Shroff S.R. Rotary Institute of Chemical Technology

First Year Curriculum of
Postgraduate Degree in Electrical Engineering

A. Structure of curriculum:

Master of Electrical Engineering

Semester-I

Sr. No.	Category	Course Code	Course Name	Hours Per Week			Total Hours	Credits	E	M	I	V	Total
				L	T	P							
1	Program Core I	EE3101	Power System Analysis	3	0	2	5	4	70	30	20	30	150
2	Program Core II	EE3102	Power Converters & Applications	3	0	2	5	4	70	30	20	30	150
3	Program Elective I	EE3103/ EE3104	Program Elective I	3	1	0	4	4	70	30	0	0	100
4	Program Elective II	EE3105/ EE3106	Program Elective II	3	0	2	5	4	70	30	20	30	150
5	Research Methodology and IPR	MH3101	Research Methodology	2	0	0	2	2	0	0	20	30	50
6	Audit Course -I	MH3102	Disaster Management	2	0	0	2	0	30	20	0	0	50
Total							**23**	**18**	**310**	**140**	**80**	**120**	**650**

Semester-II

Sr. No.	Category	Course Code	Course Name	Hours Per Week			Total Hours	Credits	E	M	I	V	Total
				L	T	P							
1	Program core courses	EE3107	Dynamics of Electrical Machines	4	0	0	4	4	70	30	0	0	100
2	Program core courses	EE3108	Advanced Control System	2	0	2	4	3	70	30	20	30	150
3	Program core courses	EE3109	Restructured Power System	2	0	0	2	2	70	30	0	0	100
4	Program Elective-III	EE3110/ EE3111	Program Elective-III	3	0	0	3	3	70	30	0	0	100
5	Program Elective-IV	EE3112/ EE3113	Program Elective-IV	3	0	2	5	4	70	30	20	30	150
6	Open Elective-I	EE3114/ EE3115	Open Elective-I	2	0	0	2	2	70	30	0	0	100
7	Audit Course -II	MH3104	Energy Audit	2	0	0	2	0	0	0	20	30	50
Total							**22**	**18**	**420**	**180**	**60**	**90**	**750**

Program Elective-I	
Course Code	**Course Name**
EE3103	AI Techniques
EE3104	Neural Networks & Fuzzy Logic

Program Elective-II	
Course Code	**Course Name**
EE3105	Power Quality
EE3106	Switch mode Power Converters

Professional Elective-III	
Course Code	**Course Name**
EE3110	Renewable Energy System
EE3111	Advanced Power System Stability

Professional Elective-IV	
Course Code	**Course Name**
EE3112	HVDC & FACTs
EE3113	Advanced Microcontrollers and Applications

Open Elective-I	
Course Code	**Course Name**
EE3114	Electric & Hybrid Vehicles
EE3115	Economics of Energy Generation & Supply

Course code and definition:

Course code	Definitions
L	Lecture
T	Tutorial
P	Practical
E	Theory External Examination Marks
M	Theory Internal Examination Marks
I	Practical Internal Examination Marks
V	Practical External Examination Marks

Masters of Engineering
Course Code: EE3101
Course Name: Power System Analysis

Shroff S.R. Rotary Institute of Chemical Technology

Semester: I

Type of course: Program Core course

Prerequisite: Basic courses on Power System Analysis of UG level.

Rationale: Power systems are typically characterized by large size and complex nature. Therefore, its analysis for various purposes is extremely important. The assessment of load flows under the presence of complex components, fault analysis of large systems, security assessment, contingency analysis, power system state estimation and voltage stability have got importance in modern power systems.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA(I)	
3	0	2	4	70	30	30	20	150

Course Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Load flow: Formulation of power flow problem – solution through Gauss-Seidel method, Newton Raphson method - decoupled and fast decoupled power flow solutions - DC power flow solution – comparison of GS – NR – FDC method.	**8**
2	Fault Analysis: Simultaneous faults, Open conductors faults, Short Circuit Studies of a Large Power System Networks, Symmetrical Fault Analysis Using Bus Impedance Matrix, Algorithm for Formation of Bus Impedance Matrix.	**8**
3	Security Analysis: Power System Security: Introduction, Factors Affecting Power System Security, , Contingency Analysis: Detection of Network Problems, Overview of security analysis, Linear Sensitivity Factors, Contingency Selection, Concentric Relaxation, Bounding Security state diagram, contingency analysis, generator shift distribution factors, Line outage distribution factor, multiple line outages, Overload index ranking.	**8**

Masters of Engineering
Course Code: EE3101
Course Name: Power System Analysis

	SECTION-B	
4	Power system stability Introduction, Mechanics of angular motion, The swing Education, transfer reactance, power relations, Steady state stability, Synchronizing power coefficient, Analysis of steady state stability, steady state stability with automatic voltage regulators, concept of shunt fault, transfer reactance during fault, reduction of power system to one machine connected to infinite bus, Transient stability, simplified transient generator model, The equal area stability criterion, solution of swing equation, Numericals	**8**
5	State Estimation: Introduction to State Estimation in Power Systems: Introduction, Power system state estimation, Maximum Likelihood Concept , Weighted Least Squares Estimation, Statistics in state estimation-Gaussian Probability Distribution Function, Matrix Formulation, State Estimation of an AC network, Development of Method, Structure of Jacobian in state estimation, State Estimation by Orthogonal Decomposition, An Introduction to Advanced topics in state estimation, Detection and Identification of Bad measurements : Bad by Chisquare technique, Estimation of quantities not being measured, Network Observability and Pseudo measurements, Application of Power Systems State Estimation	**8**
6	Voltage Stability: Voltage stability, instability and collapse, Factors contributing voltage instability, Voltage Collapse Proximity Indices(VCPI) sensitivity based VCPI, Line indices, The continuation power flow, Predictor corrector technique,, Q-V and P-V curves, multiple power flow solution, optimal multiplies load flow	**8**

Text Books:

1. J.J. Grainger & W. D. Stevenson, “Power system analysis”, McGraw Hill ,2003.
2. A. R. Bergen & Vijay Vittal, “Power System Analysis”, Pearson, 2000.
3. L. P. Singh, “Advanced Power System Analysis and Dynamics”, New Age International, 2006.

Reference Books:

1. G. L. Kusic, “Computer aided power system analysis”, Prentice Hall India, 1986.
2. A. J. Wood, “Power generation, operation and control”, John Wiley, 1994.

List of Practical: (Min. 10 Practical should be performed):

1. Formation of Primitive, incidence Ybus and Zbus matrix for given network.
2. Derivation of static load flow equation for a sample 4 bus system
3. Solution of static load flow equation using approximate method of Load Flow
4. Solution of static load flow equation using Gauss-Seidel Method of Load Flow
5. Solution of static load flow equation using Newton Raphson Method of Load Flow.
6. Solution of static load flow equation using Fast Decoupled Load Flow Method of Load Flow.
7. Find the steady state/transient stability of the system for various disturbances in power system.
8. Find critical clearing time using equal area criterion.
9. Solution of swing equation using step by step method.
10. Find the penalty factor for the given system.

Masters of Engineering
Course Code: EE3101
Course Name: Power System Analysis

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Perform load flow analysis using Gauss-Seidel, Newton-Raphson, Fast decoupled and DC power flow methods.
CO-2	Formulate bus impedance matrix using building algorithm and apply for short circuit studies.
CO-3	Analyze the power system for contingency.
CO-4	Analysis of Power System Stability.
CO-5	Analyze the power system for state estimation.
CO-6	Understanding the concept of Voltage Stability.

List of Open Source Software/learning website:
1. E-materials available at the website of NPTEL- http://nptel.ac.in/
2. MATLAB (Trial version): Software is useful for simulation and analysis of electrical systems.

References used for designing a course:

1. GTU
2. AICTE

Masters of Engineering
Course Code: EE3102
Course Name: Power Converters and Applications

Shroff S.R. Rotary Institute of Chemical Technology

Semester: I

Type of Course: Program Core Course-II

Prerequisite: Power Electronics – I, Power Electronics – II

Rationale: The power electronic devices and converters employing power electronics devices are now widely used in domestic applications as well as in industrial applications like Electrical Drives, Power Systems, Renewable Energy based power generation, heating applications etc. The course is designed to provide exposure of power electronic converters and their operation and control.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Course Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Semiconductor Devices:** Review of Semiconductor devices like Power BJT, SCR, MOSFET, IGBT, GTO, MCT; Static and dynamic characteristics of these devices; Single quadrant, Two quadrant and bid-directional switches.	6
2	**AC-DC Converters:** Single phase and three phase half wave and full wave, 1-phase and 3- phase half controlled and fully controlled converters, Analysis with R & RL load, Performance parameters for converters,, Operation in continuous and dis-continuous mode, Reactive power considerations, Operation in conversion and inversion mode, Effect of source inductance, Power factor improvement techniques, Dual Converters, Applications.	5
3	**Switching Voltage Regulators:** Introduction; Linear power supply (voltage regulators); Switching voltage regulators; Review of basic dc-dc voltage regulator configurations - Buck, Boost, Buck-Boost converters and their Analysis and design for continuous and discontinuous mode; C'uk converter, Sepic Converter, Applications.	7

