Name of the Program: **III Semester M. Tech. (Energy Management Systems)**
Course Code: **PEMS31**
Course Title: **SELF STUDY COURSE**

Lectures	Tutorial(s)	Practical	Total periods/week (each of 60 minutes duration)	Credits
-	02	-	02	04

Evaluation System						
Theory				Practical		
MSE	IE	ESE	TOTAL	TW	POE	TOTAL
10	20	70	100	-	-	-

Contents

Recent trends in PV cell designing. SPV Balance of System, Battery sizing. Fuel cell design aspects.

Salient features and different WTGs: SFIG, DFIG and PMSG type. Wind electricity development in India. Removal of CO2 and H2O from bio gas. Biogas Compression techniques. Energy Plantation.

Diesel generating systems, Factors affecting selection, energy performance assessment of diesel generating systems, its environmental & economic issues.

Financial analysis of energy system: Project cash flows, time value of money, life cycle approach; Project appraisal criteria; Risk analysis; Aims oriented project planning; Social cost benefit analysis.

General Principles & Strategy of Energy Management, Methods for preparing process flow, Materials and Energy Balance diagram, Identification of losses and Improvements. Energy Balance sheet and Management Information System (MIS).

Reference Books

The students are advised to refer the text books mentioned for all the theory courses of First & Second Semester M.Tech(EMS) program.

Name of the Program: **III Semester M. Tech. (Energy Management Systems)**
Course Code: PEM32x
Course Title: **ADVANCE POWER ELECTRONICS (ELECT-III)**

Lectures	Tutorial(s)	Practical	Total periods/week (each of 60 minutes duration)	Credits
03	02	-	05	04

Evaluation System

		Theory			Practical	
MSE	IE		ESE	TOTAL	TW	POE	TOTAL
10	20		70	100	-	-	-

Contents

Resonant Converters:
Introduction Basic resonant circuit concepts Classification Load resonant converters Resonant switch converters Zero voltage switching clamped voltage converters Resonant DC link inverters High frequency link integral half cycle converters Phase modulated resonant converters.

Modeling of DC
DC Converters:Basic ac modeling approach State space averaging Circuit averaging and averaged switch modeling Canonical circuit modeling Converter transfer functions for buck boost and buckboost topologies.

Current Mode Control Introduction types advantages and disadvantages Slope compensation Determination of duty cycle and transfer functions for buck boost and buckboost converters.

Design of Switching Power Converters:Controller Design: Introduction mechanism of loop stabilization Shaping E/A gains vs frequency characteristics Conditional stability in feedback loop Stabilizing a continuous mode forward and flyback converter Feedback loop stabilization with current mode control right plane zero.Design of Power Converters Components: Design of magnetic componentsdesign of transformer Design of Inductor and current transformer Selection of filter capacitor Selection of ratings for devices input filter design Thermal design

Reference Books

1.Power Electronicscircuits, Devices & Applications: M.H.Rashid, PHI.
2.Power Electronics: Converters, Applications & Design: NedMohan, T.M.Undeland, William P.Robbins, John Wiley & Sons.
3.Switching Power Supply Design: Abraham I. Pressman, Mc Graw Hill International.
4.IEEE Publications on Power Electronics

Name of the Program: **III Semester M. Tech. (Energy Management Systems)**
Course Code: PEM32x
Course Title: **ENERGY EFFICIENT BUILDING (ELE-III)**

Lectures	Tutorial(s)	Practical	Total periods/week (each of 60 minutes duration)	Credits
03	02	-	05	04
		Theory	Practical	

MSE	IE		ESE	TOTAL	TW	POE	TOTAL
10	20		70	100	-	-	-

Contents

ArchitectureBuilding Science and its significance. Indoor Environment. Components of Indoor Environment. Quality of Indoor Environment.

Human ComfortThermal, Visual, Acoustical and Olfactory comfort. Concept of Solair temperature and its significance. Ventilation and is significance.

