COURSE STRUCTURE

M. TECH.

POWER ELECTRONICS & POWER SYSTEMS

Under

Choice Based Credit System (CBCS)

Ref: RU/FET/EE/BOS/2020/001 **Dated: 20/04/2020**

Faculty of Engineering & Technology

Department of Electrical Engineering

Minutes of Meeting

Boards of Studies

A meeting of Boards of Studies of Electrical Engineering, FET was held on 20/04/2020 (Monday) at 2:30 PM. in conference room of FET. The following members were present:

1. Mr. Amit Kumar Singh - Chairperson
3. Ms. Abhishek Mishra - Member
3. Mr. Dileep Kumar - Member

The following members agreed to review the minutes in Delhi.

1. Prof. N.C. Sarkar - External Member
2. Mr. Anurodh Singh - External Member

In view of the existing pandemic of Covid-19, all social distancing norms were observed.
The External Expert, Dr. Vishal Awasthi agreed to join the proceedings online via Zoom app.

Agenda:

1. Action Taken Report (ATR) on Minutes of Previous Meeting.

The BOS committee confirmed the minutes of the BOS meeting held on 27/04/2019.

2. To review Result analysis.

The Board reviewed the result analysis and found it to be acceptable but need more improvements.

3. To consider and approve the panel of Examiners for Theory and Practical Examinations for PG courses for academic session 2020-2021.

The members consider the proposed lest of examiners for Theory and Practical Examinations of PG courses for academic session 2020-2021 and Recommended for approval by the Academic Council with suggestion that the members authorized the chairman BOS to change the examiner as per need. List of Examiners is attached.

4 . Review of the existing program and their curricula

S. No.	Item No.	Existing	Recommendation /Action Taken
1	Revised Syllabus of P.G Course in Power Electronic & Power System as per CBCS system admitted in session 2020-21	Marks Based Evaluation System	The BOS discussed the item and Recommended for approval the revised syllabus of P.G Course Power Electronic & Power System which is designed as per CBCS system. Curriculum and Syllabus are attached.

5. **Recommendation on New Courses/ Short term training**

S. No.	Item No.	Feedback from Faculty/Student	Recommendation /Action Taken
1	To review the Short Term Courses of Electrical system Design.	To consider the feedback of Faculty member and students A short term course is proposed.	The Board reviewed the Short Term Courses and recommended for approval by the Academic Council with following suggestion • The learning content of the course shall be in electronic form • Demo videos shall be recorded for as much content as possible • The Faculty shall use a LMS like Moodle or any other suitable platform for delivering the Course • The hands-on lab training part shall be scheduled in way that crowding is avoided

			• Evaluation (except where laboratory exercises are involved) shall be conducted online. The Ordinance of the STCs have been sent to Dean-Academics for formal approval.
2.	To consider and approved the new PG course M.Tech (Part Time) in Power System & Power Electronic to start from academic session 2020-2021.	To consider the feedback of Faculty member, Industry, alumni and students. A new PG course M.Tech (Part Time) in Power System & Power Electronic to start from academic session 2020-2021. is proposed.	The BOS discussed about the Curriculum and Syllabus for M.Tech (Part Time) in Power System & Power Electronic which is designed as per CBCS system and Recommended for the approval by the academic council for academic session 2020-2021. Curriculum and Syllabus are attached. The Ordinance of the new PG course M.Tech (Part Time) in Power System & Power Electronic to start from has been sent to Dean-Academics for formal approval.

The meeting concluded with a vote of thanks to the chair.
Date of the Next Meeting: to be decided and conveyed later

Amit
(Chairman)

CC:
1. Dean
2. Registrar Office

Program Educational Objectives (PEO's):

PEO$_1$- To produce electrical power Electronic & Power Systems post graduates, who are employable in public and private industries/ Institutes/Organization, or pursue higher education.

PEO$_2$- To prepare graduates who have the ability to identify and address current and future problems in the domain of power systems, power electronics and electrical machines.

PEO$_3$- To inculcates research attitude and lifelong learning among graduates.

PEO$_4$- Students should be able to acquire knowledge for realizing it into gainful employment or entrepreneurship being useful to the societal needs.

Program specific outcomes (PSOs):

PSO $_1$- Students will be proficient in designing, developing and analyzing the power converters and their applications.

PSO $_2$- Students will be expertise in state-of-art simulation tools and real-time control platforms and exposure to multidisciplinary collaborative research works to emphasis their skills to attain key positions in research centers and industry or to emerge as entrepreneur.

PSO $_3$- Students will be able to assimilate in depth knowledge in power industry to obtain optimal solutions to complex problems.

PSO $_4$- Students are imbibed with ethical and social responsibilities in their professional endeavors.

Program Outcomes (PO's):

POs are defined for the program is aligned with the graduate attributes as follows:

PO-1: Acquire in-depth knowledge in the domain of power Electronic & Power systems or professional area with an ability to discriminate, evaluate, analyze and synthesize existing and new knowledge.

PO-2: Ability to critically analyze various power Electronic & Power systems components, models and their operation.

PO-3: Ability to apply fundamentals and concepts to analyze, formulate and solve complex problems of electrical power Electronic & Power systems and its components.

PO-4: Apply advanced concepts of electrical power engineering to analyze, design and develop electrical components, apparatus and systems and to put forward scientific findings at national and international levels.

PO-5: Ability to use advanced techniques, skills and modern scientific and engineering tools for professional practice.

PO-6: Preparedness to lead a multidisciplinary scientific research team and communicate effectively.

PO-7: Demonstrate and apply knowledge and understanding of engineering principles for project management.

PO-8: To motivate exploring ideas and to encourage for independent, reflective and lifelong learning.

PO-9: The in-depth education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context.

PO-10: Ability to contribute to the community for sustainable development of society.

PO-11: Ability to learn from mistakes without depending on external feedback.

MAPPING OF PEO WITH PO

Program Educational Objectives (PEO)	Program Outcomes(PO)										
	1	2	3	4	5	6	7	8	9	10	11
1	√	√	√	√	√	√	√		√	√	
2	√	√	√	√	√	√	√				
3								√	√	√	
4	√	√		√	√			√	√	√	√

First Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HRS/WK
			L	T	P	CA	MTE	ETE			
1.	MEE-101	Power System Operation & Control	3	1	0	30	20	100	150	4	5
2.	MEE-102	Advanced Power System Analysis	3	1	0	30	20	100	150	4	5
3.	MEE-103	Advanced Power Electronics	3	1	0	30	20	100	150	4	5
4.	MEE-104	Digital Control System	3	1	0	30	20	100	150	4	5
		PRACTICALS									
5.	MEE-151	Power System Lab	0	0	4	-	20	30	50	2	2
6.	MEE-152	Power Electronics Lab	0	0	4	-	20	30	50	2	2
		TOTAL	**12**	**4**	**8**	**120**	**120**	**460**	**700**	**20**	**24**

Second Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HRS/WK
			L	T	P	CA	MTE	ETE			
1.	MEE-201	Power System Protection	3	1	0	30	20	100	150	4	5
2.	MEE-202	Advanced Electrical Machines	3	1	0	30	20	100	150	4	5
3.	MEE-203	HVDC Transmission	3	1	0	30	20	100	150	4	5
4.	MEE 011 to MCS 014	Departmental Elective-I	3	1	0	30	20	100	150	4	5
PRACTICALS											
6.	MEE-251	Electrical Machine Lab	0	0	4	-	20	30	50	2	2
7.	MEE-252	Advance Machine Lab	0	0	4	-	20	30	50	2	2
		TOTAL	12	4	8	120	120	460	700	20	24

Third Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HRS/WK
			L	T	P	CA	MTE	ETE			
1.	MEE 024 to MEE 027	Departmental Elective-II	3	1	0	30	20	100	150	4	5
2.	MEE 037 to MEE 040	Departmental Elective-III	3	1	0	30	20	100	150	4	5
PRACTICALS											
3.	MEE 301	Project/Seminar	0	0	16	-	200	300	500	12	6
		TOTAL	**6**	**2**	**16**	**60**	**240**	**500**	**800**	**20**	**16**

Fourth Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HRS/WK
			L	T	P	CA	MTE	ETE			
PRACTICALS											
3.	MEE 451	Dissertation	0	0	24	-	200	600	800	20	10
		TOTAL	**0**	**0**	**24**	**00**	**200**	**600**	**800**	**20**	**10**

Program Core

S. NO.	CODE	SUBJECT	TEACHING SCHEME				EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HR/WK	PRE- REQUISITES
			L	T	P	J	CA	MTE	ETE				
THEORY													
1.	MEE-101	Power System Operation & Control	3	1	0	0	30	20	100	150	4	5	
2.	MEE-102	Advanced Power System Analysis	3	1	0	0	30	20	100	150	4	5	
3.	MEE-103	Advanced Power Electronics	3	1	0	0	30	20	100	150	4	5	
4.	MEE-104	Digital Control System	3	1	0	0	30	20	100	150	4	5	
5.	MEE-201	Power System Protection	3	1	0	0	30	20	100	150	4	5	
6.	MEE-202	Advanced Electrical Machines	3	1	0	0	30	20	100	150	4	5	
7.	MEE-203	HVDC Transmission	3	1	0	0	30	20	100	150	4	5	
PRACTICALS													
8.	MEE-151	Power System Lab	0	0	4	0	-	20	30	50	2	2	
9.	MEE-152	Power Electronics Lab	0	0	4	0	-	20	30	50	2	2	
10.	MEE-251	Electrical Machine Lab	0	0	4	0	-	20	30	50	2	2	
11.	MEE-252	Advance Machine Lab	0	0	4	0	-	20	30	50	2	2	
		Total	**21**	**7**	**16**	**0**	**210**	**220**	**820**	**1250**	**36**	**43**	

