APPENDIX 1

SCHOOL OF ELECTRICAL ENGINEERING

ONE YEAR POST GRADUATE DIPLOMA PROGRAM IN

"POWER AND ENERGY MANAGEMENT"

(To be commenced from: July,2017)

COURSE STRUCTURE

SEMESTER-I

Sl. No.	Course Code	Subjects	L	T	P	Total	Credit
A.1	EE5101	Power System Analysis and Operations	3	-	-	3	3
A.2	EE5103	Managing Power System Dynamics	3	-	-	3	3
A.3	EE5105	Energy Audit and Management	3	-	-	3	3
A.4	EE5107	Managing Energy Saving Projects	3	-	-	3	3
A.5		Elective 1	3	-	-	3	3
A.6		Elective 2	3	-	-	3	3
Total of Theory						18	18
Practical							
B.1	EE5191	Power Quality Lab	-	-	3	3	2
B. 2	EE5193	Power System Simulation Lab			3	3	2
B. 3	EE5195	Smart Grid and Hybrid Energy System Lab	-	-	3	3	2
Sessional							
C.1	EE5181	Professional Communication	-	-	4	4	2
C.2	EE5183	Load Survey and Energy Audit	-	-	4	4	2
Total Practical and Sessional						17	10
Semester Total						35	28

SEMESTER-II

Sl. No.	Course Code	Subjects	Credit
1	EE5182	Internship Training & Project Work	20

Elective I

D.11	EE5109	Power System Protection and safety	3	-	-	3	3
D.12	EE5111	Intelligent system for Transmission and Distribution of Electric Power	3	-	-	3	3
D.13	EE5113	Solar and Wind Power	3	-	-	3	3

Elective 2

D.21	EE5115	Power System Monitoring and Quality Management	3	-	-	3	3
D.22	EE5117	Power System Reforms and Trading	3	-	-	3	3
D.23	EE 5119	Thermal Power and Building Utility Services	3	-	-	3	3

EE5101	Power System Analysis and Operations	L-T-P 3-0-0	**Cr-3**	**Total Hours:36**

Course Outcome (CO) : At the end of the course, the students will be able to:

CO1	Be familiar with modeling and analysis of Power system for better understanding of the grid
CO2	Analyse type of faults and their impacts
CO3	Analyse Voltage Stability and harmonic Analysis.

Course Contents:

Module	Text	Hours
Module-1	Load Flow analysis: Need for load flow analysis, modeling of power system, Per unit Calculation, Different techniques for load flow analysis, Reactive power optimization, Contingency Analysis, Economic Scheduling, Practical Consideration of load flow analysis, Case studies & applications.	9 hours
Module-2	Short Circuit Studies: Need for Short Circuit Study, Symmetrical faults, Asymmetrical Faults, Fault Currents and MVA levels computation Case studies & Application.	9 hours
Module-3	Voltage Instability Analysis: Introduction, Factors affecting Voltage stability, Types of stability, Available methods with case studies.	9 hours
Module-4	Harmonic Analysis: Harmonics within the power system, Linear Harmonic Measurement, Elimination of Harmonic, Filter Design	9 hours

Suggested Readings

Author	Title of the Book	Publisher/ Year of Edition
D P Kothari & I J Nagrath	Modern Power System Analysis	TMH/2013
J.Arrillaga	Power System Harmonic Analysis	Willey/2014
R C Dugan	Electrical Power Systems Quality	TMH/2008

EE5103	Managing Power System Dynamics	L-T-P 3-0-0	**Cr-3**	**Total Hours:36**

Course Outcome (CO) : At the end of the course, the students will be able to:

CO1	To analyze the effect of system disturbances and the urgency to restore steady state voltage and frequency
CO2	Analyze Dynamic stability of the power system
CO3	Analyze over voltage studies in power system.