Cooling and heating concepts, Passive concepts appropriate for the various climatic zones in India. Classification of building materials based on energy intensity.

Energy Management of Buildings and Energy Audit of Buildings.Energy management matrix monitoring and targeting.

Energy Efficient Landscape DesignModification of microclimate through landscape elements for energy conservation.

Reference Books

1.SodhaM.,Bansal, N.K., Bansal,P.K., Kumar, A.. and Malik, M.A.S.,"Solar Passive Buildings", Pergamon Press, 1986.
2. Koenigsberger, O.H., Ingersoll, T.G., Mayhew Alan and Szokolay, S. V., "Manual of Tropical Housing and Building part 1: Climatic Design", OLBN 0 00212 0011,Orient Longman Limited, 1973
3. Bureau of Indian Standards, I.S. 11907 1986 Recommendations for calculation of Solar Radiation Buildings, 1986.
4. Givoni,B., "Man, Climate and Architecture", Elsevier, Amsterdam, 1986.
5. Smith, R. J., Phillips, G.M. and Sweeney, M. "Environmental Science", Longman Scientific and Technical, Essex, 1982.

Name of the Program: **III Semester M. Tech. (Energy Management Systems)**
Course Code: PEM32x
Course Title: **THERMAL STORAGE SYSTEM (ELECT-III)**

Lectures	Tutorial(s)	Practical	Total periods/week (each of 60 minutes duration)	Credits
03	02	-	05	04
		Theory	Practical	

MSE	IE		ESE	TOTAL	TW	POE	TOTAL
10	20		70	100	-	-	-

Contents

INTRODUCTIONNeed of Energy Storage, Different modes of Energy Storage.

ENERGY STORAGEPotential Energy: Pumped Hydro Storage, KE and Compressed gas system: FlywheelStorage, Compressed air energy Storage, Electrical and magnetic energy storage: Capacitors, Electromagnets and battery storage systems.

Chemical Energy Storage: ThermoChemical, BioChemical, Electro Chemical, Fossil fuels and synthetic fuels and Hydrogen storage.

SENSIBLE HEAT STORAGE SHS mediums, Stratified storage systems, Rockbed storage systems, Thermal storage in buildings, Earth storage, Energy storage in aquifers, Heat storage in SHS systems, Aquifers storage.

LATENT HEAT THERMAL ENERGY STORAGE Phase Change Materials(PCMs), Selection Criteria Of PCMs, Stefan Problem, Solar Thermal LHTES Systems, Energy Conservation Through LHTES Systems, LHTES Systems in Refrigeration and Air Conditioning Systems.

Enthalpy formulation, Numerical heat transfer in melting and freezing process.

SOME AREAS OF APPLICATION OF ENERGY STORAGE Food Preservation, Waste Heat Recovery, Solar Energy Storage, Green House Heating,

Power Plant Applications, Drying and Heating for Process Industries.

Reference Books

1.H.P.Garg et al, D Reidel (1885) "Solar Thermal Energy Storage", Publishing Co.
2.V Alexiades&A.D.Solomon(1993)"Mathematical Modeling of Melting and Freezing Proces" ,Hemisphere Publishing Corporation,
3.WashingtonNarayan R, ViswanathB(1998),Chemical and Electro Chemical Energy System, Universities Press
4.A. TerGazarian(1994), "Energy Storage for Power Systems", Peter PeregrinusLtd.London
5.B.Kilkis and S.Kakac (1989),"Energy Storage Systems",(Ed),KAP,London,1989

Name of the Program: **III Semester M. Tech. (Energy Management Systems)**
Course Code: PEM32x
Course Title: **DATA ANALYSIS (ELECT-III)**

Lectures	Tutorial(s)	Practical	Total periods/week (each of 60 minutes duration)	Credits
03	02	-	05	04
		Theory	Practical	

MSE	IE		ESE	TOTAL	TW	POE	TOTAL
10	20		70	100	-	-	-

Contents

INTRODUCTION TO BIG DATA:
Introduction to Big Data, Distributed file system, Big Data and its importance, Four Vs, Drivers for Big data, Big data analytics, Big data applications.
Data Analytics Life Cycle: Introduction to Big data Business Analytics - State of the practice in analytics, role of data scientists - Key roles for successful analytic project - Main phases of life cycle Developing core deliverables for stakeholders.

