SCHEME OF TEACHING AND EXAMINATION

M.TECH.- Energy Systems & Management (EEM)

I SEMESTER

Subject Code	Name of the Subject	Teaching hours/week			Duration of Exam in Hours	Marks for			Total Marks
						Internal Assessment		Exam	
		Lecture	Practical	Field Work / Tutorial		Test	Practical/ Field Work / Tutorial		
10EEM11	Applied Mathematics	4	--	2	3	30	20	100	150
10EEM12	Energy Storage Devices	4		2	3	30	20	100	150
10EEM13	Energy Auditing	4	2	--	3	30	20	100	150
10EEM14	Electrical Energy Conservation and Management	4	2	--	3	30	20	100	150
10EEM15X	Elective-I	4	--	2	3	30	20	100	150
10EEM16	Seminar	--	--	3	--	Topic Content-25 Presentation-25		--	50
Total		**20**	**04**	**09**	**15**	**300**		**500**	**800**

Note: The internal assessment marks for core subjects with two hours of practical is 30 marks for theory and 20 marks for practical.

Elective – I	
10EEM151	Computer Modeling of Electrical Power System
10EEM152	Switched mode Power Conversion
10EEM153	Engineering Economics & Management

M.TECH.- Energy Systems & Management (EEM)

Semester-I

10EEM11 APPLIED MATHEMATICS

Subject Code	**10EEM11**	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Numerical Methods: Solution of Polynomial equations-Iterative methods for simple roots, multiple roots, complex roots. Iterative methods for a system of nonlinear equations-Newton-Raphson method. Iterative methods for Polynomial equations-Birge-Vieta method, Bairstow method.

Linear algebraic equations and eigen value problems-Greschgorin circle, Iteration methods-Gauss-Seidel method. Eigen value problems-Finding all the eigen values, finding the largest eigen value.

Spline Interpolation-Direct Integration of Second order differential equations-Dahlquist methods, Numerov method-Stability

Calculus of variations-Introduction, Fundamental Theorem Functional of single function, Euler's equation Geodesics.

Integer Arithmetic: Eucledian algorithm, the Diaphantine equation, Linear congruence-Chinese remainder Theorem, Fermats factorization method, Fermats Little Theorem, Euler's Phi-function-properties-Euler's Theorems, Cryptography

Stochastic Processes: Overview of Probability-Conditional probability-Random variables & distributions-Binomial, Poisson & Normal distributions-mean and variance, joint Probability density function.

Sequences of random variables, limit theorem, central limit theorem, Random processes, Correlation function, Power Spectral densities.

REFERENCE BOOKS:

M.K. Jain, S.R.K. Iyengar and Jain R.K. "**Numerical Methods**", 1995, Wiley Eastern.
M.K. Jain, "**Numerical Solution of Differential Equations",** 2nd Edition, Wiley Eastern Ltd.
Donal E. Kirk, "**Optimal Control Theory",Universal Book Stall**, Delhi. 1995
B.S. Grewal, "**Higher Engineering Mathematics**" 35th Edition, 2000
A Popoulis, Probability, "**Random Variables, Statistical Processes**" Edn. 4, McGraw Hill.
Manson Hayes, "**Statistical Digital Signal Processes**" Wiley Eastern Ltd. \

10EEM12 ENERGY STORAGE DEVICES

Subject Code	**10EEM12**	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Introduction: Traditional use of fuels for storage Load management, Space conditioning. Transportation. Utility system. Variable energy sources. Role of different energy forms. Energy quality. Energy efficiency. Energy and power densities.

Storage Methods:

(a) Mechanical energy storage – gravitational (elevated masses, natural water cycle, pumped hydro-storage). Elastic (solid springs and rubber, compressed gases). Kinetic energy (linear motion, rotational motion, fly wheels).

(b) Electromagnetic energy storage – Static fields, transient electric fields, magnetic materials, transient magnetic fields, radiant storage.

(c) Organic fuels – Biomass (living bio-mass storage, harvested bio-mass, coal lignite and peat), liquid bio-fuels (oil, synthetic crude, liquid fuels iron biomass), gaseous bio-fuels (natural gas, synthesized gas, gaseous fuels from biomass).

(d) Hydrogen – gaseous and liquid hydrogen, hydrides,

(e) Electro-chemical storage, Electro-chemical cell, fuel cells, batteries (lead acid, alkaline electrolyte, high temperature).

(f) Chemical reaction storage. Phase transition. Heat capacity. Nuclear fuel.

Energy Storage Systems : (a) Storage applications – utilities, transport, industry, households, (b) Total energy system – hybrid, combined, integrated.