Program Elective

S. NO.	CODE	SUBJECT	TEACHING SCHEME				EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HR/WK	PRE-REQUISITES
			L	T	P	J	CA	MTE	ETE				
Bouquet: Elective I													
THEORY													
1.	MEE 011	EHVAC Transmission	3	1	0	0	30	20	100	150	4	5	
2.	MEE 012	Applied Instrumentation	3	1	0	0	30	20	100	150	4	5	
3.	MEE 013	Distributed Generation	3	1	0	0	30	20	100	150	4	5	
4.	MEE 014	Power Electronics for Renewable Energy Systems	3	1	0	0	30	20	100	150	4	5	

Program Elective

S. NO.	CODE	SUBJECT	TEACHING SCHEME				EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HR/WK	PRE-REQUISITES
			L	T	P	J	CA	MTE	ETE				
Bouquet: Elective II													
THEORY													
1.	MEE 024	Energy Management and Audit	3	1	0	0	30	20	100	150	4	5	
2.	MEE 025	Microprocessor & their Application	3	1	0	0	30	20	100	150	4	5	
3.	MEE 026	FACTS Devices	3	1	0	0	30	20	100	150	4	5	
4.	MEE 027	SCADA Systems and Applications	3	1	0	0	30	20	100	150	4	5	

Program Elective

S. NO.	CODE	SUBJECT	TEACHING SCHEME				EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HR/WK	PRE-REQUISITES
			L	T	P	J	CA	MTE	ETE				
Bouquet: Elective III													
THEORY													
1.	MEE 037	Advanced Electrical Drives	3	1	0	0	30	20	100	150	4	5	
2.	MEE 038	Non Conventional Energy Systems	3	1	0	0	30	20	100	150	4	5	
3.	MEE 039	Energy Efficient Machines	3	1	0	0	30	20	100	150	4	5	
4.	MEE 040	Power Quality	3	1	0	0	30	20	100	150	4	5	

Projects

S. NO.	CODE	SUBJECT	TEACHING SCHEME				EVALUATION SCHEME			TOTAL MARKS	CREDITS	CONTACTS HR/WK	PRE-REQUISITES
			L	T	P	J	CA	MTE	ETE				
PRACTICALS													
1.	MEE 301	Project/Seminar	0	0	16	0	-	200	300	500	12	6	
2.	MEE 451	Dissertation	0	0	24	0	-	200	600	800	20	10	
TOTAL			**0**	**0**	**40**	**0**	**-**	**400**	**900**	**1300**	**32**	**0**	

MEE-101: POWER SYSTEM OPERATIONS AND CONTROL

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:

The course is designed to meet with the objectives of:

1. To understand the electrical power plant operation and control.
2. To know the importance of compensation & compensating techniques in power system.

Detail Contents:

Unit-I: Economic operation: **8 Hours**

Load forecasting-Method of last square curve fit-unit commitment-constraints in unit commitment solution methods-The economic dispatch problem of thermal units-Gradient method-Newton's method-Base point and participation factor method-Unit commitment versus economic dispatch.

Unit -II: Hydro-thermal co-ordination: **8 Hours**

Hydroelectric plant models-scheduling problems-short term hydrothermal scheduling problem gradient approach-Hydro units in series pumped storage hydro plants hydro scheduling using Dynamic programming and linear programming.

Unit -III: Automatic generation control (A.G.C.): **8 Hours**

Review of LFC and economic dispatch control (EDC) using the three modes of control viz. Flat frequency- tie-line control and tie-line bias control-AGC implementation-AGC features static and dynamic response of controlled two area system.

Unit -IV: MVAR control power system security: **8 Hours**

MVAR control–voltage monitoring-application of voltage regulator-synchronous condenser-transformer taps–static VAR compensators-Thyristor switched capacitors-Thyristor controlled reactors. Power system security: Factors affecting system security contingency analysis-linear sensitivity factors-AC power flow methods-contingency selection-concentric relaxation-bounding-security constrained optimal power flow- interior point algorithm-bus incremental costs.

Unit -V: Inventory Control: **7 Hours**

Inventory, Cost, Deterministic Models, Introduction to supply chain management. Quality Control: Process control, SQC, Control charts, Single, Double and Sequential Sampling, Introduction to TQM.

Course Learning Outcomes (CLO):

Students successfully completing this module will be able to:

1. Identify and explain the different methods of generation, distribution, control and compensation involved in the operation of power systems.
2. Design the mathematical models of the mechanical and electrical components.
3. Solve the problems related to the economic dispatch of power, plant scheduling, and unit commitment.

Test Books:-

1. Allen J. Wood and Brace F Wollenberg, " Power Generation Operation and C ontrol", John Willey & Sons.
2. O.I. Elgerd, "Electric Energy S ystem Theory: - An Introduction", TMH.

Reference Books:-

1. L.K. Krichmayer, "Economic Operation of Power Systems", Jo hn Willey & Sons, N.Y.
2. E.L. Grant, "Principles of Engineering Economy", Ronald Press, N.Y.
3. Nagrath, I.J. and Kothari D.P, "Modern Power System Analysis", TMH, New Delhi

Mapping of CLO with PO's:

Course Learning Outcomes (CLO)	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	3	2				1			
2	2		3	1							
3	2	2	2				2			1	2

MEE-102: ADVANCED POWER SYSTEM ANALYSIS

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:

The course is designed to meet the objectives of:

1. In-depth understanding of specialist bodies & Application of engineering methods to complex engineering problem solving.
2. Fluent application of engineering techniques, tools and resources.

Detail Contents:

UNIT-I: **8 Hours**

Formation of network matrices, singular and non-singular Transformation, matrices from Graph theoretic approach – Building algorithm for Bus impedance matrix – Modification of Z Bus matrix due to changes in primitive network. Sparsity techniques – Triangular factorization – Optimal ordering – Optimal load flow in power systems.

UNIT-II: **8 Hours**

Load Flow Studies – Overview of Gauss – Seidel and Newton – Raphson Methods – Decoupled Newton Load Flow – Fast Decoupled Flow – AC/DC load flow – Three phase Load Flow, , Z- Bus formulation for load flow solution, Comparison of various methods of load flow solution.

UNIT-III: **8 Hours**

Three Phase Networks, Three Phase Network Elements, Balanced Network, Transformation Matrices, Three Phase Unbalanced network Elements, Algorithm formation of Three Phase Bus Impedance Matrix, Modification of Three Phase Bus Impedance Matrix for changes in the Network.

UNIT-IV: **8 Hours**

Network faults and Contingency Analysis – Contingencies using Z-bus in a superposition method – A second method of using Z bus for contingencies. Short Circuit Studies – Short circuit calculations using Z bus – short Circuit calculations for balanced and unbalanced three phase network using Z-bus – short circuit studies using bus hybrid matrix.

UNIT-V: **7 Hours**

State Estimation-method of least squares-statistics-errors-estimates-test for bad data-structure and formation of Hessian matrix-power system state estimation, AI applications, case study.

Course Learning Outcomes (CLO):

Students successfully completing this module will be able to:

1. Relate the operation and control of synchronous generators to the fulfilling of various power system requirements.
2. Use a mathematical model that describes the electromechanical dynamics of a power system, to determine the transient stability limits under fault conditions.
3. Determine the static and dynamic frequency response of a power system under load and generation step change.

Text Books:

1. Glonn N. Stagg and Aimed H. El-abiad, "Computer Method in Power S ystem Analysis", McGraw Hill, International addition.
2. George L. Kusic, "Computer Aided Power S ystem Analysis", Prentice Hall.
3. J. Arrillage, C.P. Amold and S. J. Harker, "Computer Modeling of Electrical Power Systems", John. Willey and Sons.

Reference Books:

1. O.I. Elgard, "Electric Energy systems an Introduction", Tata McGraw Hill.
2. M. A. Pai, "Computer Techniques in Power Systems Analysis", Tata McGraw Hill.
3. P.M. Anderson, "Analysis of Faulted Power System", IEEE Press Book

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	2		1			2	2		2
2	2	1	3	2						2	2
3	3	1	3		2		2				1

MEE-103: ADVANCED POWER ELECTRONICS

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:

The course is designed to meet the objectives of:

1. To provide the students a deep insight in to the working of different switching devices & their characteristics.
2. To analyze different converters and control with their applications.

Detail Contents:

UNIT-I: Power Devices: **8 Hours**

Diode V-I Characteristics, Reverse Recover y Characteristics, Power Diodes Types, Forward and Reverse Recovery Time, BJT, MOSFET, IGBT & GTOs - operating characteristics and gate drive requirements and circuits.

UNIT-II: Thyristor **8 Hours**

V-I Characteristics, Turn ON & Turn OFF Characteristics, Thyristor Type, di/dt and dv/dt protection, Series and Parallel Operation of Thyristor, Thyristor circuit, UJT and PUJT Thyristor connection Techniques.

UNIT-III: Controlled rectifiers **8 Hours**

Single Phase & Three Phase Full Converter with R-L load, Single phase & three phase dual converters, Power factor improvement technique.

UNIT-IV: A.C. voltage controllers **8 Hours**

Single Phase and Three Phase Full Controllers, Cycloconvertor, A.C.Voltage Controllers with PWM Control, Effects of source & Load Inductances.

DC- DC converters:

Chopper classification, principle of operation of buck, boost, buck-boost, Cuk, flyback, forward, push-pull.

UNIT-V: inverter **8 Hours**

Voltage source inverters: - single phase & six step inverters, voltage control & PWM strategies, space vector modulation, modification of power circuit for four quadrant operation of Inverter. Current source inverters: single phase and three phase power circuit configuration and analysis. Load commutated inverters: principle of operation, modification of power circuit configuration for low frequency operation.

Course Learning Outcomes (CLO):

Students successfully completing this module will be able to:

1. Articulate the basics of power electronic devices
2. Student should be able to understand the operation of inverter from different perspective.

3. Design of power electronic converters in power control applications
4. Ability to express characteristics of SCR, BJT, MOSFET and IGBT.

Text Books:

1. M. H. Rashid, "Power Electronics, Circuits Devices and Applications", PHI.
2. P.C. Sen, "Power Electronics", TMH.
3. P.S. Bhimbara, "Power Electronics", Khanna Publishers.