Course Contents:

Module	Text	Hours
Module-1	Transient Stability Study: Steady State Stability, Behavior of machine for different faults, Swing equation, Synchronous machine models, modeling of cyclic loads, excitation system, speed governors.	9 hours
Module-2	Dynamic Stability Analysis: Dynamic stability analysis for the given power system in both frequency domain (Eigen value analysis) and time domain, growing oscillation phenomena or damping, initial state or operating condition of the system.	9 hours
Module-3	Over Voltage Studies: Voltage stress in power system, Temporary overvoltage, switching and Lightening surges, design & function of lightening arrestor, Insulation co-ordination, relevant standards, practical examples	9 hours
Module-4	Grid Management : Reasons for grid collapse, outages and consequent economic loss	9 hours

Suggested Readings

Author	Title of the Book	Publisher/ Year of Edition
KR Padiyar	Power System Dynamics	BS Publication/2011
P Kundur	Power System Stability and control	TMH/1994

EE5105	Energy Audit and Management	L-T-P 3-0-0	**Cr-3**	**Total Hours:36**

Course Outcome (CO) : At the end of the course, the students will be able to:

CO1	Analyze energy scenario of various sources
CO2	Understand the need of energy audit and different assessment methods
CO3	Analyze various applications and types of energy audit

Course Contents:

Module	Text	Hours
Module-1	Indian Energy scenario, Thrust on renewable energy, Potential of other sources of energy, economics, Energy Audit, Material and Energy balance, Energy Efficiency, Energy Performance Assessment for Equipment and Utility Systems, Project financing.	6 hours
Module-2	Energy Audit, Material and Energy balance, Energy Efficiency, Energy Performance Assessment for Equipment and Utility Systems.	6 hours
Module-3	Energy efficiency, Energy intensity, Energy conservation, Role of BEE, Star marking, Designated industry, Energy Mangers	6 hours
Module-4	Need for energy audit, Investment need, financial analysis, Material and Energy balance, Sanky diagram, Energy audit reporting format, Types and methodology, Inventory, impact on efficiency, environment concerns	6 hours
Module-5	Data analysis, reporting, MIS, Accountability, Internal audit,Third party audit,ESCO.	6 hours
Module-6	Demand side management, Benchmarking, Reflecting audit recommendations in improving system	6 hours

Suggested Readings

Author	Title of the Book	Publisher/ Year of Edition
Abbi,Y P; Jain, Shashank	Management: Handbook on Energy Audit and Environment	Teri/2012
BEE	BEE Publications(Energy Audits)	BEE

EE5107	Managing Energy Saving Projects	L-T-P 3-0-0	**Cr-3**	**Total Hours:36**

Course Outcome (CO) : At the end of the course, the students will be able to:

CO1	Be familiar with data analysis and project report generation during energy studies.
CO2	Manage energy audit/saving projects and Financing models
CO3	Familiarity with different types of energy efficient systems

Course Contents:

Module	Text	Hours
Module-1	Energy: Energy Scenario, Energy Audit, Material and Energy balance, Energy Efficiency, Energy Performance Assessment for Equipment and Utility Systems , Detailed of plant energy studies, power and energy measurement methodologies at the site, fluid flow measurement, chemical and electrical method for analysis of line gases, Data collection methodologies of various sectors, computation methods for data analysis, evaluation of saving opportunities, preparation of project report on the plant energy studies	12 hours
Module-2	Management procedures for energy audit, details of energy audit and identification of energy management opportunities, details of utility energy bill analysis,	12 hours

	studies on lighting, heating, ventilation and air-conditioning systems. Project definition and details of preparation methodologies	
Module-3	Instruments for thermal, electrical chemical energy assessment, Flue gas analyzer, measurement of waste heat and process for recovery, assessment on excess air, stack temperature, waste-heat-steam generation, assessment of steam and condensate efficiency, load balancing, boiler blow down, condense return, fuel quality, waste heat survey, waste heat exchangers, economics of waste heat recovery.	12 hours

Suggested Readings

Author	Title of the Book	Publisher/ Year of Edition
Abbi,Y P; Jain, Shashank	Management:Handbook on Energy Audit and Environment	Teri/2012

EE5109	Power System Protection and safety	L-T-P 3-0-0	**Cr-3**	**Total Hours:36**

Course Outcome (CO) : At the end of the course, the students will be able to:

CO1	Familiarity with Types of Relays, Protection Schemes, Computer Applications, Fault calculation
CO2	Familiar with Unit protection schemes, Protections of Transformers and Generators, Feeder Protection, motor protection, line unit protection.
CO3	Familiar with Recent trends of Numerical relays, protocol compatability,etc

Course Contents:

Module	Text	Hours
Module-1	Overview: Protective relaying, Need for Protection, General Philosophy, Types of Relays, Protection Schemes, Computer Applications, Fault calculation.	6 hours

Module-2	Over Current Relay Coordination: Overcurrent relays, General Philosophy, major protection issues, relay coordination.	9 hours
Module-3	Distance Relay Coordination: Distance relays, General Philosophy, Zone wise protection, relay coordination, Different characteristics.	9 hours
Module-4	Unit Protection: Unit protection schemes, Protections of Transformers and Generators, Feeder Protection, motor protection, line unit protection.	6 hours
Module-5	Recent trends, Numerical relays, protocol compatability,etc	6 hours

Suggested Readings

Author	Title of the Book	Publisher/ Year of Edition
Badri Ram	Power System Protection & Switchgear	TMH/2012

EE5111	Intelligent system for Transmission and Distribution of Electric Power	L-T-P 3-0-0	**Cr-3**	**Total Hours:36**

Course Outcome (CO) : At the end of the course, the students will be able to:

CO1	Familiar with architecture and application, smart grid operations, communications infrastructure,
CO2	Know about Phasor Measurement Units (PMUs), SCADA Applications, Energy Management Systems Functions for monitoring,
CO3	Familiar with CEA regulations concerning to EA 2003

Course Contents:

Module	Text	Hours
Module-1	Smart Grid: Overview of the smart grid, Technologies, Components, Architecture and Application, Smart grid operations, Communications Infrastructure, Distributed generation, Energy Storage elements, Smart grid	9 hours

	control elements, Smart grid challenges.	
Module-2	WAMS: Phasor Measurement Units (PMUs), introduction to WAMS, architecture, applications, components, network behavior under dynamic conditions.	9 hours
Module-3	Architecture/App: SCADA Specification, Implementation, operation and maintenance, MTU, RTUs, SCADA Applications, Energy Management Systems Functions for monitoring, Assessment and Control.	9 hours
Module-4	Emerging Technologies for distribution loss reduction, Best Practices to be adapted for reduction of Technical and Commercial loss, Distributed Generation, Distribution Investment Planning, Analysis of benefit-to-cost ratio, Case studies.	9 hours

Suggested Readings

Author	Title of the Book	Publisher/ Year of Edition
James Momoh	Smart Grid: Fundamentals of Design and Analysis	Willey/2012
Arturo Roman Messina	Wide Area Monitoring of Interconnected Power Systems	IET/2015
Northcote,Green	Control & Automation of Electrical Power Distribution Systems	CRC Press
A G Phadke	Synchronizes Phasor Measurement and Their Applications	Springer/2008

EE5113	Solar and Wind Power	L-T-P 3-0-0	**Cr-3**	**Total Hours:36**

Course Outcome (CO) : At the end of the course, the students will be able to:

CO1	Be familiar with different types of wind turbines and generators and analyze their operations.
CO2	Be familiar with standalone and grid connected PV systems and analyze their operations.

Course Contents:

Module	Text	Hours
Module-1	Major Power Electronics Components in Wind Power Plants Power Electronics Wind Power Plants: Type-A WPP with Squirrel cage Induction generator: Type-B WPP with Wound Rotor Induction generator: Type-C WPP with Doubly-fed Induction generator: Type-D WPP with Wound Rotor Synchronous generator: Type-D WPP with Permanent Magnet Synchronous generator	9 hours
Module-2	Economics of Wind Power Plants Wind Power Quality and Electrical Generators: Grid Integration of Wind Power Plants: Wind resource Assessment: Siting Of Wind Power Plants: Economics of Wind Power Plants: Choice of Wind Turbines: Wind Power Project development	9 hours
Module 3	Solar PV Systems Introduction to solar PV and Solar Thermal grid/off-grid system.Factors affecting the battery performance, Batteries for PV systems, Algorithm of MPPT, Charge controller.	9 hours
Module-4	Photovoltaic System Design Introduction to Solar PV systems, Stand alone PV system configurations, Design methodology PV systems, Wire sizing in PV system, Precise sizing of PV systems , Hybrid PV systems, Grid connected PV systems, Simple payback period, Life cycle costing(LCC)	9 hours