REFERENCE BOOKS :

Johannes Jensen Bent Squrensen, "**Fundamentals of Energy Storage**", John Wiley, NY , 1984.
IEE Energy Series' "**Electro-chemical Power Sources"**.
Baader, W., Dohne, E., Brenndorfer**,** "**Bio-gas in Theory and Practice"**
P.D.Dunn, "**Renewable Energies**". Peter Peregrinus Ltd, London, United Kingdom , First Edition, 1986

10EEM13 ENERGY AUDITING

Subject Code	**10EEM13**	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

History of Energy Management: Energy forecasting, Limitations of energy resources. Renewable energy recourses. Load management. Energy management. Demand side management (DSM) Energy conservation in realistic distribution system. Short term load forecasting for de-centralized load management.

Energy Situation and Global Energy Sources: World energy consumption. Energy in developing countries. Firewood crises. Indian energy sources. Non-conventional renewable energy sources. Potential of renewable energy sources. Solar energy types. Wind energy. Wave, tidal and OTEC. Super-conductors in power system. Wind power generation for large scale generation of electricity. Wind driven induction generators. .

Energy Auditing as Applicable to an Industry: Classification of energy audit System optimization. Power factor improvement. Preventive maintenance. Process modification. Non-conventional energy sources. Electricity tariffs. Types of off-peak tariffs. .

Elements of Energy Auditing and Metering Methodologies(Case Studies): Capacity utilization. Technology up-gradation. Fine tuning. Energy conservation. Concept and methods of energy conservation.

Demand Side Management: Introduction to DSM . Concept of DSM. Benefits from DSM. DSM techniques. Time of day pricing. Multi-utility exchange model. Time of day pricing models for planning, load management. Load priority technique. Peak clipping. Peak shifting. Valley filling. Strategic conservation. Energy efficient equipment. Socioeconomic awareness programs.

REFERENCE BOOKS:

D.P.Sen Gupta, K.R.Padiyar, Indranil Sen, M.A. Pai(ED)' "**Recent Advances in Control and Management of Energy Systems**", Interline Publishers, Bangalore, 1993
Munasinghe, Mohan; Desai, Ashok V –" **Energy Demand** :**Analysis, Management and Conservatioin**", Wiley Eastern Ltd., New Delhi, 1990.

TERI Reports.
Jyothi Prakash- "**Demand Side Management**", Tata McGraw-Hill Publishers.
VI NPSA 1990 – "**Power Systems for the Year 2000 and Beyond**"
N.K.Bansal, Kleeman Millin, "**Renewable Energy Sources and Conservation Technology**", Tata McGraw-Hill Publishers, 1990

10EEM14 ELECTRICAL ENERGY CONSERVATION AND MANAGEMENT

Subject Code	**10EEM14**	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Power Sector Reforms in India: Study of power sector reforms. Various governmental and non-governmental agencies related to power sector. Power sector rules and regulations.

Electric Motors.: Motor efficiency, Motor selection. Factors affecting motor performance. Electricity use efficiently. Measuring load. Reducing under-loading. Sizing to variable load. Energy efficient motors. Power factor correction. Flat belt transmission drove. Case studies.

Pumps and Fans: Pump system design. Input energy requirements. Sensor location in variable speed design. Estimating systems pressure loss. Variable speed drives for pumps. Fan system design. System characteristics. Matching fan and system characteristics. Efficient system operation. Capacity control. Variable speed. Case studies.

Compressors: Air compressor systems. Efficient system design. Capacity control, System design for variable loads. Losses – refrigeration system design. Efficient system operation. Matching capacity to varying system load. Electrical controls.

Energy Conservation in Industrial Lighting: Choice of lighting, Energy saving. Control of lighting. Energy consumption management.

Economic Operation of Industrial DG Sets: Maintenance practice. Load matching. PF improvement and parallel operation. Waste heat recovery in industrial DG sets

Strategies for Promotion of Cogeneration: Types of cogeneration processes. Topping cycle plant. Bottoming cycle plant. Choice of configuration. Effect of legislation. Case studies.

REFERENCE BOOKS:

K.R.Gangadhar Rao, "Electrical Estimating and Energy Mangement", Sapna Book House , 1998.
M.V.Despande , "Elements of Electrical Power Station Design", 3rd Edition, Wheeler Publishing, 1986.
M.M.El-Wakil, "Power Plant Technology", Mc.Graw Hill International Edition, 1984.
Proceedings of National Productivity Council, 1977 – "**Electrical Energy Conservation"**
Government of India, "**Annual Reports of Ministry of Power**".

10EEM151COMPUTER MODELING OF ELECTRICAL POWER SYSTEM

Subject Code	**10EEM151**	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Introduction to Modeling of Power Transmission Plant: Introduction. Linear transformation techniques. Basic single phase modeling. Three phase system analysis. Three phase models of transmission lines and transformers. Formation of the system admittance matrix.

Modeling of Static AC-DC Conversion Plant: Introduction. Rectification, inversion. Commutation reactance. DC transmission.