Reference Books:

1. Cyril, W. Lander, "Power Electronics", MHI.
2. M.D. Singh & K.B. Khanchandani, "Power Electronics", TMH

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	1		1						2
2	3	3	2				1			2	2
3	2			3	2		2				
4	3		3		1		2				2

MEE-104: DIGITAL CONTROL SYSTEM

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:
The course is designed to meet the objectives of:

1. The ability to understand the characteristics of various types of nonlinearities present in physical systems.
2. The ability to carry out the stability analysis of non-linear control systems.
3. The ability to design compensators for digital control system to achieve desired specifications.
4. The ability to analyze the effect sampling on stability, controllability and observability.

Detail Contents:

UNIT-I: Signal Processing in Digital Control **8 Hours**
Digital control, Configuration of the basic Digital control scheme, Principles of signal conversion, Basic Discrete-Time signals, Time-Domain Models for Discrete- Time Systems, Transfer function Model, Stability in the Z-Plane & Jury stability criterion, Sampling as impulse modulation, Sampled spectra & Aliasing, Filtering, Practical aspects of the choice of sampling rate, Principles of Discretization, The Routh stability Criterion on the r-Plane.

UNIT-II: Models of Digital Control Devices & Systems **8 Hours**
Z-Domain, Description of Sampled continuous-Time Plants, Z-Domain Description of Systems with Dead Time, Implementation of Digital Controllers, Digital temperature Control System, Digital Position Control System, Stepping motors & their control.

UNIT-III: Design of Digital Control Algorithms **8 Hours**
Z-Plane specifications of control system design, Digital Compensator Design using frequency response plots, Digital Compensator design using root locus plots, Z-Plane Synthesis.

UNIT-IV: Control System analysis using State Variable methods **8 Hours**

State Variable representation, Conversion of state Variable models to Transfer functions, Conversion of Transfer functions to Canonical state Variable models, Eigen values & Eigen Vectors, Solution of state equations, Concepts of Controllability & Observability, Equivalence between transfer function & State Variable Representation, Multivariable systems.

UNIT-V: State Variable analysis of Digital Control Systems **8 Hours**

State descriptions of Digitals Processors, State description of Sampled continuous- Time Plants, State description of Systems with dead Time, Solution of state differential equations, Controllability & Observability, Multivariable Systems.

Course Learning Outcomes (CLO):

Students successfully completing this module will be able to:

1. To impart the knowledge of AC rotating machine & 3 phases alternator and synchronous motor.
2. To impart the knowledge of 3 phases induction motor and special machine.

Text Books:

1. Raven, F.H., "Automatic Control Engg." McGraw Hill Book Company.
2. Shinners, S.M., "Modern Control System Theory & Design", John Wiley & Sons.
3. KUO, B.C., "Automatic Control System", Prentice Hall.

Reference Books:

1. Ogata, K., "Modern Control Engineering", Prentice Hall.
2. Nagrath, I.J., & M. Gopal, "Control S ystems Engg., John Wiley & Sons.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	2	1			1				2
2	3	3	2	1			2			2	2

MEE-151: POWER SYSTEM LAB

L	T	P	Credit	Pre-requisites
0	0	4	2	None

Note: - At least 10 experiments should be performed out of which 3 should be simulation based. (A)Hardware Based:
List of experiments:

1. To determine direct axis reactance (xd) and quadrature axis reactance (xq) of a salient pole alternator.
2. To determine negative and zero sequence reactances of an alternator.
3. To determine sub transient direct axis reactance (xd) and sub transient quadrature axis reactance (xq) of an alternator
4. To determine fault current for L-G, L-L, L-L-G and L-L-L faults at the terminals of an alternator at very low excitation
5. To study the IDMT over current relay and determine the time current characteristics
6. To study percentage differential relay
7. To study Impedance, MHO and Reactance type distance relays
8. To determine location of fault in a cable using cable fault locator
9. To study ferranty effect and voltage distribution in H.V. long transmission line using transmission line model.
10. To study operation of oil testing set.

Simulation Based Experiments (using MATLAB or any other software)

11. To determine transmission line performance.
12. To obtain steady state, transient and sub-transient short circuit currents in an alternator
13. To obtain formation of Y-bus and perform load flow analysis
14. To perform symmetrical fault analysis in a power system
15. To perform unsymmetrical fault analysis in a power system

Course Learning Outcomes (CLO):

Students successfully completing this module will be able to:

1. Analyze the performance of transmission lines and relays.
2. Calculate the different parameters of alternator.
3. Find out fault location of transmission line.
4. Verify the different parameters of alternator & transmission line using MATLAB.

MAPPING OF CLO WITH PO

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1					3	2	2		1	2	2
2					3	1	2			2	2
3					3	3	1		2		
4					3	2	2		2	1	1

MEE-152: POWER ELECTRONICS LAB

L	T	P	Credit	Pre-requisites
0	0	4	2	None

- **List of experiments:**

1. SCR Characteristics.
2. Speed Control of AC motor using TRIAC.
3. Panel for speed control of 3-phase induction motor through AC drive (vector controlled).
4. MOSFET based chopper motor controller.
5. Simulation of 3-phase semi converter using MATLAB.
6. Simulation of 3-phase fully controlled converter using MATLAB.
7. Simulation of 1-phase dual converter using MATLAB.
8. Simulation of 1-phase semi converter for R, RL, RLE load using MATLAB.
9. Simulation of 3-phase semi converter for R, RL, RLE load using MATLAB.
10. Simulation of 3-phase full bridge inverter at (a) 180 degree mode operation (b) 120 degree mode operation.

Course Learning Outcomes (CLO):

Students successfully completing this module will be able to:

1. Design the control circuit and the power circuit for speed control of ac motor.
2. Critically compare various outcomes of different type of converter using MATLAB.
3. Familiar with simulation using MATLAB.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1					3	2	2		1	2	2
2					3	1	2			2	2
3					3	2	2		1		2

MEE-201: POWER SYSTEM PROTECTION

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:

The course is designed to meet the objectives of:

1. To isolate a faulty section of electrical power system from rest of the live system.
2. To learn basic concept of Protection system in power system and coordination of protection relays.
3. To learn the functional requirements of protection relay

Detail Contents:

UNIT-I: Fundamentals of Relaying: **8 Hours**

Types of relays, their classifications and theory, Phase and amplitude comparators. Static Comparators, Computer Applications to protective relaying.

UNIT-II: Protection of Lines: **8 Hours**

Transmission Line Protection, Carrier Current Protection. Applications of microwave Channels for protective relaying, Selection of suitable static relaying, scheme for transmission line protection. Performance specifications of distance relay effect of fault resistance and effects of power swings on operation of relays. Distance relay settings. Requirement of Characteristic for different zeros. Selection of suitable static relaying schemes for transmission lines.

UNIT-III: Protection of Electrical Devices: **8 Hours**

Generators and Transformers Protection, CT's and PTs burden and accuracy and their connections. Protection of rotor winding, miscellaneous protection schemes for generators and transformers, over fluxing protection of transformers.

UNIT-IV: Differential Relays: **8 Hours**

Operating Characteristics, Restraining Characteristics, Analysis of Electromagnetic and differential Static relays schemes. Bus zone Protection: Types of bus bar faults, Protection requirements, protection schemes and modern trend in bus-bar protection.

UNIT-V: Circuit Breakers: **7 Hours**

Physical stress in circuit breakers, Vacuum circuit breakers, SF6, Circuit breakers, direct current C.B's, Short circuit testing of circuit breakers. Comparison of different types of circuit breakers.

Course Learning Outcomes (CLO):

At the end of this course, the learner will be able to

1. Understand Fundamentals of apparatus and system protection.

2. Understand that system protection is primarily achieved by under frequency, over frequency and rate of change of frequency relays.

Text Books:

1. T.S. Madhava Rao, "Power System Protections (Static Relays)", Tata McGrwaw-hill.
2. A.R. van C Warrington, "Protective Relays", Chapman and Hall London.
3. S.K. Basu and S. Chaudhary, "Power System Protection", Raju Primlan Oxford and IBH.

Reference Books:

1. Ravindra Nath M. Chander, "Power System Protection and Switch Gear", John Wiley Eastern.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	1	1	2					2	1
2	3	2	1	1			2			1	2

MEE-202: ADVANCED ELECTRICAL MACHINES

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:

The course is design to meet with the objectives

1. To get detailed knowledge of design of Transformers, DC machines, Induction motors and synchronous machines.
2. To get detailed knowledge of construction and operating principles of Electro Mechanical AC Machines.
3. To make student understand equivalent circuit parameters and performance parameters of both synchronous and asynchronous AC Machines.

Detail Contents:

UNIT-I: **8 Hours**

Mathematical: Basic Synchronous machine parameters, Voltage, Flux linkage and inductance relations, Park's transformation-its physical concept, equations of performance. Balanced Steady State Analysis: Phasor equations and Phasor diagrams, Power-angle characteristics, cylindrical rotor and Salient pole machines, Short circuit ratio.

UNIT-II: **8 Hours**

Transient Analysis: Three phase short circuits, Armature and field transients, Transient torque, sudden reactive loading and Unloading. Transient Analysis-a qualitative approach, Reactances and Time-Constants from equivalent circuits, Measurement of reactances, Transient Power-angle characteristics.

UNIT-III: **8 Hours**

Synchronous Machines: Introduction, Voltage and torque equations in machine variables, Voltage and Torque Equations in Arbitrary reference Frame Variables, Voltage and Torque Equations in Rotor Reference Frame Variables, Torque Equations in Substitute variables, Analysis of steady state operation, Dynamic Performance during a sudden change in Input torque, Linearized model, Eigen values and small displacement stability, Reduced order equations and dynamics.

UNIT-IV: **8 Hours**

Induction Machines: Introduction, Voltage and torque equations in machine variables, Equations of Transformation for rotor circuit, Voltage and Torque Equations in Arbitrary reference Frame Variables, Analysis of steady state operation, Free acceleration characteristics viewed from other reference frame, Dynamic performance during sudden change in load torque, Linearized model, Eigen values and small displacement stability, Reduced order equations and dynamics.

UNIT-V: **8 Hours**

Multi-Circuit Transformers: General theory, Equivalent circuits, Three winding transformer as a multi-circuit transformers, Determination of parameters.