Suggested Readings

Author	Title of the Book	Publisher/ Year of Edition
Chetan Singh Solanki	Solar Photovoltaics Fundamentals, Technologies and Applications,	PHI Publication/2015
Mukund Patel	Wind and solar systems	CRC Press/2006
Njenkins,	Wind Energy Technology	John Wiley & Sons/2015
Joshua Earnest ,	Wind Power Plants and Project Development	PHI Publication/2011

Tore Wizelius		

EE5115	Power System Monitoring and Quality Management	L-T-P 3-0-0	**Cr-3**	**Total Hours:36**

Course Outcome (CO) : At the end of the course, the students will be able to:

CO1	Familiar with smart meters and measurement standards.
CO2	Analyze harmonic measurements
CO3	Analyze Feeder management

Course Contents:

Module	Text	Hours
Module-1	Power/ Energy: Importance of measurement in monitoring, Power Measurement in Single-Phase & Three-Phase Systems, Power and Energy-Measuring Instruments, energy meters, smart meters and measurement standards.	9 hours
Module-2	Harmonics: Power system harmonics - harmonic problem, harmonic levels, harmonic measurement, harmonic transfer and driving point impedances for both transmission and distribution power systems	9 hours
Module-3	Asset monitoring /GPS Survey: Role of geographical information system, GPS/DGPS Survey, Automated single line diagram generation with case studies	6 hours
Module-4	Feeder management: Introduction, monitoring, instrumentation, feeder modeling, analysis, feeder as a profit centre and evaluation of issues to determine hosting capacity, modeling.	9 hours

Suggested Readings

Author	Title of the Book	Publisher/ Year of Edition
William H.	Distribution System Modeling & Analysis	CRC

Kersting		Press/2012
Abbi,Y P; Jain, Shashank	Management:Handbook on Energy Audit and Environment	Teri/2012

EE5117	Power System Reforms and Trading	L-T-P 3-0-0	**Cr-3**	**Total Hours:36**

Course Outcome (CO) : At the end of the course, the students will be able to:

CO1	Familiar with Power system planning, load -forecasting
CO2	To realize the concepts of Load Despatch centre
CO3	Understand with De-Regulation in Power System

Course Contents:

Module	Text	Hours
Module-1	Power System Planning Load Forecast: Power system planning, load -forecasting and load characteristics, short term and long term load forecast, different load forecast techniques.	9 hours
Module 2	Load Despatch centre, its function, role of system integrator, Scheduling of generation	9 hours
Module-3	De-Regulation in Power System Generation/ Transmission/ Distribution: Open access, ABC of ABT, Evolution of ABT, Legal Framework and Issues, Special Energy Meters for ABT regime, ABT operation for Distribution companies Power Trading, Power banking, exchanges, connectivity and congestion issues.	9 hours
Module-4	Design considerations in Thermal , Hydro and Nuclear Power stations	9 hours

Suggested Readings

Author	Title of the Book	Publisher/ Year of Edition
MV Deshpande	Electrical Power System Design	TMH/2012

EE 5119 Thermal Power and Building Utility Services

Course Outcome (CO) : At the end of the course, the students will be able to:

CO1	Be familiar with general aspect of energy management and energy audit.
CO2	Energy conservation opportunities in electrical system, motors, compressed air system, HVAC and refrigeration system, Pumping systems and cooling towers.
CO3	Energy conservation opportunities in lighting systems

Course Contents:

Module	Text	Hours
Module-1	Process and methodologies of energy audit, different types steps, presentation of reports, financial analysis of energy saving projects. Simple pay back, Internal Rate of Return(IRR)	9 hours
Module-2	Types of Refrigeration systems; Common Refrigerant and Properties; Compressor types and applications; Performance assessment of Refrigeration plants; Energy conservation opportunities. Fans and blowers; Types, Performance evaluation, efficient system operation, Capacity selections; Performance assessment of fans and blowers;	9 hours
Module-3	Energy conservation opportunities; Pumping systems and cooling towers; Types, Performance evaluation, efficient system operation; Energy conservation opportunities in pumping systems; Introduction to cooling towers; cooling tower performance, efficient system operation;	9 hours
Module-4	Energy conservation opportunities in cooling towers; Lighting systems Basic terms of lighting systems; Lamp and Luminaries types, recommended illumination level; Methodology of lighting systems energy efficiency study; Cast study,	9 hours