Load Flow: Introduction, Basic nodal-method. Conditioning of Y matrixwhen one voltage is known. Analytical definition of the problem. Newton-Raphson method of solving load flow problem. Techniques that make Newton-Raphson Method competitive in load flow. Characteristics of the Newton-Raphson load flow method. Decoupled Newton load flow method. Fast Decoupled load flow. Convergence criteria and tests. Numerical examples.

AC-DC Load Flow: Introduction. Formulation of the problem. DC system model. Solution techniques. Control of converter AC terminal voltage. Extension to multiple and or multi-terminal DC systems. DC convergence tolerance. Test system and results, Numerical examples.

REFERENCE BOOKS:

J.Arrillaga and C.P.Arnold and B.J.harker, "**Computer Modeling of Electrical Power Systems**", Wiley Inter-science Publications, John Wiley & Sons(Text Book).

E.Clarke-"**Circuit Analysis of AC Power Systems**", Vol.I John Wiley & Sons Ltd, New York.

Glenn W.Stagg and E.L.Abiad, "**Computer Methods in Power System Analysis**", McGraw Hill Publishers.

E.W.Kimbark "**Direct Current Transmission**", Vol.1, Wiley Inter-Science, London

10EEM152 SWITCHED MODE POWER CONVERSION

Subject Code	**10EEM152**	IA Marks	: 50
No. of Lecture Hours/Week	04	Exam Hours	: 03
Total No. of Lecture Hours	52	Exam Marks	: 100

DC-DC Converters (Basic Converters): Principle of operation and analysis of Buck, Boost, and Buck-Boost converter for continues and discontinues current mode.

Derived Converters: Principle of operation and analysis of forward, Flyback, Pushpull, Half bridge, Full bridge converters, cuk converters.

Control of DC-DC Converter: Modelling of DC-DC Converters using state space averaging, current mode control.

Resonant Converters: Introduction, classification, Basic Resonant circuit concepts, Resonant switch converters, Zero voltage switching, clamped voltage topologies, Resonant DC buck converters.

REFERENCE BOOKS:

Ned Mohan, Tore.M. Undeland and William.P Robbins, "**Power Electronics Converters"**, applications and design", John Wiley 2003

Rashid M.H. Power Electronics – "**Circuits Devices and Applications**", Prentice Hall India Third Edition

10EEM153 ENGINEERING ECONOMICS AND MANAGEMENT

Subject Code	**10EEM153**	IA Marks	50
No. of Lecture Hours/Week	04	Exam Hours	03
Total No. of Lecture Hours	52	Exam Marks	100

Interest and Time Value of Money: Simple interest. Compound interest. Single payments. Uniform series payments. Interest factors and tables. Nominal and effective interest rates. Continuous compounding. Uniform continuous payments.

Methods for Evaluation of Tangible Alternatives: Present worth comparison. Equal, unequal live assets. Study period. Capitalized cost. Bond valuation. Equivalent uniforms annual cost comparison. Rate of return comparison.

Replacement Analysis: Review of conventional approach. Analysis with time value accounting. Current salvage value of the defender. Defender and challenger with different lives. Additional one year assessment. Review of project management – PERT and CPM Crashing cost system.

Project Feasibility Analysis: Case study: Report preparation. Depreciation reasons,depreciation accounts. Causes of declining value. Depreciation methods. Costs volume profit analysis. Review of conventional approach. Analysis with time value, linear, nonlinear multi product analysis.

Marketing Feasibility: Types of market identification of investment opportunities. Market and demand analysis. Forecasting demand(review). Forecast control. Secondary sources of information.

Technical Feasibility: Product design and development. Concept of concurrent engineering. Plant design and capacity planning. Equipment selection. Process planning. Line balancing. Purchasing, Make versus buy decisions. Productivity analysis.

Financial feasibility: Means of financing. Financial institutions – all India and state level. Profitability. Cash flows of a project. Financial leverage of a business. Tax factors in investment analysis. Direct, indirect, advance tax. Tax rates. Incentives for new industries in backward areas.

Risk Analysis and Decision Trees: Recognizing risk, including risk in economic analysis. Expected value. Payoff table. Decision trees, Discounted decision trees. Present economic policy. Liberalization, Privatization, Globalization, Scope for industrial growth.

REFERENCE BOOKS:

James.L.Riggs – "**Essentials of Engineering Economics**", Mcgraw Hill Book Company, 1982

Prasanna Chandra, "**Project Preparation, Appraisal and Implementation"**, Tata McGraw Hill, New Delhi, 1992(Text book)

Norman.N.Barish, "**Economics Analysis for Engineering and Managerial Decision Making**", McGraw hill Book Company, 1983

Leland.T.Blank, Anthony.J.Jarquin, "**Engineering Economy**", McGraw Hill Company, 1983.