Masters of Engineering
Course Code: EE3102
Course Name: Power Converters and Applications

SECTION-B		
4	**DC-AC converters/Inverters:** Classification; Review of line commutated inverters, Concept of Unipolar and Bipolar PWM, 120° and 180° conduction mode of inverter, Sine-triangular PWM, Effect or carrier frequency on the harmonics, Space Vector Pulse Width Modulation, Other PWM techniques, Current Source Inverters, Impedance source inverter, Applications.	**6**
5	**Three phase AC voltage controllers and Cycloconverters:** **AC voltage controllers:** Review of On-off and phase control; Single phase full wave controllers and their analysis with resistive loads; Three phase full wave controllers, Analysis with R-load, Three phase bidirectional delta-connected controllers **Cycloconverters:** single-phase to single-phase Cycloconverter, 3-phase to 1-phase cycloconverter, 3-phase to 3-phase Cycloconverter circuits; circulating current operation; non-circulating current operation; mean output voltage and harmonics in supply current waveform	**6**
6	**Driver circuits, protection and other design considerations:** Preliminary design considerations for power electronic converters; DC coupled drive circuits with unipolar and bipolar outputs; Importance of isolation in driver circuits; Electrically isolated drive circuits; Some commonly available driver chips; Cascade connected drive circuits; Thyristor drive circuits; Protection in driver circuits; Blanking circuits for bridge inverters.	**6**

Text Books:

1. Dr. D. M. Patel, “Power Electronics”, Atul Prakashan, 2021
2. J. S. Katre, “Power Electronics”, Tech Knowledge Publication, 2020.

Reference Books:

1. Mohan, Undeland and Robbins, “Power Electronics – Converters, Applications and Design”, John Willey & sons, Inc., 3rd ed., 2003.
2. M. H. Rashid, “Power electronics: circuits, devices, and applications”, Pearson Education India, 2009.
3. P.S. Bimbhra, “Power Electronics”, Khanna Publishers, New Delhi, 2012.

List of Practical: (Min. 10 Practical should be performed):

1. To design and analyze the single phase controlled rectifier circuit for R load.
2. To design and analyze the single phase controlled rectifier circuit for R-L load.
3. To design and analyze the three phase controlled rectifier circuit for R load.
4. To design and analyze the three phase controlled rectifier circuit for R-L load.
5. To design the Buck Converter for Continuous Conduction Mode of Operation.
6. To design the Boost Converter for Continuous Conduction Mode of Operation.
7. To plot the output voltage profile of 3-phase inverter in 180^0 conduction mode of operation.
8. To plot the output voltage profile of 3-phase inverter in 120^0 conduction mode of operation.
9. To design the single phase AC voltage converter circuit for variable AC output.

10. To design the three phase AC voltage converter circuit for variable AC output.
11. To design driver circuits/firing circuits for power electronic devices/converters.

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	**Ability** to analyze the characteristics of Power electronics devices and to determine the suitable device for a particular application.
CO-2	**Analyze** and operate DC-DC converters, phase controlled converters, inverters and AC to AC converters.
CO-3	**Illustrate** operation, design and control of DC to DC converters.
CO-4	**Recognize** the need of PWM techniques in inverter operation.
CO-5	**Analyze**, operate and design of Cycloconverters & AC Voltage Regulators.
CO-6	**Ability** to design of driver, protection and control circuits for power electronic devices.

List of Open Source Software/learning website:

1. cw.mit.edu/courses/electrical.../6-334-power-electronics-spring-2007
2. Courses available through NPTEL - website: https://nptel.ac.in

References used for designing a course:

1. AICTE Model Curriculum-Jan 2018
2. GTU

Masters of Engineering
Course Code: EE3103
Course Name: AI Techniques

Shroff S.R. Rotary Institute of Chemical Technology

Semester: I

Type of course: Professional Elective I

Prerequisite: Knowledge of computer programming.

Rationale: This course provides detailed concepts of various Artificial Intelligence Techniques which can be useful in solving the problems of Electrical Engineering.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA(I)	
3	1	0	4	70	30	0	0	100

Course Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Introduction The AI Problems, The Underlying Assumption, What is An AI Techniques? Difference between soft computing techniques and hard computing systems, Expert systems brief history of ANN, Fuzzy and GA.	**4**
2	Artificial Neural Networks Transient system model, Introduction, History of neural network research, Basic concepts of Neural Networks, Human brain, Model of Artificial Neuron, Neural Network architectures, Perceptron, Single layer feed forward Network, Multi layer feed forward network, recurrent networks, Feedback networks and Radial Basis Function Networks, Characteristics of NN, Learning Methods, LMS and Back Propagation Algorithm, training Examples of models, Advances in Neural networks	**6**
3	Fuzzy Logic Introduction, Comparison between Fuzzy and crisp logic, Fuzzy sets, Membership function, Basic fuzzy set operations, properties of Fuzzy set, fuzzy relations, Fuzzy interference system, Mamdani, Sugeno, Fuzzy rule based system, Defuzzification methods, Fuzzy Neural Networks	**6**

Masters of Engineering
Course Code: EE3103
Course Name: AI Techniques

	SECTION-B	
4	Genetic Algorithm Working principles, difference between GA and traditional methods, Different types of coding methods, Fitness function, different types GA operators 1. Roulette wheel selection 2. Stochastic remainder Roulette wheel selection , Rank selection, Tournament selection and stochastic universal sampling, Different types of cross over methods in GA, Mutation, Schema theorem, elite preserving operator, GA's for constrained optimization, understating of working of GA using flow chart	**8**
5	Optimization Techniques Differential Evolution Algorithm, Particle swarm optimization Algorithm – Basics and Applications.	**4**
6	Applications Applications of Above Techniques in power systems operation and control for solving problem of Load forecasting, voltage control, voltage stability, security assessment, feeder load balancing, AGC, Economic load dispatch, Unit commitment. Condition monitoring.	**4**

Text Books:

1. J M Zurada , "An Introduction to ANN",Jaico Publishing House.
2. Simon Haykins, "Neural Networks", Prentice Hall .
3. Artificial intelligence techniques in power systems by Kevin warwick, Arthur Ekwue Raj Agrawal.

Reference Books:

1. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic: Theory and Applications, Prentice Hall.
2. Neural Networks, Fuzzy logic and Genetic algorithms By S. Rajasekaran, G. A. Vijayalakshmi Pai PHI publication.

List of Practical: (Min. 10 Practical should be performed): NA

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Analyze how Different Soft computing techniques can be used for solving the problems of power systems operation and control.
CO-2	Design of ANN based systems for function approximation used in load forecasting.
CO-3	Design of Fuzzy based systems for load frequency control in power systems.
CO-4	Understand the operators of Genetic Algorithm (GA); Distinguish Evolutionary Program (EP) & GA.
CO-5	Analyze various optimization Techniques.
CO-6	Solve problem of Optimization in power systems.

Masters of Engineering
Course Code: EE3103
Course Name: AI Techniques

List of Open Source Software/learning website:

1. MATLAB (Trial version): Software is useful for simulation and analysis
2. https://onlinecourses.nptel.ac.in/noc18_cs13

References used for designing a course:

1. GTU
2. AICTE

Masters of Engineering

Course Code: EE3103

Course Name: AI Techniques

Master of Engineering
Course Code: EE3104
Course Name: Neural Networks & Fuzzy Logic

Shroff S.R. Rotary Institute of Chemical Technology

Semester: I

Type of course: Program Elective-I

Prerequisite: Fundamentals of Control System

Rationale:
The objective of this course is to present sufficient background in both fuzzy and neural network so that students in future can pursue advanced soft computing methodologies. This course combines knowledge, techniques, and methodologies from various sources, using techniques from neural networks and fuzzy set theory, As an extension, the course uses the Neuro Fuzzy models for the complex engineering problems.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	1	0	4	70	30	0	0	100

Course Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Introduction to Artificial Neural Network:** Artificial neural networks and their biological motivation: Terminology, Models of neuron, Topology, characteristics of artificial neural networks, types of activation functions; learning methods: error correction learning, Hebbian learning, Perceptron: XOR Problem, Perception learning rule convergence theorem; Adaline.	06
2	**Feedforward and Recurrent Neural Networks** Architecture: perceptron model, solution, single layer artificial neural network, multilayer perceptron model; back propogation learning methods, effect of learning rule co-efficient ;back propagation algorithm, factors affecting backpropagation training, applications; Recurrent neural networks: Linear auto associator – Bi-directional associative memory – Hopfield neural network.	06
3	**Fuzzy Logic & Fuzzy Sets:** Introduction to Fuzzy Logic, Classical and Fuzzy Sets, Membership Function ,Membership Grade, Universe of Discourse, Linguistic Variables, Operations on Fuzzy Sets: Intersections, Unions, Negation, Product, Difference, Properties of Classical set and Fuzzy sets, Fuzzy vs Probability, Fuzzy Arithmetic, Fuzzy Numbers.	06

Master of Engineering
Course Code: EE3104
Course Name: Neural Networks & Fuzzy Logic

SECTION-B		
4	**Fuzzy Relations & Aggregations:** Essential Elements of Fuzzy Systems, Classical Inference Rule, Classical Implications and Fuzzy Implications, Crisp Relation and Fuzzy Relations, Composition of fuzzy relations, Cylindrical Extension and Projection. Fuzzy IF-THEN rules, Inference: Scaling and Clipping Method, Aggregation, Fuzzy rule based Model: Mamdani Model, TSK model, Fuzzy Propositions, Defuzzification: MOM, COA	**06**
5	**Fuzzy Optimization:** Fuzzy optimization –one-dimensional optimization and its applications	**03**
6	**Neuro Fuzzy Systems:** Introduction of Neuro-Fuzzy Systems, Architecture of Neuro Fuzzy Networks and its applications	**03**

Text Books:

1. Ross, Timothy J. Fuzzy logic with engineering applications. John Wiley & Sons, 2009.
2. Yegnanarayana, B. Artificial neural networks. PHI Learning Pvt. Ltd., 2004.