DATA ANALYSIS:
Evolution of Analytic scalability, analytic processes and tools, Analysis vs reporting – Modern data analytic tools, Statistical concepts: Sampling distributions, resampling, statistical inference, and prediction error. Regression modeling, Multivariate analysis, Bayesian modeling, inference and Bayesian networks, Support vector and kernel methods, Analysis of time series: linear systems analysis, nonlinear dynamics, learning and generalization, competitive learning.

MINING DATA STREAMS:
Introduction to Streams Concepts – Stream data model and architecture – Stream Computing, Sampling data in a stream – Filtering streams – Counting distinct elements in a stream – Estimating moments – Counting oneness in a window – Decaying window – Realtime Analytics Platform (RTAP) applications – case studies – real time sentiment analysis, stock market predictions.

FREQUENT ITEMSETS AND CLUSTERING:
Mining Frequent itemsets – Market based model – Apriori Algorithm – Handling large data sets in Main memory – Limited Pass algorithm – Counting frequent itemsets in a stream – Clustering Techniques – Hierarchical – K- Means – Clustering high dimensional data – CLIQUE and PROCLUS – Frequent pattern based clustering methods – Clustering in non-euclidean space – Clustering for streams and Parallelism.

FRAMEWORKS AND VISUALIZATION:
Introduction to 'R', MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases – S3 – Hadoop Distributed file systems – Visualizations – Visual data analysis techniques, interaction techniques; Systems and applications:

Reference Books

1. Michael Berthold, David J. Hand, Intelligent Data Analysis, Springer, 2007.
2. AnandRajaraman and Jeffrey David Ullman, Mining of Massive Datasets, Cambridge University Press, 2012.
3. Bill Franks, Taming the Big Data Tidal Wave: Finding Opportunities in Huge Data Streams with advanced analystics, John Wiley & sons, 2012.
4. Glenn J. Myatt, Making Sense of Data, John Wiley & Sons, 2007 Pete Warden, Big Data Glossary, O'Reilly, 2011.
5. Jiawei Han, MichelineKamber "Data Mining Concepts and Techniques", Second Edition, Elsevier, Reprinted 2008.
6. Mark Gardener, "Beginning R - The Statistical Programing Language", John Wiley & Sons, Inc., 2012.

Name of the Program: **III Semester M. Tech. (Energy Management Systems)**
Course Code: PEM32x
Course Title: **NEURAL NETWORK & FUZZY LOGIC (ELECT-III)**

Lectures	Tutorial(s)	Practical	Total periods/week (each of 60 minutes duration)	Credits
03	02	-	05	04
		Theory	Practical	

MSE	IE		ESE	TOTAL	TW	POE	TOTAL
10	20		70	100	-	-	-

Contents

Evolution of neural networks; Artificial Neural Network: Basic model, Classification, Feed forward and Recurrent topologies, Activation functions; Learning algorithms: Supervised, Un-supervised and Reinforcement; Fundamentals of connectionist modeling: McCulloach – Pits model, Perceptron, Adaline, Madaline.

Topology of Multi-layer perceptron, Back propagation learning algorithm, limitations of Multi-layer perceptron. Radial Basis Function networks: Topology, learning algorithm; Kohenen's self-organising network: Topology, learning algorithm; Bidirectional associative memory Topology, learning algorithm, Applications.

Recurrent neural networks: Basic concepts, Dynamics, Architecture and training algorithms, Applications; Hopfield network: Topology, learning algorithm, Applications; Industrial and commercial applications of Neural networks: Semiconductor manufacturing processes, Communication, Process monitoring and optimal control, Robotics, Decision fusion and pattern recognition.