Harmonics in three-phase transformers. Transformer Transients: Inrush current phenomena, Qualitative approach, Analytical approach, Inrush current in 3-phase transformers. Unbalanced Operation of three-phase Transformers, Single-Phasing in 3-phase transformers, Effect of using tertiary winding.

Course Learning Outcomes (CLO):

At the end of this course, the learner will be able to

1. Understand how to analyze the working of any electrical machine using mathematical model under loaded and unloaded conditions.
2. The skill to analyze the response & troubleshoot of any electrical machine.

Text Books:

1. "Generalized Theory of Electrical Machines" by Dr. P.S. Bimbhra (Khanna Publishers.)
2. "Generalized Theory of Electrical Machines" by B. Edikins.

Reference Books:

1. "Synchronous Machines" by Concordia.
2. Adkins B., "The General Theory of Electrical Machines", John Wiley Sons, 1957.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	2	1							2
2	3	3	1	3						2	2

MEE-203: HVDC TRANSMISSION

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:
The course is design to meet with the objectives
1. To introduce students with the concept of HVDC Transmission system, converters and their control system.
2. To expose the students to the harmonics and faults occur in the system and their prevention.

Detail Contents:

UNIT-I: Introduction: **8 Hours**
Introduction to AC and DC Transmission-application of DC Transmission-description of DC transmission-DC system components and their functions-modern trends in DC Transmission.

UNIT-II: HVDC converters: **8 Hours**
6 pulse converter circuits and working principle, converter bridge characteristics, working principle and characteristics of a twelve pulse converter with two & three valve conduction mode, three valve conduction mode and three and four valve conduction mode.

UNIT-III: HVDC Controllers: **8 Hours**
General principle of DC link control-converter control characteristics-system control hierarchy- firing angle control-current and extinction angle control-DC link power control-high level controllers.

UNIT-IV: Filters: **7 Hours**
Introduction to harmonics-generation of harmonics-design of AC filters-DC filters-carrier frequency and RI noise

UNIT-V: Protection: **7 Hours**
Basics of protection-DC reactors-voltage and current oscillations-circuit breakers-over voltage protection-switching surges-lightning surges - lightning arrestors for DC systems.

Course Learning Outcomes (CLO):
At the end of this course, the learner will be able to
1. Develop the knowledge of HVDC transmission and converters and the applicability and advantage of HVDC transmission over conventional AC transmission.
2. Formulate and solve mathematical problems related to rectifier and inverter control methods.

3. Analyze the different harmonics generated by the converters and their variation with the change in firing angles.

Text Books:

1. Kimbark E.X., "Direct Current Transmission", Vol. I, Wiley Interscience, NewYork.
2. Allan Greenwood, "Electrical Transients in Power Systems", John Wiley and Sons N.Y.
3. Adamson and Hingorani N.G., "High Voltage Direct Current PowerTransmission", Garraway ltd.,England.

Reference Books:

1. Padiyar K.R., "H V D C Transmission Systems", Wiley Eastern.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	2	2	1				2		1
2	3	3	1	2			2		2	2	1
3	3	3	2	1	2		2		2		2

DEPARTMENTAL ELECTIVE-I

MEE-011: EHVAC TRANSMISSION

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:
The course is design to meet with the objectives
1. Relate the performance and applications of VSI & CSI.
2. Know the importance of compensation methods in power system network.
3. Extend the knowledge of active & reactive power and voltage control with FACTS devices.

Detail Contents:

UNIT-I: **7 Hours**
Introduction to E.H.V. A.C. Transmission, tower configurations, Thermal ratings of lines and cables, Transformer technology.

UNIT-II: **7 Hours**
Circuit breakers, Voltage gradients of conductors, corona effects, power loss and audible noise.

UNIT-III: **7 Hours**
Radio interference, Electrostatic field of transmission lines, Lighting and lighting protection.

UNIT-IV: **7 Hours**
Insulation characteristics of long air gaps, Design of E.H.V. lines based upon steady state limits, Transient over-voltages.

UNIT-V: **7 Hours**
Voltage stability series and shunt compensation, Reactive power control apparatus.

Course Learning Outcomes (CLO):
At the end of this course, the learner will be able to
1. **To Know** the necessity, merits and demerits of EHVAC transmission and mechanical aspects

2. **Evaluate** the Inductance and capacitance of two conductor and multi conductor lines
3. **Analyze** the effect of corona, electrostatic field of EHVAC lines
4. **Analyze** the surface gradient on two conductor and bundle with more than 3 sub conductors.

Text Books:

1. R.D. Begamudre, "E.H.V.-A.C. Transmission", Wiley Eastern Ltd...
2. Transmission line Reference book 345 KV and above EPRI, Palo Alto, USA.

Reference Books:

1. "Electrical Transmission and Distribution" Reference book, Oxford book Company, Calcutta.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	2						2		2
2	3	3	2				2				
3	2	3	1	2							2
4	3	2	2								

MEE-012: APPLIED INSTRUMENTATION

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:

The course is design to meet with the objectives

1. Students will have a sound knowledge base and skill sets to develop and expand professional careers in fields related to instrumentation technologies, process control, and industrial processes automation.
2. Students will meet industry expectations in managing ethical, societal, and environmental issues in the practice of Instrumentation Engineering Technology.

Detail Contents:

UNIT-I: **7 Hours**

Transducers, Classification of Transducers, including analog and digital transducers, Selection of Transducers Static and Dynamic response of transducer System.

UNIT-II: **8 Hours**

Measurement of length & thickness, linear Displacement, Angular Displacement, force, weight, torque, Moisture, Level, Flow, pH & Thermal Conductivit y, Measurement of Frequency Proportional, Geigermuller & Scintillation Counters.

UNIT-III: **7 Hours**

Telemetry: Basic Principles, Proximity & remote Action Telemetry systems, Multiplexing, Time Division and frequency division.

UNIT-IV: **8 Hours**

Various types of Display Device, Digital Voltmeters, Dual Slope DVMS, Digital encoders, Analog and Digital encoders, Analog and Digital Data Acquisition System, A/D Converter.

UNIT-V: **8 Hours**

Fibre Optic Technology for data transmission, Supervisory Control and Data Acquisition Systems (SCADA), Q-meter, Electrical noise in control signals, its remedial measures.

Course Learning Outcomes (CLO):

At the end of this course, the learner will be able to

1. Design and implement systems utilizing analog / digital control devices.
2. Understand the continuous and discrete systems.
3. Implementation of instrument and control systems utilizing appropriate software and hardware tools.

Text Books:

1. W.D. Coopper & A.D. Helfrick, "Electronic Instrumentation and Measurement Techniques", PHI.

2. B.C. Nakra and K.K. Choudhary, "Instrumentation Measurement Analysis", Tata McGraw-Hill.
3. "Instrument Transducers" by Hermann, K.P. Neubert.

Reference Books:

1. Electrical Transducers for Industrial Measurement" by pH Mansfield.
2. Instrumentation systems" by Mani Sharma, Rangan.
3. Principles & Methods of Telemetry" by Borden & & Thgnel Telemetry Method" by Foster

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	2		2					2	2
2	3	2	2		1		1				2
3	2	2	2	2			1				2

MEE-013: DISTRIBUTED GENERATION

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:

The course is design to meet with the objectives

1. Demonstration and deployment of renewable energy and distributed generation technologies in Partnership countries.
2. Identify country development needs and the opportunities to deploy renewable energy and distributed generation technologies.
3. Enumerate financial and engineering benefits of distributed energy systems that contribute to the economic development and climate goals of the Partnership.

Detail Contents:

UNIT-I: **8 Hours**

Basic characteristics of sunlight-solar energy resource-photovoltaic cell-cell efficiency characteristics-equivalent circuit-photo voltaic for battery charging-charge regulators-PV modules-battery backup limitations-equipments and systems-types of fuel cells-losses in fuel cells-MHD generators-application of MHD generation.

UNIT-II: **8 Hours**

Wind source-wind statistics-energy in the wind-aerodynamics-rotor types-forces developed by blades-aerodynamic models-braking systems-tower-control and monitoring system-power performance-wind driven induction generator-power circle diagram-steady state performance- modelling-integration issues-impact on central generation-transmission and distribution systems- wind farm electrical design.

UNIT-III: **8 Hours**

Wind-diesel systems-fuel savings-performance magnet alternators-modelling-steady state equivalent circuit-self excited induction generators-integrated wind-solar systems.

UNIT-IV: **7 Hours**

Micro-hydel electric systems-power potential-scheme layout-generation efficiency and turbine part flow isolated and parallel operation of generators-geothermal-tidal.

UNIT-V

OTEC systems- classification of bio fuels-conversion process-applications.

Course Learning Outcomes (CLO):

At the end of this course, the learner will be able to

1. Accelerates deployment of renewable energy and distributed generation over the next five years.
2. To close the remaining gap between the cost of renewable energy generation and conventional generation.
3. To identify market and policy barriers, and implement mechanisms to overcome such barriers, to enable Partner countries to achieve their deployment goals.

Text Books:

1. John F. Walker 7 Jenkins N., "Wind Energy Technology", John Wiley and Sons, Chichester, U.K.
2. Van Overstraeton R.J and Mertens R.P., "Physics, Technology and Use of Photovoltaics", Adem Hilger, Bristol.
3. Sukhatme, S.P., "Solar Energy-Principles of Thermal Collection and Storage", Tata
4. McGraw-Hill, New Delhi.

Reference Books:

1. Soo S L, "Direct Energy Conversion", Prentice Hall Publication.
2. Freries L.L., "Wind Energy Conversion System", Prentice Hall, U.K.
3. Kreith F and Kreider J F, "Principles of Solar Engineering", Mc-Graw-Hill Book Co.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	2		2					2	2
2	3	2	2		1		1				2
3	2	2	2	2			1				2

MEE-014: POWER ELECTRONICS FOR RENEWABLE ENERGY SYSTEMS

L	T	P	Credit	Pre-requisites
3	1	0	4	Power Electronics , Renewable Energy

Course Objectives:

The course is design to meet with the objectives

1. To provide knowledge about the stand alone and grid connected renewable energy systems.
2. To equip with required skills to derive the criteria for the design of power converters for renewable energy applications.
3. To analyse and comprehend the various operating modes of wind electrical generators and solar energy systems.
4. To design different power converters namely AC to DC, DC to DC and AC to AC converters for renewable energy systems. To develop maximum power point tracking algorithms.