Reference Books:

1. Zurada, Jacek M. Introduction to artificial neural systems, West St. Paul, 1992.
2. Hagan, Martin T., Howard B. Demuth, and Mark H. Beale. Neural network design. Boston: Pws Pub., 1996.
3. Haykin, Simon. Neural networks: a comprehensive foundation. Prentice Hall PTR, 1994.
4. Passino, Kevin M., and Stephen Yurkovich. Fuzzy control. Vol. 42. Menlo Park, CA: Addison-Wesley, 1998.

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Identify and describe Fuzzy Logic and Artificial Neural Network techniques in building intelligent machines
CO-2	Apply Artificial Neural Network models to handle uncertainty and solve engineering problems.
CO-3	Apply Fuzzy Logic models to handle uncertainty and solve engineering problems.
CO-4	Apply Fuzzy Rule base models to handle uncertainty and solve engineering problems.
CO-5	Apply fuzzy optimization techniques for engineering problems.
CO-6	Recognize the feasibility of applying a Neuro-Fuzzy model for a particular problem.

Master of Engineering
Course Code: EE3104
Course Name: Neural Networks & Fuzzy Logic

List of Open Source Software/learning website:

1. https://nptel.ac.in/courses/neural network

References used for designing a course:

1. SGT University, Gurugram-Neural Networks & Fuzzy Logic

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Masters of Engineering
Course Code: EE3105
Course Name: Power Quality

Shroff S.R. Rotary Institute of Chemical Technology

Semester: I

Type of course: Program Elective- II

Prerequisite: Power Electronics, Power Systems, Measurement and Instrumentation

Rationale: Quality of power can have direct impact on many industrial consumers. There has recently been a great emphasis on revitalizing industry with more automation and more modern equipment. Changing power system regulations and increased use of nonlinear devices have made power quality (PQ) a highly important issue. The short duration transient disturbances, along with the stationary harmonics have become very common due to the increased use of power electronic switches. Both utility and consumers are equally responsible for poor power quality and hence power quality parameter need to be monitored, assessed and mitigated based on data acquired. This course would make the students aware about the various issues affecting the power quality as well as techniques available to improve the quality of power.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA(I)	
3	0	2	4	70	30	30	20	150

Course Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Introduction to Power Quality Introduction-power quality-voltage quality-overview of power Quality phenomena classification of power quality issues, Power quality measures and standards-THD-TIF-DIN-C-message weights, Responsibility of supplier and users of elect power Quality ,Susceptibility Criteria, Flicker factor transient phenomena-occurrence of power quality problems, Power Quality Standards and recommended practices such as; IEEE 519, IEEE 1159-2009, IEC 61000-4-30 etc.	6
2	Transient Disturbances Modelling of networks and components under non-sinusoidal conditions, Transmission and distribution systems, Transient system model, Examples of models & response, Types and causes of transients, Examples of transient wave forms	6

Masters of Engineering
Course Code: EE3105
Course Name: Power Quality

3	Harmonics Harmonics-individual and total harmonic distortion, Triplen harmonics, effect of harmonic distortion, Causes and Effects of harmonics, Important harmonic introducing devices; SMPS, three phase power converters, arcing devices, saturable devices, other nonlinear loads, Guide lines for harmonic voltage & current limitation, Harmonic Signatures of Non-linear Loads; fluorescent lamps, LED lamps, controlled & uncontrolled rectifiers, etc.	**6**
SECTION-B		
4	Harmonic Mitigation Harmonic Filters, Devices for Controlling Harmonic Distortion, Standards of Harmonics, Active Harmonic Filters, Passive Harmonic Filters, Types, Ac network impedance, Design of filters – single tuned, double tuned & damped filter, filter component ratings, Dynamic Voltage Restorers for sag, swell and flicker problems	**7**
5	Power Factor Improvement Effects of poor Power Factor, Power factor penalty, voltage rise due to capacitance, Power factor improvement- Passive Compensation, Passive Filtering, Harmonic Resonance, Impedance Scan Analysis, Active Power Factor Corrected Single Phase Front End, Control Methods for Single Phase APFC, Three Phase APFC and Control Techniques, PFC based on Bilateral Single Phase and Three Phase Converter.	**7**
6	Grounding & Bonding Grounding and wiring introduction, NEC grounding requirements-reasons for grounding, Typical grounding and wiring problems solutions to grounding and wiring problems, Ground electrodes, Earth resistance tests, Earth ground grid system, Power Ground system, Signal reference ground and methods	**4**

Text Books:

1. G.T. Heydt, “Electric power quality”, McGraw-Hill Professional, 2007
2. Math H. Bollen, “Understanding Power Quality Problems”, IEEE Press, 2000

Reference Books:

1. J. Arrillaga, “Power System Quality Assessment”, John wiley, 2000
2. C. Sankaran, “Power quality”, CRC Press, 2002

List of Practical: (Min. 10 Practical should be performed):

1. Evaluate the impact of various non-linear loads on utility by using simulation software.
2. Analysis of input current in rectifier with and without capacitor at output of rectifier.
3. Harmonics analysis of input current in induction motor with and without load.
4. Power Factor improvement by using passive filter.
5. Determine input displacement and true power factor in non-linear load.
6. Comparison of input power factor in case of AC- DC converter.
7. Transient Response Analysis of RLC circuits.
8. Simulate phenomena of flickering in house hold applications
9. Simulate the phenomena of voltage sag due to sudden starting of large induction motor.
10. Design and simulate a passive filter for harmonic damping

Masters of Engineering
Course Code: EE3105
Course Name: Power Quality

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Acquire knowledge about the harmonics, harmonic introducing devices and effect of Harmonics on system equipment and loads
CO-2	Develop analytical modeling skills needed for modeling
CO-3	Analyse of harmonics in networks and components
CO-4	Learn active power factor correction based on static VAR compensators And its control techniques
CO-5	Introduce series and shunt active power filtering techniques for harmonics
CO-6	Understand different parameters for earthing and grounding

List of Open Source Software/learning website:

1. http://nptel.ac.in
2. https://pqs.schaffner.com/

References used for designing a course:

1. AICTE
2. GTU
3. PDPU

Masters of Engineering
Course Code: EE3106
Course Name: Switch mode Power Converters

Shroff S.R. Rotary Institute of Chemical Technology

Semester: I

Type of course: Program Elective- II

Prerequisite: Power Electronics Converters and Applications

Rationale: Starting from the basic configurations and the operating principle, various aspects related to the design of SMPS like selection of components, design of magnetic components, stability study, control strategies, protection etc. are covered in this subject. Thus, the subject is intended to provide the needed information and theory for understanding and design of switching power supplies.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Course Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Review of Basic SMPS topologies: Linear regulator versus SMPS, Buck, Boost, Buck-Boost SMPS Topologies, Basic Operation-Waveforms - modes of operation -switching stresses, Switching and conduction losses, Optimum switching frequency, Practical voltage, current and power limits - design relation, Voltage mode control principles.	6
2	Isolated converters: Push-Pull converter: Basic operation, Waveforms, Flux imbalance problem, coping with flux imbalance, transformer design, output filter design, switching stresses and losses, output filter design Forward Converter: Configuration, Basic operation and analysis, waveforms, voltage mode control, forward converter magnetics, transformer design, output filter design, double-ended and interleaved forward converters	6
3	Half and Full Bridge Converters: Basic Operation and Waveforms. Magnetics, Output Filter, Blocking capacitance for coping up flux imbalance, power limit Flyback converter: Configuration, basic operation, and waveforms, discontinuous and continuous mode of operation, flyback magnetics, design relations and sequential steps for design, control strategy	6

Masters of Engineering

Course Code: EE3106

Course Name: Switch mode Power Converters

SECTION-B		
4	Resonant Converters: Classification of Resonant Converters. Basic Resonant Circuit Concepts, Load Resonant Converter, Resonant Switch Converters, Zero Voltage Switching Clamped Voltage Topologies, Resonant DC Link Inverters with Zero Voltage Switching. High Frequency	**6**
5	Current Mode Control of SMPS. Current Mode Control Advantages, Current Mode Vs Voltage Mode, Current Mode Deficiencies, Slope Compensation, Comparison of performance of various configurations for voltage control and current control modes of operation, Study of a typical Current Mode PWM Control	**6**
6	Design Considerations: EMI Generation and Filtering in SMPS - Conducted and Radiated Emission Mechanisms in SMPS, Techniques to reduce Emissions, Shielding and Grounding, Power Circuit Layout for minimum EMI, EMI Filtering at Input and Output, Effect of EMI Filter on SMPS Control, Power factor correction and chips for power factor correction	**6**

Text Books:

1. Abraham I Pressman, "Switching Power Supply Design,". McGraw Hill Publishing Company,2001
2. Daniel M Mitchell, "DC-DC Switching Regulator Analysis," McGraw Hill Publishing Company-1988.