Classical and fuzzy sets: Introduction, Operations and Properties, Fuzzy Relations: Cardinality, Operations and Properties, Equivalence and tolerance relation, Value assignment: cosine amplitude and max-min method; Fuzzification: Membership value assignment- Inference, rank ordering, angular fuzzy sets. Defuzzification methods, Fuzzy measures, Fuzzy integrals, Fuzziness and fuzzy resolution; possibility theory and Fuzzy arithmetic; composition and inference; Considerations of fuzzy decision-making.

Basic structure and operation of Fuzzy logic control systems; Design methodology and stability analysis of fuzzy control systems; Applications of Fuzzy controllers. Applications of fuzzy theory.

Reference Books

1. Limin Fu, *"Neural Networks in Computer Intelligence,"* McGraw Hill, 2003.
2. Fakhreddine O. Karray and Clarence De Silva., *"Soft Computing and Intelligent Systems Design, Theory, Tools and Applications,"* Pearson Education, India, 2009.
3. Timothy J. Ross, *"Fuzzy Logic with Engineering Applications,"* McGraw Hill,1995.
4. B.Yegnanarayana, *"Artificial Neural Networks,"* PHI, India, 2006.

Name of the Program: **III Semester M. Tech. (Energy Management Systems)**
Course Code: **PEMS34**
Course Title: **PRE DISSERTATION**

Lectures	Tutorial(s)	Practical	Total periods/week (each of 60 minutes duration)	Credits
-	06	-	06	05

Evaluation System						
Theory				Practical		
MSE	IE	ESE	TOTAL	TW	POE	TOTAL
-	-	-	-	100	50	150

WORK EXPECTED TO BE CARRIED OUT

The Pre Dissertation is the preliminary work required to be carried by the Candidate, under the supervision of his/ her allotted Supervisor, towards acquiring the goals of his/ her targeted Dissertation work.

The PRE DISSERTATION work shall involve (but not limited to) the categories of preparation as mentioned below, as far as possible :

- Discussing the proposed work with his/ her Guide in the period allotted during the week. Finalizing broad topic to be taken for Dissertation work.

- Extensive literature Survey on the related topic & collection of hard copies of the research papers.
  Securing permission from the Company, if the work is to be experimented/ investigated in Company.
  Developing outline of Model/ Experiment(s)/ investigations/ analysis to be carried out.
  If model is to be fabricated, the list of required materials/ equipments/ instruments shall be prepared. Their suppliers / manufacturers shall be contacted & the quotations shall be kept ready.
- Related Computer software shall be mastered, if computer simulation is there. Presentation of work.
  Any other specific preparation.

The above mentioned tentative preparation(s) may change partially depending on the individual's need & requirements. However, the PRE DISSERTATION work shall be assessed with respect to all such preparation categories only for award of marks in Term Work. However, the marks in POE shall be awarded in the presence of EXTERNAL EXAMINER based on Candidate's performance in Presentation and/or viva voce.

Name of the Program: **III Semester M. Tech. (Energy Management Systems)**
Course Code: **PEMS33**
Course Title: **INDUSTRIAL TRAINING**

Lectures	Tutorial(s)	Practical	Total periods/week (each of 60 minutes duration)	Credits
-	05	-	05	05

Evaluation System						
Theory				Practical		
MSE	IE	ESE	TOTAL	TW	POE	TOTAL
-	-	-	-	150	50	200

WORK EXPECTED TO BE CARRIED OUT

The **INDUSTRIAL ENERGY / ENVIRONMENTAL AUDIT TRAINING** is included in the syllabus to give practical feel of understanding/ assessing/ investigating/ applying the contents of the subjects which they have studied during their first year of the course. As mentioned in the title itself, the Training may be carried out in either of the field of Industrial Energy Audit or Environmental Audit Training.