UNIT-I:

INTRODUCTION **8 Hours**

Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment (cost-GHG Emission) - Qualitative study of different renewable energy resources: Solar, wind, ocean, Biomass, Fuel cell, Hydrogen energy systems and hybrid renewable energy systems.

UNI-II: **7 Hours**

ELECTRICAL MACHINES FOR RENEWABLE ENERGY CONVERSION

Reference theory fundamentals-principle of operation and analysis: IG, PMSG, SCIG and DFIG.

UNIT-III: **8 Hours**

POWER CONVERTERS Solar: Block diagram of solar photo voltaic system -Principle of operation: line commutated converters (inversion-mode) - Boost and buck-boost converters- selection of inverter, battery sizing, array sizing Wind: Three phase AC voltage controllers- AC-DC-AC converters: uncontrolled rectifiers, PWM Inverters, Grid Interactive Inverters-matrix converters.

UNIT-IV: **8 Hours**

ANALYSIS OF WIND AND PV SYSTEMS Stand alone operation of fixed and variable speed wind energy conversion systems and solar system Grid connection Issues -Grid integrated PMSG, SCIG Based WECS, grid Integrated solar system.

UNIT-V: **8 Hours**

HYBRID RENEWABLE ENERGY SYSTEMS

Need for Hybrid Systems- Range and type of Hybrid systems- Case studies of Wind-PV Maximum Power Point Tracking (MPPT).

Course Learning Outcomes (CLO):

At the end of this course, the learner will be able to

1. Ability to understand and analyze power system operation, stability, control and protection.
2. Ability to handle the engineering aspects of electrical energy generation and utilization.

TEXT BOOKS:

1. S. N. Bhadra, D.Kastha, S.Banerjee, "Wind Electrical Systems", Oxford University Press, 2005.
2. B.H.Khan Non-conventional Energy sources Tata McGraw-hill Publishing Company, New Delhi, 2009.

REFERENCES:

1. Rashid .M. H "power electronics Hand book", Academic press, 2001.
2. Ion Boldea, "Variable speed generators", Taylor & Francis group, 2006.
3. Rai. G.D, "Non conventional energy sources", Khanna publishes, 1993.
4. Gray, L. Johnson, "Wind energy system", prentice hall linc, 1995.
5. Andrzej M. Trzynnadlowski, 'Introduction to Modern Power Electronics', Second edition, wiley India Pvt. Ltd, 2012.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	2		2					2	2
2	3	2	2		1		1				2

MEE-251: ELECTRICAL MACHINE LAB

L	T	P	Credit	Pre-requisites
0	0	4	2	None

Note: Minimum eight experiments are to be performed from the following list:
List of experiments:

1. To obtain magnetization characteristics of a d.c. shunt generator
2. To obtain load characteristics of a d.c. shunt generator and compound generator (a) Cumulatively compounded (b) differentially compounded
3. To obtain efficiency of a dc shunt machine using Swinburn's test
4. To perform Hopkinson's test and determine losses and efficiency of DC machine
5. To obtain speed-torque characteristics of a dc shunt motor
6. To obtain speed control of dc shunt motor using (a) armature resistance control (b) field control
7. To obtain speed control of dc separately excited motor using Conventional Ward-Leonard/Static Ward –Leonard method.
8. To study polarity and ratio test of single phase and 3-phase transformers
9. To obtain equivalent circuit, efficiency and voltage regulation of a single phase transformer using C.C. and S.C. tests.
10. To obtain efficiency and voltage regulation of a single phase transformer by Sumpner's test.
11. To obtain 3-phase to 2-phase conversion by Scott connection.
12. To determine excitation phenomenon (B.H. loop) of single phase transformer using C.R.O.

Course Learning Outcomes (CLO):

At the end of this course, the learner will be able to

1. Discriminate and realize the various dc generator & machine.
2. Obtain the equivalent circuit parameters of dc generator, dc machine and transformer.
3. Convert phase of transformer & maximizes the output of transformer using different testing method.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1		3	2	2			2		3	2	
2		2	2				2		1	2	
3		2	1	2			1		2	2	

MEE-252: ADVANCED MACHINE LAB

L	T	P	Credit	Pre-requisites
0	0	4	2	None

Note: The minimum 8 experiments are to be performed from the following, out of which there should be at least two software based experiments.

List of experiments:

1. To perform no load and blocked rotor tests on a three phase squirrel cage induction motor and determine equivalent circuit.
2. To perform load test on a three phase induction motor and draw: Torque -speed characteristics Power factor-line current characteristics.
3. To perform no load and blocked rotor tests on a single phase induction motor and determine equivalent circuit.
4. To study speed control of three phase induction motor by Keeping V/f ratio constant
5. To study speed control of three phase induction motor by varying supply voltage.
6. To perform open circuit and short circuit tests on a three phase alternator and determine
7. Voltage regulation at full load and at unity, 0.8 lagging and leading power factors by (i) EMF method (ii) MMF method.
8. To determine V-curves and inverted V-curves of a three phase synchronous motor.
9. To determine Xd and Xq of a three phase salient pole synchronous machine using the slip test and draw the power-angle curve.
10. To study synchronization of an alternator with the infinite bus by using: dark lamp method (ii) two bright and one dark lamp method.

Software based experiments (Develop Computer Program in 'C' language or use MATLAB or other commercial software)

11. To determine speed-torque characteristics of three phase slip ring induction motor and
12. Study the effect of including resistance, or capacitance in the rotor circuit.
13. To determine speed-torque characteristics of single phase induction motor and study the effect of voltage variation.
14. To determine speed-torque characteristics of a three phase induction motor by (i) keeping v/f ratio constant (ii) increasing frequency at the rated voltage.
15. Draw O.C. and S.C. characteristics of a three phase alternator from the experimental data and determine voltage regulation at full load, and unity, 0.8 lagging and leading power factors.

Course Learning Outcomes (CLO):

At the end of this course, the learner will be able to

1. Analyze different steady state speed control methods for Induction motors, and understand the closed loop block diagrams for different methods.
2. Properly select induction motor for industrial application.
3. Study different parameter of induction motor using MATLAB software.
4. Develop Computer Program in 'C' language for control of induction motor.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1		3	3	2			2		3	2	
2		2	2				2		2	2	
3	3	2	2	2			2		2	2	
4		3	2	2			2	2	2	2	2

DEPARTMENTAL ELECTIVE-II

MEE-024: ENERGY MANAGEMENT AND AUDIT

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:

The course is design to meet with the objectives

1. To understand Energy Audit procedure along with relevant technologies/ tools.
2. To understand Energy Conservation measures undertaken across different user segments using case studies.
3. To develop Energy Audit Report writing skills.
4.

Detail Contents:

UNIT-I: Energy Scenario: **8 Hours**

Energy sources, security, conservation, strategy. Basics of energy and its various forms

Energy Management & Audit:

Energy costs, Bench marking, efficiency, audit instruments.

UNIT-II: Energy Action Planning: **8 Hours**

Role, motivation, training, information systems

Energy Monitor of Electrical System:

Power supply, Electricity billing, Electrical load management and maximum demand control, Power factor improvement and its benefit, Selection and location of capacitors, Performance assessment of PF capacitors, Distribution and transformer losses.

UNIT-III: Electric Motors: **8 Hours**

Types, characteristics, losses, efficiency, selection, energy efficient motors, Factors affecting motor performance, Rewinding and motor replacement issues. Energy saving opportunities with pumps, cooling towers, fans and blower.

UNIT-IV: Lighting System: **8 Hours**

Light source, choice of lighting, luminance requirements and energy conservation avenues.

Energy Efficient Technologies in Electrical System:

Maximum demand controllers, Automatic power factor controllers, Energy efficient motors, Soft starters with energy saver, Variable speed drives, Energy efficient transformers, Electronic ballast, Occupancy sensors, Energy efficient lighting controls.

Course Learning Outcomes (CLO):

At the end of this course, the learner will be able to

1. Energy Audit helps to map the flow of energy (in its various forms) across the value chain, highlighting areas for interventions.

2. This course is designed to sensitize students on the mechanism of energy audit and the technologies/ tools typically employed to undertake an audit exercise, supported by case studies & site visits.

Text Books:

1. Albert: Plant Engineers & Managers Guide to Energy Conservation.
2. Wayhe C. Tuner: Energy Management Handbook.
3. Anthony J. Pansini: Engineering Economic Analysis Guide Boo.

Reference Books:

1. D. Paul-Mehta: Handbook of Energy Engineering.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3				3	2	1	2	2	3	
2	3				3		1		2		

MEE-025: MICROPROCESSORS AND THEIR APPLICATIONS

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:

The course is design to meet with the objectives

1. Understand the architecture and operation of typical microprocessors and microcontrollers.
2. To familiarize the students with the programming and interfacing of microprocessors and microcontrollers.
3. To provide strong foundation for designing real world applications using microprocessors and microcontrollers.

Detail Contents:

UNIT-I: Microprocessor **8 Hours**

Intel 8085- Introduction, register structure, memory Addressing, Addressing Modes, Instruction Set, Timing Methods, CPU Pins and Associated Signals, Instruction timing and execution, programming I/O, Interrupt System, DMA, SID & SOD lines, Instruction set, 8085, based system design, Intel 8086 - Introduction, Architecture, Addressing modes, instruction set memory management, assembler dependent instructions, Input/output, system design using 8086.

UNIT-II: Peripheral Interfacing **8 Hours**

Parallel versus serial transmission, synchronous and asynchronous serial data transmission, interfacing of hexadecimal keyboard and display unit, interfacing of cassette recorders and CRT. Parallel, serial interface standards

UNIT-III: Microprocessor Applications to Power Engineering Protective Relaying **7 Hours**

Over-current, impedance, MHO, reactance, bi-directional relays.