Reference Books:

1. L. Umanand and S. Bhat, "Design of Magnetic Components for Switched Mode Power Converters", New Age International Ltd., New Delhi, 2001
2. M. K. Kazimierczuk, 'Pulse-width Modulated DC–DC Power Converters', John Wiley and Sons, 2008

List of Practical: (Min. 10 Practical should be performed):

1. Study of basic topologies of DC-DC Converters.
2. To design transformer for forward converter/fly-back converter/ push-pull converter/ half bridge converter/ full bridge converter
3. Study of series loaded resonant converter in various operating modes
4. Study of parallel loaded resonant converter in various operating modes
5. Study of ZCS converter
6. Study of ZVS converter
7. Modelling of dc-dc converter (like buck, boost, buck-boost) and to study the frequency response for the transfer functions
8. Develop closed loop control of buck/boost converter in voltage mode control.
9. Develop closed loop control of buck/boost converter in current mode control.
10. Develop PWM circuit using SG3525/TL494 Integrated circuit.

Masters of Engineering
Course Code: EE3106
Course Name: Switch mode Power Converters

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Understand different topologies of SMPS.
CO-2	Analyze non-isolated and isolated hard-switched DC-DC converters.
CO-3	Design the control scheme for voltage-controlled and current controlled dc-dc converters.
CO-4	Design the soft-switched converters with a view to minimize the switching losses and stresses.
CO-5	Analyze various configurations for voltage control and current control modes of operation.
CO-6	Design the filters, magnetic components and protection circuits for SMPS.

List of Open Source Software/learning website:

1. http://nptel.ac.in
2. https://powersimtech.com

References used for designing a course:

1. AICTE
2. GTU
3. PDPU

Masters of Engineering
Course Code: MH3101
Course Name: Research Methodology

Shroff S.R. Rotary Institute of Chemical Technology

Semester: I

Type of course: Research Methodology and IPR
Prerequisite: Research interest and eagerness to learn new things and invent novel ideas into practical reality.

Rationale: The purpose of this subject is to orient the students to the scientific methodology of research and presenting their thesis. Student will learn to present and defend the problem and the solution he/she has found, in a simple and easy manner. During the process of learning students will also learn to use proper technical language, refine the content and articulation part that can be presentable in a unified manner.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	0	2	00	00	30	20	50

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1.	**Introduction research, research methodology & research gaps** What is research? Types of research. What is not research? How to read a Journal paper? Identify specific requirements for evaluation/review and what constitutes completion of your work, Find where the source is available Learn to Critique existing knowledge and how to find the gap.	6
2.	**Defining the research Problem** Understand what the key aspects of your problem statement should be Examples of effective and ineffective Titles, identify problem and experimental/theoretical data for comparison with your model, Learn how to extrapolate/scale data for validation, Find what acceptable level of error and justification thereof	6

Masters of Engineering
Course Code: MH3101
Course Name: Research Methodology

3.	**Learning from Literature Search** Differentiate between journals, conferences, books, magazines and their Quality, Understand how to establish their quality and authenticity, Finding Information, Identify main ideas in scholarly literature, Write notes to organize your ideas.	4
	SECTION-B	
4.	**Report writing, Writing Skills and Presentation Steps** How to write Report, How to write a research paper? Problem Identification and solving, Developing a Research Proposal, Format to write research proposal, How to review and finalize your work	4
5.	**Intellectual Property** Process of Patenting and Development: Technological research Innovation, patenting, development, National and International Scenario, International cooperation on Intellectual Property.	2
6.	**Patent Rights** Scope of Patent Rights. Licensing and transfer of technology, Patent information and databases. Geographical Indications. Case studies on: IPR of Biological Systems, Computer Software etc.	2

Text Books

1. Kothari, C. K. "Research Methodology: Methods and Techniques", New Age Internationals, 2004.

Reference Books:

1. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
2. Mayall, "Industrial Design", McGraw Hill, 1992.
3. Niebel, "Product Design", McGraw Hill, 1974.
4. Asimov, "Introduction to Design", Prentice Hall, 1962.
5. Robert P. Merges, Peter S. Menell, Mark A. Lemley, "Intellectual Property in New TechnologicalAge", 2016.
6. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

Course Outcome:

At the end of the course the students should be able to:

Sr. No.	CO statement
CO-1	To brief and outline a quality literature review and find the research gap
CO-2	To discuss on Problem Statement & its Validation
CO-3	To demonstrate on literature search, how to prepare the key points and organize research ideas
CO-4	To formulate and develop the Writing Skills and Presentation Steps in an effective manner in written or in spoken form
CO-5	To describe on Intellectual Property rights and analyze principles on National and International Scenario.

Masters of Engineering

Course Code: MH3101

Course Name: Research Methodology

CO-6	To illustrate on IPR protection and Patent Right

List of Open-Source Software/learning website:

- NPTEL lecture series

Masters of Engineering
Course Code: MH3102
Course Name: Disaster Management

Shroff S.R. Rotary Institute of Chemical Technology

Semester: I

Type of course: Audit Course-I

Prerequisite: To provide students an exposure to disasters, their significance, types Comprehensive understanding on the concurrence of Disasters and its management.

Rationale: To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention, risk reduction and the basic understanding of the research methodology for risk reduction measures. Equipped with knowledge, concepts, and principles, skills pertaining to Planning, Organizing, Decision- making and Problem solving methods for Disaster Management.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
L	T	P	C	Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
2	0	0	0	30	20	0	0	50

Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Introduction Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.	04
2	Repercussions of Disasters And Hazards: Economic Damage, Loss of Human And Animal Life, Destruction of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks of Disease And Epidemics, War And Conflicts	04
3	Disaster Prone Areas In India Study of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster DiseasesAnd Epidemics.	04

Masters of Engineering
Course Code: MH3102
Course Name: Disaster Management

SECTION-B		
4	Disaster Preparedness And Management Preparedness: Monitoring of Phenomena Triggering A Disaster Or Hazard; Evaluation of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness, Emergency Stage, Post Disaster stage-Rehabilitation. Remedy to Disasters, Role of panchayats in disaster mitigations	04
5	Risk Assessment Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies for Survival.	04
6	Disaster Mitigation Meaning, Concept And Strategies of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs of Disaster Mitigation In India.	04

Text book

1. Disaster Education and Management, A joyride for students, Teachers andDisaster managers by Rajendra Kumar Bhandari, Springer

Reference Books:

1. Disaster Science and Management by Bhattacharya,T., Mc-Graw Hill.
2. Understanding Earthquake Disasters by Sinvhal, A., Mc-Graw Hill.
3. Environmental Geography by Singh, S., Prayag Pustak Bhawan.
4. Disaster Management by Gupta, H.K., University Press.
5. Disaster Mitigation Experiences And Reflections by Sahni, Pardeep, Prentice Hall OfIndia, New Delhi.
6. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company
7. Goel S. L. , Disaster Administration And Management Text And Case Studies" ,Deep &Deep Publication Pvt. Ltd., New Delhi

Masters of Engineering
Course Code: MH3102
Course Name: Disaster Management

Course Outcomes:

After Learning this Course, Students will be able to:

Sr. No.	CO statement
CO-1	Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations
CO-2	Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response
CO-3	Understand Disaster management and Risk Reduction measures.
CO-4	Apply the concepts in real life scenario.
CO-5	Identify the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in
CO-6	Classify understanding of key concepts in disaster risk reduction and humanitarian response

List of Open Source Software/learning website:

- http://nptel.ac.in/

Master of Engineering
Course Code: EE3107
Course Name: Dynamics of Electrical Machines

Shroff S.R. Rotary Institute of Chemical Technology

Semester: II

Type of course: Program Core Course

Prerequisite: Fundamentals of Electrical Machine I & II

Rationale: This course provides detailed concepts of various Artificial Intelligence Techniques which can be useful in solving the problems of Electrical Engineering.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA(I)	
4	0	0	4	70	30	00	00	100

Course Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Brushless DC Machines:** Construction and working principle, Equivalent magnetic circuit, Type of converter and speed control, Comparison between the axial and radial permanent magnet motors, applications.	6
2	**Switched Reluctance Motor:** Construction, operating performance, Type of converter and speed control, applications.	6
3	**Stepper Motors:** Definition and types of stepper motors, Various modes of operation of Variable reluctance (VR) stepper motors, Micro stepping control of stepper motor, Multi stack VR stepper motor construction and working, , Torque-angle characteristics of the stepper motor.	6
	SECTION-B	
4	**Energy Efficient motors:** Standard motor efficiency, concept of Energy efficient motor. Efficiency evaluation technique, Comparison, motor efficiency labeling, Energy efficient motor standards. Motor life cycle, Direct Savings and pay back analysis, Efficiency evaluation factor.	6
5	**Reference frame theory**: Introduction, Equation of transformation, stationary circuit variables transformed to the arbitrary reference frame- commonly used reference frames-transformation between reference frames, transformation of a balanced set, balanced steady state phasor relationships, balanced steady state voltage equations, variables observed from several frames of reference..	10