Suggested Readings

Author	Title of the Book	Publisher/ Year of Edition
BEE guide	General Aspect of Energy Management	2010.

book	and Energy Audit,	
BEE guide book	Energy Efficiency in Thermal Utilities, 2010,	2010.
BEE guide book	Energy Efficiency in Electrical Utilities,	2010.
Turner WC.	Energy Management Handbook,	5th Edition, The Fairmont Press, 2005
Capehart, Turner, Kennedy.	Guide to Energy Management.	Fifth Ed. The Fairmount Press, 2006.
Thumann, Younger.	Handbook of Energy Audit.	Sixth Ed. The Fairmount Press, 2003.
Thumann, Mehta	Handbook of Energy Engineering.	Fifth Ed. The Fairmount Press, 2001

LABORATORIES/SESSIONAL

EE5195	Smart Grid and Hybrid Energy System Lab	L-T-P 0-0-3	**Cr-2**	**Total Hours:36**

Course Outcome (CO) : At the end of the course, the students will be able to:

CO1	Familiar with solar PV systems
CO2	Analyze the operation and characteristic of solar PV water pumping system
CO3	Study and analyze grid connected PV-wind hybrid system

Course Contents:

1. Measurement of Solar Radiation (Direct and Diffuse).

2. Study of V-I Characteristics and P-V Characteristics of Solar PV Module
    a. using different color Spectrum.
    b. using different shadings.

3. Study of V-I Characteristics and P-V Characteristics of Solar PV Modules by
    a. Series Connection.
    b. Parallel Connection.
4. Study of V-I Characteristics and P-V Characteristics of Solar PV Module for different tilt angle position.
5. Characteristics of solar PV Water Pumping Systems.
6. Study of a Sun Tracking Solar Array (single/Two Axis).
7. Energy simulation by RET screen software package of a test case.
8. Find the MPP manually by varying the resistive load across the PV-panel.
9. To draw the charging and discharging characteristic of the battery.
10. Workout power flow calculation of stand-alone PV system of dc and ac load with battery.
11. Workout power flow calculations of Grid connected PV-wind hybrid system of ac-load with battery.

EE5193	Power and Energy Simulation Lab	L-T-P 0-0-3	**Cr-2**	**Total Hours:36**

Course Outcome (CO) : At the end of the course, the students will be able to:

CO1	Perform load flow studies using MiPower software
CO2	Familiar with ETAP software and perform load flow studies
CO3	Perform short circuit and transient analysis using MiPower and ETAP software

Course Contents:

1. Load flow studies of IEEE 5 bus system using MiPower.
2. Load flow studies of IEEE 14 bus system using MiPower.
3. Load flow studies of IEEE 5 bus system using ETAP.
4. Load flow studies of IEEE 14 bus system using ETAP.
5. Short circuit analysis of IEEE 5 bus system using MiPOWER.
6. Short circuit analysis of IEEE 14 bus system using MiPOWER.
7. Short circuit analysis of IEEE 5 bus system using ETAP.
8. Short circuit analysis of IEEE 14 bus system using ETAP.
9. Transient Stability of IEEE 5 bus system using MiPOWER with DG.
10. Transient Stability of IEEE 14 bus system using ETAP with DG.

EE5191	Power Quality Lab	L-T-P		**Total**

		0-0-3	**Cr-2**	**Hours:36**

Course Outcome (CO) : At the end of the course, the students will be able to:

CO1	Estimate power quality indices during any power quality disturbances
CO2	Analyze the different power quality events
CO3	Familiarity with different power quality disturbances

Course Contents:

1. Harmonic distortion measurement of voltage and current signal.

2. Harmonic estimation in transmission line during sag and swell.

3. Power factor improvement in a single phase non-linear load.

4. Measurement of different power factor under non-sinusoidal condition.

5. Measurement of harmonic reactive power under non-sinusoidal condition.

6. Harmonic distortion measurement of voltage flicker.

7. Harmonic distortion measurement of a harmonic notch voltage.

8. Harmonic distortion measurement of a transient voltage.

9. Harmonic distortion measurement of a transient voltage with harmonic.

10. Measurement of harmonic distortion of sag and swell signals with harmonic.