UNIT-IV: Measurements **8 Hours**

Frequency, power angle & power factor, Voltage and Current, KVA, KW, & KVAR, maximum demand, Resistance, Reactance, Temperature Controls.

Course Learning Outcomes (CLO):

At the end of this course, the learner will be able to

1. Assess and solve basic binary math operations using the microprocessor.
2. Apply knowledge and demonstrate programming proficiency using the various addressing modes and data transfer instructions of the target microprocessor and microcontroller.
3. Analyze assembly language programs; select appropriate assemble into machine a cross assembler utility of a microprocessor and microcontroller.

Text Books:

1. Rafiquzzaman, M. Theory & Applications PHI Publications.
2. Gaonkar R. S. Microprocessor Architecture, Programming and Applications John Wiley.

Reference Books:

1. Ram B. Fundamentals of Microprocessors and Microcomputers, Dhanpat Rai & Sons.
2. Liu Yu Cheng and Gibson, G.A. PHI.
3. Leventhal, L.A. Introduction to Microprocessors: Software, Hardware, Programming

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	3	2							
2	3	2	3	2							
3	3	2	3								

MEE-026: FACTS DEVICES

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:

The course is design to meet with the objectives

1. To familiarize power engineers about the Flexible AC Transmission devices and their applications in power systems with respect to active/reactive power control.
2. To impart the students with various FACTS devices which are used for proper operation of existing AC system more flexible in normal and abnormal conditions.
3. To enable students to design power electronics circuit that can control active and reactive power flow.

Detail Contents:

UNIT-I: Facts and Preliminaries: **8 Hours**

FACTS concept and general system considerations-Power flow in AC system-Definitions on FACTS-Basic types of FACTS controllers. Converters for Static Compensation-Three-phase converters and standard modulation strategies (Programmed Harmonic Elimination and SPWM)- GTO Inverters-Multi-Pulse Converters and Interface Magnetics-Transformer Connection for 12, 24 and 48 pulse operation-Multi-Level Inverters of Diode Clamped type and Flying Capacitor type and suitable modulation strategies (includes SVM) –Multi-Level inverters of Cascade type and their modulation-Current Control of Inverters.

UNIT-II: Static Shunt and Series Compensators: **8 Hours**

Static Shunt Compensators-SVC and STATCOM-operation and control of TSC, TCR, STATCOM-Compensator Control-Comparison between SVC and STATCOM-STATCOM for transient and dynamic stability enhancement, Static Series Compensation-GCSC, TSSC, TCSC and SSSC-operation and control-external system control for series compensators-SSR and its damping-static voltage and phase angle regulators-TCVR and TCPAR-operation and control.

UNIT-III: UPFC and IPFC: **8 Hours**

The Unified Power Flow Controller-operation, comparison with other FACTS devices-control of P and Q-dynamic performance-Special Purpose FACTS Controllers-Interline Power Flow Controller-operation and control.

UNIT-IV: Power Quality and Introduction to Custom Power Devices: **8 Hours**

Power Quality issues related to distribution systems-custom power devices-Distribution STATCOM-Dynamic Voltage restorer-Unified Power Quality Conditioner-Application of D- STATCOM, DVR and UPQC for improving power quality in distribution systems.

Course Learning Outcomes (CLO):

At the end of this course, the learner will be able

1. Understand the operations of different FACTS devices.
2. Select the controllers for different Contingencies.
3. Analyze the different FACTS devices in different stability conditions

4. Select an appropriate FACTS device for a particular application.

Text Books:

1. K.R. Padiyar, "FACTS Controller in Power Transmission and Distribution", New Age International.
2. N.G. Hingorani & L. Gyugyi, "Understanding FACTS: Concepts and Technology of Flexible AC Transmission Systems", IEEE Press.

Reference Books:

1. Ned Mohan et.al, "Power Electronics", John Wiley & Sons.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3			2	2						
2					2		3				
3	3	3	2	1							
4				2	3				1		

MEE-027: SCADA SYSTEMS AND APPLICATIONS

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:

The course is design to meet with the objectives

1. To understand what is meant by SCADA and its functions.
2. To know SCADA communication.
3. To get an insight into its application

Detail Contents:

UNIT-I: **8 Hours**

Introduction to SCADA: Data acquisition systems, Evolution of SCADA, Communication technologies. Monitoring and supervisory functions, SCADA applications in Utility Automation, Industries SCADA.

UNIT-II: **8 Hours**

Industries SCADA System Components: Schemes- Remote Terminal Unit (RTU), Intelligent Electronic Devices (IED), Programmable Logic Controller (PLC), Communication Network, SCADA Server, SCADA/HMI Systems.

UNIT-III: **8 Hours**

SCADA Architecture: Various SCADA architectures, advantages and disadvantages of each system single unified standard architecture –IEC61850.

UNIT-IV: **8 Hours**

SCADA Communication: various industrial communication technologies-wired and wireless methods and fiber optics. Open standard communication protocols.

UNIT-V: **8 Hours**

SCADA Applications: Utility applications- Transmission and Distribution sector-operations, monitoring, analysis and improvement. Industries - oil, gas and water, Case studies, Implementation, Simulation Exercises.

Course Learning Outcomes (CLO):

At the end of this course, the learner will be able

1. Describe the basic tasks of Supervisory Control Systems (SCADA) as well as their typical applications.
2. Acquire knowledge about SCADA architecture, various advantages and disadvantages of each system.

3. Knowledge about single unified standard architecture IEC 61850.
4. To learn about SCADA system components: remote terminal units, PLCs, intelligent electronic devices, HMI systems, SCADA server.
5. Learn and understand about SCADA applications in transmission and distribution sector, industries.

TEXT BOOKS:

1. Stuart A. Boyer: "SCADA-Supervisory Control and Data Acquisition", Instrument Society.
2. Gordon Clarke, Deon Reynders: "Practical Modern SCADA Protocols: DNP3, 60870.5 and Related Systems", Newnes Publications, Oxford, UK, 2004.

REFERENCES:

1. William T. Shaw, "Cyber security for SCADA systems", Penn Well Books, 2006.
2. David Bailey, Edwin Wright, "Practical SCADA for industry", Newnes, 2003.
3. Wiebe, "A guide to utility automation: AMR, SCADA, and IT systems for electric power", Penn Well 1999.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3			2	2						
2					2		3				
3	3	3	2	1							
4				2	3				1		
5	3	3	2		3				1	2	

DEPARTMENTAL ELECTIVE-III
MEE-037: ADVANCED ELECTRICAL DRIVES

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:

The course is design to meet with the objectives

1. To impart knowledge about fundamentals of Electric drives and control, operational strategies of dc and ac motor drives as per different quadrant operations and to discuss.
2. To provide students with a strong back ground in different types of electrical drives.
3. To train the students to have the solid foundation in mathematical and technical concepts required to engineering problems.

Detail Contents:

UNIT-I: Modeling: **8 Hours**

Dynamic modeling of induction machines – 3-phase to 2-phase transformation power equivalence – generalized model in arbitrary reference frame – electromagnetic torque - derivation of stator reference frame model, rotor reference frame model, synchronously rotating reference frame model - equations in flux linkages - dynamic d-q model of synchronous machines.

UNIT-II: Vector Control: **8 Hours**

Vector controlled induction motor drive - principle of vector or field oriented control - direct rotor flux oriented vector control - estimation of rotor flux and torque - implementation with current source and voltage source inverters - stator flux oriented vector control - indirect rotor flux oriented vector control scheme – implementation – tuning – dynamic simulation - parameter sensitivity and compensation of vector control induction motors – selection of flux level - flux weakening operation - speed controller design - simulation of vector control of induction motor using MATLAB/SIMLINK.

UNIT-III: Static Drives and Torque Control: **8 Hours**

Doubly-fed machine speed control by rotor rheostat – static Kramer drive - Phasor diagram, equivalent-speed control - power factor improvement - static scherbius drive - modes of operation - direct torque control of induction motor - principle – control strategy - space vector modulation - reduction of torque and flux ripple comparison of DTC and FOC - simulation of DTC of induction motor using MATLAB/SIMULINK.

UNIT-IV: Permanent Magnet synchronous and Brushless dc Motor Drives: **8 Hours**

Types of permanent magnet synchronous machines - vector control of PM synchronous machines model of PMSM - vector control - control strategies - constant torque angle control, unity power factor control, constant mutual flux - linkages control, optimum torque per ampere control, flux weakening operation, direct flux weakening algorithm, speed controlled PMSM drive – sensor less PMSM drives - PM brushless DC motor – modeling - drive scheme – switched reluctance motor drives.

Course Learning Outcomes (CLO):

At the end of this course, the learner will be able to

1. Describe the structure of Electric Drive systems and their role in various applications.

2. Understand basic requirements placed by mechanical systems on electric drives.
3. Review phasors and three-phase electric circuits.

Text Books:

1. R Krishnan, "Electric Motor Drives", PHI.
2. D W Novotny and T A Lipo, "Vector Control and Dynamics of AC Drives", Oxford University Press
3. B K Bose, "Modern Power Electronics and AC Drives",PHI.
4. Leonhard, "Control of Electric Drives", Springer.
5. Kazmierkowski, Krishnan, Bleiberg, "Control in Power Electronics –Selected Problems", Academic Press.

Reference Books:

1. John Chiasson, "Modelling and High Performance Control of Electric Machines",Wiley–IEEE Press.
2. I Boldea, S A Nasar, "Electric Drives", CRC Press.
3. K Rajashekara, "Sensorless Control of AC Motors", IEEE Press.
4. I Boldea, S A Nasar, "Vector control of AC Drives", CRC Pres

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	2	2					1		
2	3								1		
3	3										

2. Understand basic requirements placed by mechanical systems on electric drives.
3. Review phasors and three-phase electric circuits.