Following are the important points that shall govern this Training :

- The Training shall be undertaken individually by the Students in Industries, Organizations, Plants or Multi storied Buildings.
- The students shall report weekly to the allotted Supervisor (same as Pre Dissertation) to apprise him/ her about the progress of the work.
- To undertake extensive training for ONE MONTH, as envisaged in the Course scheme.
- To submit TRAINING CERTIFICATE from the competent authority from Industry/ Organization/ Plant, in respect of satisfactory completion of the Training.

The Training carried out by the Candidate shall be assessed & evaluated by the Department to award suitable marks/ grades to the Candidate, in Term Work. However, the marks shall be granted on the basis of candidate's performance in VIVA VOCE to be conducted in the presence of External Examiner for POE.

Name of the Program: **IV Semester M. Tech. (Energy Management Systems)**
Course Code: **PEMS41**
Course Title: **FINAL DISSERTATION**

Lectures	Tutorial(s)	Practical	Total periods/week (each of 60 minutes duration)	Credits
-	10	-	10	18

Evaluation System						
Theory				Practical		
MSE	IE	ESE	TOTAL	TW	POE	TOTAL
-	-	-	-	150	200	350

WORK EXPECTED TO BE CARRIED OUT

The AICTE envisages expanding the research attitude/ thinking/ potential/ interest of the Candidate while pursuing his/her Post Graduate Course in Engineering & Technology. This reflection is observed in the **FINAL DISSERTATION** work carried out by the Candidate.

The following points shall govern the procedure & quality of Final Dissertation work to be carried out by the Candidates:

- The Candidate shall work under the SUPERVISOR appointed by the Department, to whom he/ she shall be reporting every week, as per time table schedule.
- The Supervisor shall monitor the progress of work.
- The FINAL DISSERTATION shall be carried out as per Topic & Plan prepared during the PRE DISSERTATION work.
- The work carried out shall meet the standard & quality as defined by the Department.
- The final Dissertation shall be allowed to be submitted only after successful & satisfactory deliver of the GRAND SEMINAR in the Department.

The FINAL DISSERTATION carried out by the Candidate shall be assessed & evaluated by the Department for TERM WORK to award suitable marks to the Candidate on the basis of performance in following areas :

(i)	Quality of Work & Innovativeness	:	75
(ii)	Publications based on the Work	:	50
(iii)	Grand Seminar	:	25
	T O T A L	:	150

However, the marks shall be granted on the basis of candidate's performance in PRESENTATION and/ or VIVA VOCE to be conducted in the presence of External Examiner for POE.

Name of the Program: M. Tech. (Energy Management Systems)

DETAILED EVALUATION PROCEDURE

EXAMINATION	PROCEDURE OF EVALUATION
MSE (MID SEMESTER EXAMINATION) **(10-MARKS)**	The Mid Semester Examination marks shall be awarded by the concerned Subject Teacher on the basis of candidate‟s performance in the written examination conducted by the Department. Usually, the MSE‟s of two subjects shall be held on the same day. This will be ONE HOUR examination.
(IE) INTERNAL EVALUATION **(20-MARKS)**	The marks allotted for IA shall be awarded by the concerned Subject Teacher on the basis of Candidates performance in: Alertness/ response in the Class (05) Attendance (05) Assignments/ Tutorials (10)
(ESE) END SEMESTER EXAMINATION **(70-MARKS)**	The ESE shall be conducted by the University, as per schedule floated by it, as per its governing rules & regulations. This will be THREE HOURS written examination. The Theory paper of ESE shall comprise of EIGHT questions in all, out which the Candidate shall be required to answer ANY FIVE. All the Questions shall carry equal marks (14).
(TW) TERM WORK	The TERM WORK (TW) shall be there for the practical passing head and other passing Heads, for which theory evaluation is not there. The procedure of evaluation is already mentioned under the syllabus of respective head.
POE (PERFORMANCE & ORAL EXAMINATION)	The POE shall be there for all the passing heads where TW is there. The procedure of evaluation is already mentioned under the syllabus of respective head.