehicles and list out the components being used in electric powertrain
CO3 – Examine the power and control architecture of electric powertrain
CO4 – Classify the different energy storage elements employed in electric vehicles
CO5 – Analyze the operation of charging infrastructure and battery management systems
CO6 – Examine the emerging trends in electric vehicle technology and understand the application of artificial intelligence and IoT in electric vehicles

TEXT/REFERENCE BOOKS

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, and Ali Emadi, ***"Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design,"*** CRC Press, 2004.
2. Iqbal Hussein, ***"Electric and Hybrid Vehicles: Design Fundamentals,"*** CRC Press, 2003.
3. B. K. Bose, ***"Modern Power Electronics and ac Drives,"***Prentice Hall Inc., 2001.
4. Sheldon S. Williamson, ***"Energy Management Strategies for Electric and Plug-in Hybrid Electric Vehicles,"*** Springer, 2013.
5. C.C. Chan and K.T. Chau, ***"Modern Electric Vehicle Technology,"*** Oxford University Press, 2001.
6. Rodrigo Garcia-Valle and João A. Peças Lopes (Eds.), ***"Electric Vehicle Integration into Modern Power Networks,"*** Springer, 2012.

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100 **Exam Duration: 3 Hrs**

Part A/Question: 4 Questions, one from each unit, each carrying 15 marks 60 Marks
Part B/Question: 4 Questions, one from each unit, each carrying 10 marks 40 Marks

20EE408P					Electric Vehicles Laboratory					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
0	0	2	1	2	--	--	--	50	50	100

COURSE OBJECTIVES

1. To learn concepts related to electric vehicle design
2. To acquire knowledge about Energy Storage Systems, Charging Techniques
3. To introduce the concepts related to drive train sizing

LIST OF SIMULATIONS AND EXPERIMENTS

1. To write a code to determine the tractive effort required to propel an EV on different terrains for the given drive cycle.
2. To write a code to determine the specifications of propulsions motor driving an EV on different terrains for the given drive cycle.
3. To develop mathematical model of a battery and determine the state of charge.
4. To develop mathematical model of ultra capacitor.
5. To develop mathematical model of fuel cell.
6. To simulate charging and discharging profile of batteries.
7. To write a code to design dc-dc converter for charging of EV batteries.
8. To simulate the battery charger operation.
9. Analyze the impact of battery charger on grid.
10. Demonstrate the performance of induction motor drive.
11. Demonstrate the performance of permanent magnet synchronous motor drive.
12. Demonstrate the performance of permanent magnet brushless dc motor drive.
13. Design decoder logic to determine the gate pulse for a VSI fed permanent magnet brushless dc motor drive based on the output of hall position sensors.
14. Study and compare the different EV powertrains.
15. Design and simulate an EV powertrain,
16. Study the application of artificial neural network in EV.
17. Study the application of fuzzy logic in EV.
18. Study the application of IoT in EV.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Determine the tractive effort and specifications of propulsion motor for an electric vehicle
CO2 – Create mathematical model of energy storage elements
CO3 – Analyze the power structure for charging of battery.
CO4 – Analyze the operation an electric drives being employed for propelling the electric vehicles
CO5 – Analyze the different types of electric vehicles power trains
CO6 – Assess the application of artificial intelligence and IoT in electric vehicles

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100

Continuous evaluation	50 marks
End semester examination and Viva-voce	50 marks

PANDIT DEENDAYAL ENERGY UNIVERSITY, GANDHINAGAR
SCHOOL OF TECHNOLOGY

COURSE STRUCTURE FOR B. TECH. IN ELECTRICAL ENGINEERING														
Semester VIII			**B. Tech. in Electrical Engineering**											
Sr. No.	**Course/Lab Code**	**Course/Lab Name**	**Teaching Scheme**					**Examination Scheme**						
			L	**T**	**P**	**C**	**Hrs/Wk**	**Theory**			**Practical**		**Total**
								MS	**ES**	**IA**	**LW**	**LE/Viva**	**Marks**
1	20EE410/20EE420	Major Project/Comprehensive Project	0	0	0	13	26	--	--	--	50	50	100
Total			**0**	**0**	**0**	**13**	**0**						**100**

IA- Internal Assessment, MS-Mid Semester; ES – End Semester Exam

Students can either opt for Major Project or Comprehensive Project

20EE410					Major Project					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	-	13	26	-	-	-	50	50	100

COURSE OBJECTIVES

1. To investigate the development of student's ability to apply the basic concepts of engineering
2. To impart the managerial skill and team work spirit
3. To understand the present scenario and chance to work in inter disciplinary environment
4. To develop activities that lead to transformation of theoretical knowledge into practical

The student is required to identify and analyse problems in the field of electrical engineering. The project will include preliminary work in the area of interest based on which a simulation or experimental model will be developed. The student is required to submit detailed report consisting of objectives of study, scope of work, literature review and preliminary work done pertaining to the project undertaken, details of the simulation and/or hardware model developed. Also, the student will defend the work carried out before an evaluation committee.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Undertake problem identification, formulation and solution by considering ethical responsibility

CO2 – Demonstrate a sound technical knowledge of their selected project topic and function as a member of a team in the solution of engineering problems

CO3 – Formulate and develop a hardware/software based prototype model

CO4 – Achieve skill to write technical documents and deliver oral presentation before an evaluation committee which in turn shall develop the communication skills

CO5 – Identify and apply appropriate steps to solve problems they have met during implementation of their project

CO6 – Design engineering solutions to complex problems utilizing as system approach

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100

Synopsis	10 marks
First Review	20 marks
Second Review	20 marks
Final Review	50 marks

20EE420					Comprehensive Project					
Teaching Scheme					Examination Scheme					
L	T	P	C	Hrs/Week	Theory			Practical		Total Marks
					MS	ES	IA	LW	LE/Viva	
-	-	-	13	26	-	-	-	50	50	100

COURSE OBJECTIVES

1. To investigate the development of student's ability to apply the basic concepts of engineering
2. To impart exposure to the working environment of industry and various departments involved
3. To design and recommend solution to the industrial problem through the application of engineering knowledge
4. To develop the necessary communication, report writing and interpersonal skills

The student is required to carry out his Comprehensive project in an industry or a research organization. He/she is required to identify problem in the field of electrical engineering with the help of industry and institute mentor. The project will include preliminary work in the area of interest and defining a methodology to solve the problem. Further, a solution to the problem is to be recommended/designed. The student is required to submit detailed report consisting of objectives of study, scope of work, literature review and preliminary work done pertaining to the defined problem, details of the work carried out and proposed solution. Also, the student will defend the work carried out before an evaluation committee.

COURSE OUTCOMES

On completion of the course, student will be able to

CO1 – Understand the industry operations and its working environment

CO2 – Formulate a problem in consultation with the industry and define a methodology to solve the identified problem while understanding the ethical responsibility

CO3 – Design and recommend solution to the identified problem through the application of engineering knowledge

CO4 – Achieve the necessary skills to write technical documents, deliver oral presentations and defend the work before the evaluation committee

CO5 – Recommend appropriate solutions to the problems faced during the course of the work.

CO6 – Comprehend appropriate methodology to carry out the project

END SEMESTER EXAMINATION QUESTION PAPER PATTERN

Max. Marks: 100

Synopsis	10 marks
First Review	20 marks
Second Review	20 marks
Final Review	25 marks
Review by Industry Mentor	25 marks