6	**Wind mill Generator:** Comparison with synchronous generator, constant voltage & frequency generation, reactive power compensation.	**2**

Text Books:

1. Analysis of electric machinery and drive systems, Second edition, Wiley interscinece- Paul C.Krause, Oleg Wasynnczuk, and S.D. Sudhoff
2. "Electric Machinery", TMH Publication, 2002- A. E. Fitzerald, Charles Kingsley and Stephen D Umans

Reference Books:

1. "Brushless Permanent-Magnet Motor Design", Mcgraw Hill- D. C. Hanselman
2. "Alternating Current Machines" (ELBS publication) - M.G.Say
3. Wind Electrical Systems By Bhadra, Kastha & Benerajee (OXFORD Higher Education)

List of Practical: (Min. 10 Practical should be performed): NA

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Understand the concept and working of advanced electrical machines.
CO-2	Apply Advanced AC circuit Theory to analyze and design an electrical machine.
CO-3	Identify analyses and evaluate power conversion and control techniques to interface with an electrical machine.
CO-4	Gain knowledge of the different characteristics of Special Electrical machines for certain applications.
CO-5	Analyze various Techniques used in advanced electrical machines.
CO-6	Solve problems of BLDC, SRM and other advanced motors.

List of Open Source Software/learning website:

1. MATLAB (Simulink): Software is useful for simulation and analysis
2. NPTEL

References used for designing a course:

1. GTU Curriculum

Master of Engineering
Course Code: EE3108
Course Name: Advanced Control System

Shroff S.R. Rotary Institute of Chemical Technology

Semester: II

Type of course: Program Core Course

Prerequisite: Basic courses on Control System of UG level.

Rationale: Automatic control of industrial processes is essential for increasing the output and in turn the profit of an industry. As a result, most of the companies are using automatic control of the machineries and processes. As an engineer, a student must know the basics of automatic control system. This subject is intended to supplement the basic skill of an engineer.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA(I)	
2	0	2	3	70	30	30	20	150

Course Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Linear Spaces & Linear Operators: Review of vectors & matrices, Limitations of classical control theory; Axiomatic treatment of Field, Vector, Vector Space; Linear combination, Linear Independence, The notion of bases; Linear function/map/operator & its matrix representation, Scalar product of vectors; Quadratic functions & definite, semi-definite matrices, Gram determinant; vector & matrix norms; Rank & Nullity of a matrix; Eigenvalues, Eigenvectors & Canonical form representation of linear operators; Generalized Eigen vectors.	**8**
2	State Variable Descriptions: The concept of State: initial state, definition of state, state vector, trajectory, Consistency conditions, State Transition Relation or State Equation; State equations for dynamic discrete-time system; Time invariance; Linearity; State model for linear systems, Nonuniqueness of State model; State diagrams for linear time-invariant continuous-time & discretetime systems.	**8**
3	Physical System & State Assignment: Linear continuous time models of electrical, mechanical, hydraulic, electromechanical systems (illustrative problems). State variable representation using Phase variables, Observable Phase variable form, Controllable phase variable form, State space representation using Canonical variable or Normal form.	**8**

Master of Engineering
Course Code: EE3108
Course Name: Advanced Control System

	SECTION-B	
4	Controllability and Observability: Concept of Controllability and Observability; Kalman's Theorems on Controllability and Observability, Alternative Tests (Gilbert's Method) of Controllability and Observability; Principle of Duality; Relationship among Controllability, Observability and Transfer Function.	**8**
5	Liapunov Stability Analysis : Stability of Equilibrium State in the Sense of Liapunov; Graphical Representation of Stability; Asymptotic Stability and Instability; SignDefiniteness of Scalar Function; Second Method of Liapunov; Stability Analysis of Linear Systems; Krasovski's Theorem; Liapunov Function Based on Variable Gradient Method.	**8**
6	State Feedback Control Design: Design of Robust Control Systems; State Feedback Control-Pole Placement Design, State Feedback with Integral Control.	**8**

Text Books:

1. Modern Control Engineering, Fourth Edition, Prentice Hall, 2001- Katsuhiko Ogata.
2. Automatic Control Systems, High Education Press, 2003- B. C. Kuo.
3. Control Systems Engineering, Fifth Edition, New Age International Publishers, 2007- L. J. Nagrath & M. Gopal.

Reference Books:

1. Modern Control Systems, Sixth Edition, Addison-Wesley, 1993- Rich.
2. Manjitha Srivastava et. al., "Control Systems", TMH.

List of Practical: (Min. 10 Practical should be performed):

1. Determine transpose, inverse values of given matrix using MATLAB.
2. Find the rank, determinant, Eigen values, Eigen vector, trace and ortho-normal of the same matrix.
3. To design, implement and study the effects of different cascade compensation networks for a given system.
4. To study the performance characteristics of a d.c. motor speed control system.
5. State space model for classical transfer function using MATLAB
6. To check controllability of a control system using MATLAB.
7. To check Observibility of a control system using MATLAB.
8. Design of pole placement of a feedback system. .
9. Design of State Feedback with Integral Control.
10. Analysis of State Feedback with Integral Control.

Master of Engineering
Course Code: EE3108
Course Name: Advanced Control System

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Understanding linear space and liner operators of control system.
CO-2	Estimate Different Control models for Continuous Time Systems using Classical Control mechanisms and State Space Analysis.
CO-3	Analyze the physical system and state assignment of a control system.
CO-4	Apply controllability & observability tests to different system models.
CO-5	Analyze linear and non-linear systems using Lyapunov theorems and Design Lyapunov function for stable systems.
CO-6	Design a control system via pole assignment and observer using state feedback.

List of Open Source Software/learning website:
1. E-materials available at the website of NPTEL- http://nptel.ac.in/
2. MATLAB (Trial version): Software is useful for simulation and analysis of electrical systems.

References used for designing a course:

1. GTU
2. AICTE

Master of Engineering
Course Code: EE3109
Course Name: Restructured Power System

Shroff S.R. Rotary Institute of Chemical Technology

Semester: II

Type of course: Program Core Course - V

Prerequisite: Power System Analysis

Rationale: The restructuring of power industry has changed the way of operation of the power systems. Along with the secured and reliable operation of power systems, the economic efficiency has become an equally important consideration. Unlike the knowledge of conventional operation of power systems, understanding the restructured power systems requires basic knowledge of electrical engineering, power systems, and also the economics. This course is intended to provide a comprehensive treatment towards understanding of the new dimensions associated with the operation of power systems.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA(I)	
2	0	0	2	70	30	0	0	100

Course Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Introduction to restructuring of power industry:** Reasons for restructuring of power industry; Understanding the restructuring process, Entities involved, The levels of competition, The market place mechanisms, Sector-wise major changes required; Reasons and objectives of deregulation of various power systems across the world.	5
2	**Fundamentals of Economics**: Consumer and suppliers behavior, Total utility and marginal utility, Law of diminishing marginal utility, Elasticity of demand and supply curve, Market equilibrium, Consumer and supplier surplus, Global welfare, Deadweight loss .	4
3	**The Philosophy of Market Models:** Monopoly model, Single buyer model, Wholesale competition model, Retail competition model, distinguishing features of electricity as a commodity, Four pillars of market design, Cournot, Bertrand and Stackelberg competition model.	5

Master of Engineering
Course Code: EE3109
Course Name: Restructured Power System

SECTION-B		
4	**Transmission Congestion Management:** Transfer capability, Importance of congestion management, Effects of congestion, Classification of congestion management methods, ATC, TTC,TRM, CBM,ATC calculation. using DC and AC model, Nodal pricing, Locational Marginal Prices (LMPs), Implications of nodal pricing, Price area congestion management Capacity alleviation methods, Redispatching, Counter-trade, Curtailment .	**5**
5	**Power Trading:** Type and Classification of ancillary services, Sources of reactive power, Provisions of ancillary services, Markets for ancillary services, Introduction to transmission pricing, Principles of transmission pricing, Classification of transmission pricing, Electricity markets under imperfect competition Sources of market power, Effect of market power, Identifying market power.	**5**
6	**Reforms in Indian power sector:** Framework of Indian power sector, Reform initiatives during 1990-1995, The availability based tariff (ABT), The Electricity Act 2003, Open Access issues, Power exchange.	**4**

Text Books:

1. Fundamentals of Power System economics Daniel Kirschen and Goran Strbac, John Wiley & Sons Ltd, 2004 (for chapter 1,2,3 &5)
2. Power system restructuring and deregulation by Loi Lei Lai ,Wiley India.
3. Operation of restructured power systems by Kankar Bhattacharya, Jaap E. Daalder , Math Bollen, Springer publication,2001.