Text Books:

1. R Krishnan, "Electric Motor Drives", PHI.
2. D W Novotny and T A Lipo, "Vector Control and Dynamics of AC Drives", Oxford University Press
3. B K Bose, "Modern Power Electronics and AC Drives",PHI.
4. Leonhard, "Control of Electric Drives", Springer.
5. Kazmierkowski, Krishnan, Bleiberg, "Control in Power Electronics –Selected Problems", Academic Press.

Reference Books:

1. John Chiasson, "Modelling and High Performance Control of Electric Machines",Wiley–IEEE Press.
2. I Boldea, S A Nasar, "Electric Drives", CRC Press.
3. K Rajashekara, "Sensorless Control of AC Motors", IEEE Press.
4. I Boldea, S A Nasar, "Vector control of AC Drives", CRC Pres

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	2	2					1		
2	3								1		
3	3										

MEE-038: NON CONVENTIONAL ENERGY SYSTEMS

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:

The course is design to meet with the objectives

1. Understand the various forms of conventional energy resources.
2. Learn the present energy scenario and the need for energy conservation.
3. Explain the concept of various forms of renewable energy.
4. Outline division aspects and utilization of renewable energy sources for both domestics and industrial application

Detail Contents:

UNIT-I: **8 Hours**

Solar Energy-Introduction to solar energy: solar radiation, availability, measurement and estimation-Solar thermal conversion devices and storage-solar cells and photovoltaic conversion- PV systems-MPPT. Applications of PV Systems-solar energy collectors and storages.

UNIT-II: **8 Hours**

Wind Energy-Introduction-Basic principles of wind energy conversion-wind data and energy estimation-site selection consideration-basic components of wind energy conversion system-Types of wind machines-basic components of wind electric conversion systems. Schemes for electric generations-generator control, load control, energy storage-applications of wind energy-Inter connected systems.

UNIT-III: **8 Hours**

Chemical Energy Sources-Introduction-fuel cells-design and principles of operation of a fuel cell-classification of fuel cells. Types of fuel cells-conversion efficiency of fuel cells. Types of electrodes, work output and emf of fuel cell, Applications of fuel cells. Hydrogen energy: Introduction-hydrogen production-electrolysis, thermo chemical methods, Westinghouse Electro- chemical thermal sculpture cycle. Fossil fuel methods. Hydrogen storage, Utilization of hydrogen gas.

UNIT-IV: **8 Hours**

Energy from oceans-Introduction, ocean thermal electric conversion (OTEC), methods of ocean thermal electric power generation, open cycle OTEC system, closed OTEC cycle. Energy from tides: Basic principles of tidal power, component of tidal power plants, operation methods of utilization of tidal energy, site requirements, storage, advantages and limitations of tidal power generation. Ocean waves, energy and power from the waves, wave energy conversion devices. Geothermal energy-Introduction, estimation of geothermal power, nature of geothermal fields, geothermal sources, inter connection of geothermal fossil systems, prime movers for geothermal energy conversion.

Course Learning Outcomes (CLO):

At the end of this course, the learner will be able to

1. Describe the environmental aspects of non-conventional energy & conventional energy systems, their prospects and limitations.
2. Know the need of renewable energy resources, historical and latest developments.

3. Describe the use of solar energy and their various components.
4. Appreciate the need of Wind Energy and the various components used in energy generation and know the classifications.

Text Books:

1. SP Sukatme, "Solar Energy-Principles of thermal collection and storage", Tata McGraw Hill.
2. GD Rai, "Non Conventional Energy Sources".
3. J.A. Duffie and W.A. Beckman, "Solar Engineering of Thermal Processes", John Wiley, New York.

Reference Books:

1. D.Y. Goswami, F. Kreith and J.F. Kreider, "Principles of Solar Engineering", Taylor and Francis, Philadelphia.
2. D.D. Hall and R.P. Grover, "Bio-Mass Regenerable Energy", John Wiley, Newyork.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3								3	3	
2	3							2	3	2	
3	3								3	3	
4	3		1				2		3	2	2

MEE-039: ENERGY EFFICIENT MACHINES

L	T	P	Credit	Pre-requisites
3	1	0	4	None

Course Objectives:
The course is design to meet with the objectives

1. To prepare the students for successful career in the energy industry.
2. To produce graduates strong in energy resources, technologies and management.
3. Fundamentals, and capable in addressing the present and potential future energy problems.
4. Issues and concerns, and who can apply their specialized knowledge for the sustainable energy management.

Detail Contents:

UNIT-I: **8 Hours**
Introduction: Need for energy efficient machines, energy cost and two part tariff, energy conservation in industries and farms a necessit y, introduction to energy management and energy audit system. Review of induction motor characteristics.

UNIT-II: **8 Hours**
Energy Efficient motors: Standard motor efficiency, why more efficient motors, an energy efficient motor, Loss segregation method, Comparison, motor efficiency labeling, energy efficient motor standards.

UNIT-III: **8 Hours**
The power factor: The p.f. in sinusoidal systems, p.f. improvement, the p.f. with non-linear loads, Harmonics and the p.f., p.f. motor controllers.

UNIT-IV: **8 Hours**
Application of Electric motors: Varying duty applications, Voltage variation, Voltage Unbalance, over motoring, Poly-phase induction motors Supplied b y adjustable frequency power Supplies.

UNIT-V: **8 Hours**
Induction motors and adjustable drive systems: Energy Conservation, adjusted speed systems, Application of adjustable speed systems to fans, pumps and constant torque loads.

Course Learning Outcomes (CLO):
At the end of this course, the learner will be able to

1. Understood the conventional and non-conventional energy technologies Acquired the expertise and skills needed for the energy monitoring, auditing.
2. Acquired skills in the scientific and technological communications, and in the preparation, planning and implementation of energy projects.

Text Books:

1. John C. Andreas, "Energy efficient electric motors", Marcel Dekker Inc.
2. Albert Thuman, "Introduction to Efficient Electric System Design", the Fairmount Press Prentice-Hall.

Reference Books:

1. S.C. Tripathi, "Electric Energy Utilization and Conservation", Tata McGrwa-Hill.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3							3	3	3	
2	3				1			2	3	2	2

MEE-040: POWER QUALITY

L	T	P	Credit	Pre-requisites
0	0	12	4	None

Course Objectives:

The course is design to meet with the objectives

1. To Study the basics of power quality , power quality problems and power quality standards,
2. To Study about the characteristics of non-linear loads.
3. To Study Voltage, Current, Power and Energy measurements and analysis methods of Laplace's, Fourier and Hartley and Wavelet Transforms.
4. To Study about various devices used to enhance power quality.

Detail Contents:

UNIT-I: **8 Hours**

INTRODUCTION

Introduction of the Power Quality (PQ) problem, Terms used in PQ: Voltage, Sag, Swell, Surges, Harmonics, over voltages, spikes, Voltage fluctuations, Transients, Interruption, overview of power quality phenomenon, Remedies to improve power quality, power quality monitoring.

UNIT-II: **10 Hours**

LONG & SHORT INTERRUPTIONS

Interruptions – Definition – Difference between failures, outage, Interruptions – causes of Long Interruptions – Origin of Interruptions – Limits for the Interruption frequency – Limits for the interruption duration – costs of Interruption – Overview of Reliability evaluation to power quality, comparison of observations and reliability evaluation.

SHORT INTERRUPTIONS: definition, origin of short interruptions, basic principle, fuse saving, voltage magnitude events due to re-closing, voltage during the interruption, monitoring of short interruptions, difference between medium and low voltage systems. Multiple events, single phase tripping – voltage and current during fault period, voltage and current at post fault period, stochastic prediction of short interruptions.

UNIT-III: **8 Hours**

SINGLE AND THREE-PHASE VOLTAGE Sag CHARACTERIZATION

Voltage sag – definition, causes of voltage sag, voltage sag magnitude, and monitoring, theoretical Calculation of voltage sag magnitude, voltage sag calculation in non-radial systems, meshed systems, and voltage sag duration. Three phase faults, phase angle jumps, magnitude and phase angle jumps for three phase unbalanced sags, load influence on voltage sags.

UNIT-IV: **8 Hours**

POWER QUALITY CONSIDERATIONS IN INDUSTRIAL POWER SYSTEMS

Voltage sag – equipment behavior of Power electronic loads, induction motors, synchronous motors, Computers, consumer electronics, adjustable speed AC drives and its operation. Mitigation of AC Drives, adjustable speed DC drives and its operation, mitigation methods of DC drives.

8 Hours

UNIT-V:

MITIGATION OF INTERRUPTIONS & VOLTAGE SAGS

Overview of mitigation methods – from fault to trip, reducing the number of faults, reducing the fault Clearing time changing the power system, installing mitigation equipment, improving equipment immunity, different events and mitigation methods. System equipment interface – voltage source converter, series voltage controller, shunt controller, combined shunt and series controller.

POWER QUALITY AND EMC STANDARDS:

Introduction to standardization, IEC Electromagnetic compatibility standards, European voltage Characteristics standards, PQ surveys.

Course Learning Outcomes (CLO):

At the end of this course, the learner will be able to

1. Know the different characteristics of electric power quality in power systems,
2. Learn about the applications of non-linear loads,
3. Know the applications of Hartley and Wavelet Transforms,
4. Learn how to mitigate the power quality problems.
5. Learn about the application of FACTS device on DG side.

TEXT BOOKS:

1. "Understanding Power Quality Problems" by Math H J Bollen. IEEE Press.
2. "Power Quality VAR Compensation in Power Systems", R. SastryVedam Mulukutla S.Sarma,CRC Press.

REFERENCES:

1. Power Quality, C. Sankaran, CRC Presss.
2. Electrical Power Systems Quality, Roger C. Dugan , Mark F. Mc Granaghan, Surya Santoso, H. Wayne Beaty, Tata Mc Graw Hill Education Private Ltd.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2		2	1						
2		2	3		2					1	1
3	3	3	2	1							1
4				2	3		1		1		
5	3	3	2		3				1	2	

MEE-351: PROJECT/SEMINAR

L	T	P	Credit	Pre-requisites
0	0	16	12	None

Students will be allotted to the faculty members. On the advice of the faculty – students will select a topic of interest which is not covered in the regular class work and which enhances the students' knowledge in modern power electronics & power systems. Student will explore the recent publications and prepare a presentation and share it all the students. Faculty will monitor the presentations along with the other faculty members.