Reference Books:

1. Making competition work in electricity Sally Hunt, John Wiley & Sons, Inc., 2002

List of Practical: (Min. 10 Practical should be performed): NA

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Acquire the knowledge of the new dimensions associated with the power system and fundamentals of microeconomics.
CO-2	Differentiate the various operating mechanism between conventional and restructured power system.
CO-3	Discover various power markets and market architectural aspects
CO-4	Identify issues related to Efficient pricing and usage of the transmission network and generation entity in the power market operation.
CO-5	Analyze availability based tariff (ABT) & the Electricity Act 2003.
CO-6	Evaluate Markets for an ancillary services & transmission pricing.

Master of Engineering
Course Code: EE3109
Course Name: Restructured Power System

List of Open Source Software/learning website:

1. Bhanu Bhushan, ABC of ABT, Available online: www.nrldc.org
2. R. G. Yadav, A. Roy, S. A. Khaparde and P. Pentayya, India's fast growing power sector, IEEE Power and Energy Magazine, July / August 2005.
3. S. A. Khaparde and A. K. Sardana, Powering progress, IEEE Power and Energy Magazine, July / August 2007
4. www.nrldc.org
5. www.wrldc.org
6. www.iexindia.com
7. The Electricity Act 2003, Available Online: www.powermin.nic.in
8. www.pjim.com

References used for designing a course:

1. GTU Curriculum

Master of Engineering

Course Code: EE3110

Course Name: Renewable Energy System

Shroff S.R. Rotary Institute of Chemical Technology

Semester: II

Type of course: Program Elective III

Prerequisite: Knowledge of Basic Electrical Engineering

Rationale: The objective of this course is to provide basic understanding of the upcoming technology of renewable energy systems and to have an overall understanding of energy systems. To provide exposure to different aspects like policy, design control and grid integration of renewable energy systems. The students will be able to find the reasonableness of the use of renewable energy after comparing the available resources.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	0	3	70	30	00	00	100

Course Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Introduction of Renewable Energy (RE) :** Environmental consequences of fossil fuel use, Importance of renewable sources of energy, Needs of renewable energy, advantages and limitations of RE, present energy scenario of conventional and RE sources in India and worldwide. Comparison between renewable energy and non- renewable energy	4
2	**Solar Energy System:** Solar radiation and related terms, measurement of solar radiation, Instruments for solar radiation measurements. Conversion of Solar energy into Electricity, Advantages and disadvantages of Solar PV Energy, Solar PV Electrical Power Generation system (SPV), Components and Different configurations of SPV system and Stand-Alone and Grid Connected SPV system, Other Miscellaneous Applications of Solar Energy.	8
3	**Wind Energy system :** Wind Energy Conversion, Potential, Nature of the wind, Site selection, Types of wind turbines, basic components of wind energy conservation system (WECS), classification of WECS, advantages and disadvantages of wind energy, applications of wind energy wind energy potential and installation in India.	6

Master of Engineering

Course Code: EE3110

Course Name: Renewable Energy System

	SECTION-B	
4	**Bio Energy System:** Biomass and its conversion technology, biomass gasification, types and applications of gasifiers, Biogas & its types of plant. Advantages and disadvantages of Bio energy, Application of Bio energy	**6**
5	**Geothermal & Wave Energy System:** Resources, types of wells, methods of harnessing the energy, Advantages and disadvantages, Application of geothermal energy, potential in India, Basics of wave motion, Power in waves, Wave energy conversion devices, Advantages and disadvantages, Applications of wave energy.	**6**
6	**Hydrogen Energy System:** Hydrogen as a renewable energy source, Sources of Hydrogen, Fuel for Vehicles. Hydrogen Production processes: Thermal, electrolysis, Solar driven and Biological, Storage of Hydrogen, Application of Hydrogen energy system.	**6**

Text Books:

1. Renewable energy resources: Tiwari and ghosal, Narosa publication.
2. Non-Conventional Energy Sources. G.D.Ray, Khanna Publications.

Reference Books:

1. Non Conventional Energy Systems: K M. Mittal, A H Wheeler Publishing Co Ltd.
2. Non-conventional energy resources, Shobh Nath Singh, Pearson India
3. Solar Energy: Principles of Thermal Collection and Storage, S. P. Sukhatme and J. K. Nayak, McGrawHill Education
4. Biomass Energy, Oxford &IBH Publication Co.
5. Twidell and Wier, Renewable Energy Resources, CRC Press (Taylor and Francis).
6. C.S. Solanki, Renewal Energy Technologies: A Practical Guide for Beginners PHI Learning.

Master of Engineering

Course Code: EE3110

Course Name: Renewable Energy System

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	To Understand the Need, importance and scope of renewable energy resources
CO-2	To understand role significance of solar energy in the energy generation.
CO-3	To provide importance of Wind Energy.
CO-4	To get the utilization of Biogas plants and biomass energy
CO-5	To learn the importance of Geothermal & Wave Energy System:
CO-6	To understand the role of Hydrogen fuel in the Energy Generation

List of Open Source Software/learning website:

- https://www.NPTEL video lectures.
- https://nise.res.in/
- https://niwe.res.in
- https://mnre.gov.in/

References used for designing a course:

1. GTU Curriculum

Masters of Engineering
Course Code: EE3111
Course Name: Advanced Power System Stability

Shroff S.R. Rotary Institute of Chemical Technology

Semester: II

Type of Course: Program Elective

Prerequisite: Fundamentals of Electrical Power System, Electrical Machines.

Rationale: This course is focused on different types of substations in power system. Modelling stability (Steady state, Transient, Dynamic and small signal type) of power system components analysis are covered in this course.

Teaching and Examination Scheme:

Teaching Scheme				Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	I (V)	E (V)	
3	0	0	3	70	30	00	00	100

Course Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Introduction to power system stability problems:** Definition of stability, classification of stability, Rotor angle stability, frequency stability, voltage stability, mid-term and long-term stability, classical representation of synchronous machine in a single machine infinite bus system (SMIB), equal area criterion to asses stability of a SMIB system, limitations of classical model of synchronous machines.	**06**
2	**Modeling of power system components for stability analysis:** Synchronous machine modeling: sub-transient model, two axis model, one axis (flux decay) model, classical model. Excitation systems modeling: DC excitation, AC excitation and static excitation. Prime mover and energy supply systems modeling. Transmission line modeling, load modeling. Methods of representing synchronous machines in stability analysis.	**06**
3	**Small signal stability:** Fundamental concepts, state space representation, Modal analysis: eigen properties, participation factors, stability assessment. Effects of excitation system on stability, power system stabilizer and its design, Angle and voltage stability of multi-machine power systems and phenomenon of sub synchronous resonance.	**06**
	SECTION-B	
4	**Transient stability:** Fundamentals of transient stability, numerical solutions: simultaneous implicit and partitioned explicit methods, simulation of dynamic response, analysis of unbalanced	**06**

	faults, direct method of transient stability, transient energy function method, Methods of improving transient stability.	
5	**Voltage stability:** Classification of voltage stability, modeling requirements, voltage stability analysis: static and dynamic, sensitivity analysis, modal analysis, voltage collapse, prevention of voltage collapse	**06**
6	**Sub-Synchronous Resonance in Power System:** Turbine-generator torsional characteristic, torsional interactions with power system, sub-synchronous resonance, characteristics of series compensated transmission system, IG and TI effect, analytical methods and mitigation techniques for SSR.	**06**

Text Books:

1. "Power System Stability and Control" by P. Kundur, Tata McGrow Hill.

Reference Books:

1. "Power System Dynamics" by K. R. Padiyar, BSP publications.
2. "Power system stability" by M. A. Pai and Peter W. Sauer, Pearson Education.

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Model synchronous machines for stability analysis.
CO-2	Model excitation systems and loads for stability analysis
CO-3	Classify power system stability and apply develop linearized model of SMIB system to analyzed small-signal stability of power systems.
CO-4	Analyze transient behavior of SMIB and multi-machine power system with application of large disturbances.
CO-5	Develop static and dynamic methods for voltage stability analysis and propose measures to enhance voltage stability of power system.
CO-6	Investigate sub-synchronous resonance (SSR) in power system and propose techniques for its mitigation.

List of Open Source Software/learning website:

1. http://www.allaboutcircuits.com/

References used for designing a course:

1. https://nptel.ac.in/courses/108106026
2. https://sot.pdpu.ac.in/electrical-dept.html

Masters of Engineering
Course Code: EE3112
Course Name: HVDC & FACTS

Shroff S.R. Rotary Institute of Chemical Technology

Semester: II

Type of course: Program Elective-IV

Prerequisite: Fundamentals of Power Systems and Power Electronics

Rationale:
Electrical Power systems are heavily loaded because of the increase in the demand and restructured power system operation. The technical solution of utilizing available power system structure to deliver more power is using the power electronics devices in power systems for reactive power compensation and HVDC. The other uses of power electronics devices in the distribution and at consumer levels are also inevitable. The more and more use of power electronics devices in the power systems at every stage increases the problem of power quality. The course is aimed to provide exposure about power quality; the commonly used power electronics based compensating devices, its impact on Power Quality and Various power quality mitigation techniques.
Teaching and Examination Scheme:

Teaching Scheme				Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	E (V)	P (I)	
3	0	2	4	70	30	30	20	150

Course Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Power Quality** Introduction, Importance of Power Quality, Common Disturbances in Power Systems, Short-Duration Voltage VARiation, Long-Duration Voltage VARiations, Transients, Impulsive Transients, Oscillatory Transients, Voltage Imbalance, Harmonics, Inter harmonics, DC Offset, Notching, Noise, Voltage Fluctuations, Power Frequency VARiations, Solutions to Power Quality Problems, Ambiguous Terms CBEMA and ITI Curves, Features of Voltages in Power Systems, Grounding, Ground Electrodes, Ground Rods, Ground Rings, Plates Signal Reference Ground (SRG), Single-Point and Multipoint Grounding, Ground Loops, Isolated Ground, Electrochemical Reactions Due to Ground Grids, Reactive Power in Power Systems with Harmonic Distortion, Single-Phase Systems, Reliability, Power Quality Data Collection .	06
2	**Static VAR Compensators** Introduction, Different Static VAR Compensators, Increase in Transient Stability Margin, Damping of Power Oscillations, Voltage Support, Static VAR Compensator Systems Versus	09

Masters of Engineering

Course Code: EE3112

Course Name: HVDC & FACTS

	Synchronous Condensers, Capacitors, and Reactors, Shunt and Series Compensation, Fundamentals of Load Compensation, Reactive Power Relationships Between Wye- and Delta-Connected Systems, Static VAR Compensators for Transmission Systems, SVC Using a TCR and an FC, SVC Using a TCR and TSC, STATCOM (SVC Using Self-Commutated Inverters), SVC Using a Saturated Reactor (SR), Comparison of Static VAR Systems, Specification of SVCs, FACTS Technology, Types of FACTS Controllers, Series Controllers, Shunt Controllers, Combined Series and Shunt Controllers, Case Study, Importance Three Phase Power Flow Studies for PQ.	
3	**Control of Static VAR Compensators:** Introduction, Control Systems for SVCs in Transmission System Applications, Voltage Regulation, Gain Supervision, Reactive Power Control and Coordination, Control Signals for System Transient Stability, Power Oscillation Damping, and Sub synchronous Resonance Damping Enhancement, Control Systems for SVCs in Traction Applications, Load Compensation, Voltage Regulation and Balancing, Measurement of Sequence Components, Phase-Locked Oscillator Control System.	**06**
SECTION-B		
4	**Harmonics:** Introduction, Converter Harmonics, Effect of Transformer Connections, Harmonics When There Is Overlap in the Commutation Process, Direct-Voltage Harmonics, Imperfect System Conditions, Single-Phase Power Supplies, DC Drives, AC Drives, Pulse-Width Modulation (PWM Introduction, Undesirable Effects of the Harmonics, Specification of the Harmonic Limits, Philosophical Differences between IEEE 519-1992 and IEC 61000-Series Standards, IEEE 519-1992, IEC 61000-Series Standards.	**06**
5	**HVDC Transmission**: The State of Art Introduction, Historical Developments, Comparison of AC and DC Transmission (Economics, Technical Performance and Reliability). Application of DC Transmission, Types of HVDC Systems, Limitations of HVDC Transmission lines, Components of a HVDC system, Line Commutated Converter and Voltage Source Converter based HVDC Systems. Stability Enhancement Using HVDC Control Basic Concepts: Power System Angular, Voltage and Frequency Stability. Power Modulation: basic principles – synchronous and asynchronous links. Voltage Stability Problem in AC/DC systems.	**06**
6	**Multi Terminal HVDC System Introduction**: Types of Multi-terminal HVDC System, Parallel Operation of HVDC, Control of Power in MTDC, Disconnecting of units or converters, Modern Trends in HVDC Technology. Introduction to Modular Multi-level Converters.	**04**

Masters of Engineering
Course Code: EE3112
Course Name: HVDC & FACTS

Text Books:

1. Power Quality by C.Sankaran, CRC publication
2. K. R. Padiyar, "HVDC Power Transmission Systems", New Age International Publishers, 2011.

Reference Books:

1. Electrical Power Systems Quality by Roger C.Dugan , TMH publication
2. Harmonics and Power Systems by Francisco C. De La Rosa, CRC Publication

List of Practical: (Min. 10 Practical should be performed):

1) Study and calculation of THD and IHD of VARious types of non-linear loads
2) Power factor improvement using static VAR compensators
3) Measurement of current harmonics using current probe
4) Measurement of high frequency noise with oscilloscopes having high sampling rates
5) Measurement of true RMS value of voltage and current using true RMS meters
6) Measurement of magnetic and electric field using low frequency electromagnetic field meter
7) Study of harmonic distortion limits in agreement with IEEE 519
8) Study of power quality monitoring standards such as IEEE 1159 and IEC 61000-4-30
9) MATLAB for simulation of harmonics generated by non-linear loads.
10) Study of VARious HVDC transmission system components and its applications

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Explain VARious Power Quality terms of Electrical Power System
CO-2	Analyze the application of Static VAR Compensators for reactive power compensation in power systems.
CO-3	Analyze the causes of Harmonics, its effect on VARious equipment and its mitigation techniques
CO-4	Analyze the harmonic Standards in power systems.
CO-5	Understand the advantages of dc transmission over ac transmission.
CO-6	Evaluation of Power system angular, voltage and frequency stability using simulation models for VARious configuration of an HVDC system.

Masters of Engineering
Course Code: EE3112
Course Name: HVDC & FACTS

List of Open Source Software/learning website:

1. https://nptel.ac.in/courses/108106025

References used for designing a course:

1. GTU Sem 7 Power Quality & FACTS , HVDC
2. SVNIT Power Quality Issues.

Master of Engineering
Course Code: EE3113
Course Name: Advanced Microcontrollers and Applications

Shroff S.R. Rotary Institute of Chemical Technology

Semester: II

Type of Course: Program Elective Course-IV

Prerequisite: Fundamentals of basic Microcontroller

Rationale: The power electronic devices and converters employing power electronics devices are now widely used in domestic applications as well as in industrial applications like Electrical Drives, Power Systems, Renewable Energy based power generation, heating applications etc. The course is designed to provide exposure of power electronic converters and their operation and control.

Teaching and Examination Scheme:

Teaching Scheme			Credit	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Course Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	Basic Computer Organization • Accumulator based Processes-Architecture • Memory Organization-I/O Organization.	**6**
2	Micro-Controllers-Intel 8051, • Intel 8051- Registers, Memories • I/O Ports, Serial Communication • Timers, Interrupts, Programming, Intel 8051 – Assembly language programming • Addressing-Operations • Stack & Subroutines • Interrupts-DMA	**5**
3	PIC 16F877- Architecture Programming • Interfacing Memory/ I/O Devices • Serial I/O and data communication.	**7**

Master of Engineering
Course Code: EE3113
Course Name: Advanced Microcontrollers and Applications

SECTION-B		
4	Digital Signal Processor (DSP) • Architecture – Programming • Introduction to FPGA.	**6**
5	Microcontroller development for motor control applications • Stepper motor control using microcontroller	**6**
6	Introduction of Advanced Microcontrollers: STM32F10C8T6 controller (ARM cortex-M3, ATmega328, PIC16F877A controller, DSP 320F28335 Controller.	**6**

Text Books:

1. Kenneth J. Ayala, "The 8051 microcontroller", Cengage Learning, 2004
2. John Morton," The PIC microcontroller: your personal introductory course", Elsevier, 2005

Reference Books:

1. Raj Kamal: "The Concepts and Features of Microcontrollers", Wheeler Publishing, 2005
2. Microchip datasheets for PIC16F877.

Dogan Ibrahim," Advanced PIC microcontroller projects in C: from USB to RTOS with the PIC18F Series", Elsevier, 2008

List of Practical: (Min. 10 Practical should be performed):

1. To study basic computer organization.
2. To study architecture of 8051 microcontroller.
3. To study various addressing modes of 8051 microcontroller.
4. To study interrupts of 8051 microcontroller.
5. Write 8051 microcontroller program to perform basic arithmetic and logical operations.
6. Write 8051 microcontroller program for subroutine.
7. To study architecture of 16F877 microcontroller.
8. To study architecture of Digital Signal Processor.
9. To study basics of FPGA.
10. To develop microcontroller based application using appropriate software tool.
11. To interface microcontroller with external device/equipment for controlling purpose.

Master of Engineering
Course Code: EE3113
Course Name: Advanced Microcontrollers and Applications

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	**Describe** the operations of microprocessor architecture 8051, PIC, DSP etc..
CO-2	**Understand** the concepts of advanced microcontrollers.
CO-3	**Experimenting** the different type of programing techniques of advanced controller.
CO-4	**Integrating** the I/O of microcontroller with external devices.
CO-5	**Validating** the concepts to developing real time applications using 8051 & DSP
CO-6	**Design** advanced microcontroller based circuits.