Course Learning Outcomes (CLO):

Students successfully completing this module will be able to:

1. Understand advanced topics in power electronics & power systems.
2. Improve language and communication skills.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1				3	3		2				
2						3					

SEMESTER: IV
MEE-451: DISSERTATION

L	T	P	Credit	Pre-requisites
0	0	24	20	None

The project/dissertation shall be finalized by the students based on the III semester project/dissertation work report and shall be completed and submitted at least one month before date of which shall be notified in the academic calendar.
The assessment of performance of students should be made at least twice in IV semester. In this semester student shall present the final project live as also using overheads project or power point presentation on LCD to the internal committee as also the external examiner.
The evaluation committee shall consist of faculty members constituted by the Institution which would comprise of at-least three members comprising of the HOD, project/ dissertation guide and a nominee of the Dean. The students guide would be a special invitee to the presentation. The seminar session shall be an open house session. The internal marks would be the average of the marks given by each member of the committee separately in a sealed envelope to the HOD.

Course Learning Outcomes (CLO):
Students successfully completing this module will be able to:

3. Recognize and formulate a problem to analyze, synthesize, evaluate, simulate and create a power electronic converter and/or a drive system.
4. Carryout modeling and simulation studies pertaining to the system and prepare a presentation.
5. Build the hardware to demonstrate the principle of working.
6. Correlate the analytical, simulation and experimental results.
7. Deduce conclusions and draw inferences worthy of publication.

Mapping of CLO with PO's:

Course Learning Outcomes (CLO):	Program Outcomes(PO's)										
	1	2	3	4	5	6	7	8	9	10	11
1	3	2	3	3	1						
2	2				2	3					
3						2	3			3	
4							3	2	1	2	2
5					3	2	1			3	

Convener
Signature: ....

List of External Theory Examiner M.tech (Electrical Engineering), 2020-21, Odd Sem				
Sem.	**Name of the subject With code**	**Name of the External paper setter with address, contact no. &E-mail**	**Name of the Internal paper setter with address, contact no. & E-mail**	**Name of Moderator**
M.Tech I[st] Sem	Power System Operation & Control **MEE-101**	1. Prof.(Dr.) N.C. Sarkar Principal Diploma SRMU, Barabanki Mob: 9935300964 Email –ncsarkar@gmail.com 2. Mr. Bhashkar Pandey Assistant Professor KIPM College of Engineering &Technology,Gorakhpur Mob: 9454116782 Email –bhashker22@gmail.com 3. Mr. S. P. Singh Assistant Professor BBDNITM, Lucknow Mob: 9415159137 Email: singhshivprakash@gmail.com 4. Mr. Raghvendra Pratap Singh Assistant Professor BBDNITM, Lucknow Mob: 9473827152 Email: smartraghvendra@gmail.com	1.Mr. Amit Kumar Singh Assistant Professor Dept. of Electrical Engineering FET, Rama University, Kanpur Mob: 8756662989 Email: amit.fet@ramauniversity.ac.in 2. Mr. Dileep Kumar Assistant Professor FET, Rama University, Kanpur Mob: 8090460055 Email: dileep.fet@ramauniversity.ac.in	
M.Tech I[st] Sem	Advanced Power System Analysis **(MEE-102)**	1. Prof.(Dr.) N.C. Sarkar Principal Diploma SRMU, Barabanki Mob: 9935300964 Email –ncsarkar@gmail.com 2. Mr. Bhashkar Pandey Assistant Professor KIPM College of Engineering &Technology,Gorakhpur Mob: 9454116782 Email –bhashker22@gmail.com	1. Mr. Amit Kumar Singh Assistant Professor Dept. of Electrical Engineering FET, Rama University, Kanpur Mob: 8756662989 Email:	

		3. Mr. S. P. Singh Assistant Professor BBDNITM, Lucknow Mob: 9415159137 Email: singhshivprakash@gmail.com 4. Mr. Raghvendra Pratap Singh Assistant Professor BBDNITM, Lucknow Mob: 9473827152 Email: smartraghvendra@gmail.com	amit.fet@ramaun iversity.ac.in 2. Mr. Dileep Kumar Assistant Professor FET, Rama University, Kanpur Mob: 8090460055 Email: dileep.fet@ramau niversity.ac.in	
M.Tech I[st] Sem	Advanced Power Electronics **(MEE-103)**	1. Mr. Bhashkar Pandey Assistant Professor KIPM College of Engineering &Technology,Gorakhpur Mob: 9454116782 Email –bhashker22@gmail.com 2. Mr. S. P. Singh Assistant Professor BBDNITM, Lucknow Mob: 9415159137 Email: singhshivprakash@gmail.com 3. Prof.(Dr.) N.C. Sarkar Principal Diploma SRMU, Barabanki Mob: 9935300964 Email –ncsarkar@gmail.com] 4. Mr. Raghvendra Pratap Singh Assistant Professor BBDNITM, Lucknow Mob: 9473827152 Email: smartraghvendra@gmail.com	1. Mr. Amit Kumar Singh Assistant Professor Dept. of Electrical Engineering FET, Rama University, Kanpur Mob: 8756662989 Email: amit.fet@ramaun iversity.ac.in 2.. Mr. Dileep Kumar Assistant Professor FET, Rama University, Kanpur Mob: 8090460055 Email: dileep.fet@ramau niversity.ac.in	
		1. Bhashkar Pandey Assistant Professor KIPM College of Engineering &Technology,Gorakhpur	1. Mr. Dileep Kumar Assistant	

M.Tech I[st] Sem	Digital Control System **(MEE-104)**	Mob: 9454116782 Email –bhashker22@gmail.com 2. Prof.(Dr.) N.C. Sarkar Principal Diploma SRMU, Barabanki Mob: 9935300964 Email –ncsarkar@gmail.com 3. Mr. S. P. Singh Assistant Professor BBDNITM, Lucknow Mob: 9415159137 Email: singhshivprakash@gmail.com 4. Dr. G. R Mishra Assistant Professor, Department of electrical & Electronics Engineering Amity University Lucknow Campus Mob: 9451805326 Email: grmishra@amity.edu	Professor FET, Rama University, Kanpur Mob: 8090460055 Email: dileep.fet@ramauniversity.ac.in 2. Mr. Amit Kumar Singh Assistant Professor Dept. of Electrical Engineering FET, Rama University, Kanpur Mob: 8756662989 Email: amit.fet@ramauniversity.ac.in	
M.Tech 3[rd] Sem	ENERGY MANAGEMENT AND AUDIT **(MEE-024)**	1. Bhashkar Pandey Assistant Professor KIPM College of Engineering &Technology,Gorakhpur Mob: 9454116782 Email –bhashker22@gmail.com 2. Prof.(Dr.) N.C. Sarkar Principal Diploma SRMU, Barabanki Mob: 9935300964 Email –ncsarkar@gmail.com 3. Mr. S. P. Singh Assistant Professor BBDNITM, Lucknow Mob: 9415159137 Email: singhshivprakash@gmail.com 4. Dr. G. R Mishra Assistant Professor, Department of electrical & Electronics Engineering Amity University Lucknow Campus	1. Mr. Dileep Kumar Assistant Professor FET, Rama University, Kanpur Mob: 8090460055 Email: dileep.fet@ramauniversity.ac.in 2. Mr. Amit Kumar Singh Assistant Professor Dept. of Electrical Engineering FET, Rama University, Kanpur Mob:	

		Mob: 9451805326 Email: grmishra@amity.edu	8756662989 Email: amit.fet@ramauniversity.ac.in	
M.Tech 3rd Sem	NON CONVENTIONAL ENERGY SYSTEMS **(MEE-038)**	1. Bhashkar Pandey Assistant Professor KIPM College of Engineering &Technology,Gorakhpur Mob: 9454116782 Email –bhashker22@gmail.com 2. Dr. G. R Mishra Assistant Professor, Department of electrical & Electronics Engineering Amity University Lucknow Campus Mob: 9451805326 Email: grmishra@amity.edu 3. Prof.(Dr.) N.C. Sarkar Principal Diploma SRMU, Barabanki Mob: 9935300964 Email –ncsarkar@gmail.com 4. Mr. S. P. Singh Assistant Professor BBDNITM, Lucknow Mob: 9415159137 Email: singhshivprakash@gmail.com	1. Mr. Amit Kumar Singh Assistant Professor Dept. of Electrical Engineering FET, Rama University, Kanpur Mob: 8756662989 Email: amit.fet@ramauniversity.ac.in 2. Mr. Dileep Kumar Assistant Professor FET, Rama University, Kanpur Mob: 8090460055 Email: dileep.fet@ramauniversity.ac.in	

List of External Practical Examiner
~~Diploma~~, M.Tech (Electrical Engineering), 2020-21, Odd Sem

Sem	Name of the subject With code	Name of the External with address, contact no. &E-mail	Name of the Internal with address, contact no. & E-mail	Name of the moderator
M.Tech I[st] Sem	**Power System Lab (MEE-151)**	1. Prof.(Dr.) N.C. Sarkar Principal Diploma SRMU, Barabanki Mob: 9935300964 Email ncsarkar@gmail.com 2. Mr. S. P. Singh Assistant Professor BBDNITM, Lucknow Mob: 9415159137 Email:singhshivprakash@gmail.com 3. Mr. Sumer Chand Prasad Assistant Professor PSIT, Kanpur Mob: 9454343508 Email: sumer_p@yahoo.com 4. Mr Deepak Sati Assistant Professor S.C.E.R.T Barabanki Mob-9720962852 Email:er.deepaksati@gmail.com	1. Mr. Amit Kumar Singh Assistant Professor Dept. of Electrical Engineering FET, Rama University, Kanpur Mob: 8756662989 Email: amit.fet@ramauniversity.ac.in 2. Mr. Dileep Kumar Assistant Professor FET, Rama University, Kanpur Mob: 8090460055 Email: dileep.fet@ramauniversity.ac.in	
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