List of Open Source Software/learning website:

1. keil (Student version freeware)
2. http://www.8051projects.net/microcontroller-tutorials/
3. http://www.intorobotics.com/8051-microcontroller-programming-tutorials-simulatorscompilers-and-programmers

References used for designing a course:

1. GTU Curriculum

Master of Engineering

Course Code: EE3114

Course Name: Electric & Hybrid Vehicles

Shroff S.R. Rotary Institute of Chemical Technology

Semester: II

Type of course: Open Elective I

Prerequisite: Basic knowledge of power electronics and motor control

Rationale: The objective of this course is to provide basic understanding of the upcoming technology of electric and hybrid vehicles and to provide exposure to different aspects like sizing, design and control of drives used for hybrid and electric vehicle.

Teaching and Examination Scheme:

Teaching Scheme				Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	MSE (M)	I (V)	E (V)	
2	0	0	2	70	30	00	00	100

Course Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	History of hybrid and electric vehicles Social and environmental importance of hybrid and electric vehicles Impact of modern drive-trains on energy supplies Basics of vehicle performance, vehicle power source Characterization Transmission characteristics Mathematical models to describe vehicle performance.	5
2	Basic concept of hybrid traction, Introduction to various hybrid drive-train topologies Power flow control in hybrid drive-train topologies Fuel efficiency analysis.	4
3	Introduction to electric components used in hybrid and electric vehicles Configuration and control of DC Motor drives Configuration and control of Introduction Motor drives Configuration and control of Permanent Magnet Motor drives Configuration and control of Switch Reluctance Motor drives, drive system efficiency.	5
	SECTION-B	
4	Matching the electric machine and the internal combustion engine (ICE) Sizing the propulsion motor, sizing the power electronics. Selecting the energy storage technology Communications, supporting subsystems.	5

5	Battery Parameters, types of batteries, Schematics of hybrid drive train, control architecture Regenerative braking in EVs.	**4**
6	Introduction to energy management and their strategies used in hybrid and electric vehicle Classification of different energy management strategies Comparison of different energy management strategies Implementation issues of energy strategies Vehicle to grid and grid to vehicle.	**5**

Text Books:

1. Mehrdad Ehsani, Yimin Gao, Ali Emadi "Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals Theory and Design", CRC Press, Taylor and Francis group, FL, USA, 2nd ed., 2010.

2. Iqbal Hussain, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, FL, USA, 2011.

Reference Books:

1. Ali Emadi, "Advanced Electric Drive Vehicles", CRC Press, FL, USA, 2015.
2. Michael Nikowitz, "Advanced Hybrid and Electric Vehicles: System Optimization and Vehicle Integration", Springer International Publishing, 2016.
3. James Larminie and John Lowry "Electric Vehicle Technology Explained", John Wiley and Sons, 2nd ed., 2014.Biomass Energy, Oxford &IBH Publication Co.

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Demonstrate knowledge about fundamental concepts, principles, analysis and design of hybrid and electric vehicles.
CO-2	To define the functionality and working principles of different types of hybrid and electric vehicles.
CO-3	To illustrate the working of various Power Electronics Converters for hybrid and electric vehicles.
CO-4	To explain vehicle fundamentals of various subsystem & energy management.
CO-5	To illustrate the working of motors and conversions.
CO-6	Design and simulate electric drives used in hybrid and electric vehicles / traction.

Master of Engineering

Course Code: EE3114

Course Name: Electric & Hybrid Vehicles

List of Open Source Software/learning website:

- Courses available through NPTEL.
- MultiSim
- PSim
- Matlab (Simulink)
- ORCAD

References used for designing a course:

1. GTU Curriculum

PG Degree Engineering
Course Code: EE3115
Course Name: Economics of Energy Generation & Supply

Shroff S.R. Rotary Institute of Chemical Technology

Semester: II

Type of Course: Open Elective

Prerequisite: Fundamentals of Electrical Power System, Electrical Power Generation.

Rationale: This course is focused on learning of economics of energy generation. Basic modelling of economics of conventional and nonconventional energy supply systems are covered in this course.

Teaching and Examination Scheme:

Teaching Scheme				Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	I (V)	E (V)	
2	0	0	2	70	30	00	00	100

Course Content:

Sr. No.	Content	Total Hrs.
	SECTION-A	
1	**Energy Scenario:** Energy sources, global & Indian energy scenario, energy sector reforms, energy and environment, energy conservation, energy security	06
2	**Energy Demand analysis and forecasting:** Evolution of Demand Analysis, Overview of Energy Demand Decisions, Economic Foundations of Energy Demand, Alternative Approaches for Energy Demand Analysis, Factor Analysis, Econometric Approach, energy demand forecasting techniques – econometric approach, End-Use Method, Input–Output Model, Scenario Approach, Artificial Neural Networks, Hybrid Approach	06
3	**Energy Demand Management:** Demand-side management (DSM) – evolution, justification, load management – direct & indirect load control, energy efficiency – opportunities & economics, cost effectiveness of DSM – participant test, ratepayer impact measure, total resource cost test, utility cost test	06
4	**Economics of Fossil Fuel Supply:** Introduction, Field Development, Production, Economics of Fossil Fuel Production, Supply Forecasting	06
5	**Economics of Electricity Supply:** Basic Concepts, Economic Dispatch, Unit Commitment, Investment Decisions	06
6	**Economics of Renewable Energy Supply:** Renewable Energies for Electricity Generation, Drivers of Renewable Energy, Economics	06

PG Degree Engineering
Course Code: EE3115
Course Name: Economics of Energy Generation & Supply

Text Books:

1. "Energy Resources, Economics and Environment" by Prof. Rangan Banerjee, IIT Bombay, 2019.

Reference Books:

1. "Guide to Energy Management" by B. L. Capehart and W. C. Turner, Fairmont Press & CRC Press, 2012.
2. "Handbook of Energy Engineering" by A. Thumann and D. P. Mehta, Edward Elgar Publishing Limited, 2011.

Course Outcomes:

Students will be able to:

Sr. No.	CO statement
CO-1	Understand the concepts of energy management.
CO-2	Forecast energy demand.
CO-3	Study the demand side energy management.
CO-4	Analyze economics of Fossil fuel supply.
CO-5	Enumerate economics of electricity supply.
CO-6	Understanding economics of renewable energy supply.

List of Open Source Software/learning website:

1. E-materials available at the website of Bureau of Energy Efficiency: http://beeindia.in/content.php?page=miscellaneous/useful_download.php

References used for designing a course:

1. https://archive.nptel.ac.in/courses/109/101/109101171/
2. https://archive.nptel.ac.in/courses/108/105/108105058/

Masters of Engineering
Course Code: MH3104
Course Name: Energy Audit

Shroff S.R. Rotary Institute of Chemical Technology

Semester: II

Type of course: Audit Course-II

Prerequisite: Basic Electrical Engineering.

Rationale: The course provides basic understanding of energy audit. The consumption of energy is increasing day by day. One way to cope up with the increase in energy demand is to increase the production of energy which demands more investment and the other way is to conserve the energy because energy conserved/saved is energy generated. Energy conservation means reduction in energy consumption but not compromising with the quality or quantity of energy production. Essential theoretical and practical knowledge about the concept of energy conservation, energy management, different approaches of energy conservation in industries, economic aspects of energy conservation project and energy audit and measuring instruments in commercial and industrial sector will be achieved by this course.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE (E)	PA (M)	ESE (V)	PA (I)	
0	0	2	0	00	0	30	20	50

Content:

Sr. No.	Content	Total Hrs.
1	To Study Energy Scenario of World and India	2
2	To Study Various instruments used in Energy Audit	2
3	To understand Energy Conservation Act	2
4	To find out efficiency of Transformer	4
5	To Find out efficiency of Electric Motor	4
6	To Study Illumination system	2
7	To Study assessment of Capacitor	2
8	To Study Harmonics	2
9	To study and assessment of DG Set	2
10	To understand Electricity Bill	2

Masters of Engineering
Course Code: MH3104
Course Name: Energy Audit

Reference Books:

1. Energy Audit and Management, Volume-I, IECC Press
2. Energy Efficiency in Electrical Systems, Volume-II, IECC Press
3. Energy Management: W.R.Murphy, G.Mckay, Butterworths Scientific
4. Energy Management Principles, C.B.Smith, Pergamon Press
5. Industrial Energy Conservation, D.A. Reay, Pergammon Press
6. Energy Management Handbook, W.C. Turner, John Wiley and Sons, A Wiley Interscience
7. Industrial Energy Management and Utilization, L.C. Witte, P.S. Schmidt, D.R. Brown, Hemisphere Publication, Washington, 1988
8. Hand Book of Energy Audits, Albert Thumann, P.E., C.E.M. William J. Younger, C.E.M., CRC Press

Course Outcomes:
Upon completing the course, the student will be able to

Sr. No.	CO statement
CO-1	Understand recent scenario worldwide and India energy
CO-2	To apply the knowledge of energy audit for the energy management and operation of energy audit instruments.
CO-3	Learn Energy conservation act and it implementation in electric system
CO-4	Assess the energy saving & conservation in different electric system and equipments
CO-5	Assess electricity bill and tariff
CO-6	Prepare energy performance report of electric equipments

List of Open-Source Software/learning website: NA