TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING

COURSE OUTLINES

OF

PROPOSED MASTERS OF SCIENCE IN ENERGY SYSTEMS PLANNING AND MANAGEMENT (MS-ESPM)

January 2012

(Approved by Subject Committee of Mechanical Engineering, IOE, TU)

1. MARK DISTRIBUTION IN EACH COURSE PER SEMESTER

Year I **Part A**

S.N.	Teaching Schedule							Examination Schedule			Total	Remarks
	Course Code	Course Title	Credit	L	T	P	Total	Theory				
								Assessment Marks	Final			
									Duration	Marks		
1	EG801ME	Applied Statistics and Research Methodology	3	3	1	0	4	40	3	60	100	
2	EG802ME	Energy Economics & International Energy Markets	3	3	1	0	4	40	3	60	100	
3	EG803ME	Operation Research /Management Science	3	3	1	0	4	40	3	60	100	
4	EG804ME	Thermo-fluid Engineering	3	3	1	0	4	40	3	60	100	
5	EG805ME	Energy Resources	3	3	1	0	4	40	3	60	100	
		Total	**15**	**15**	**5**	**0**	**20**	200		300	500	

Year I **Part B**

S.N.	Teaching Schedule							Examination Schedule			Total	Remarks
	Course Code	Course Title	Credit	L	T	P	Total	Theory				
								Assessment Marks	Final			
									Duration	Marks		
1	EG851ME	Energy Systems Planning	3	3	1	0	4	40	3	60	100	
2	EG852ME	Energy Financial Management	3	3	1	0	4	40	3	60	100	
3	EG853ME	Climate Change and its Impact on Energy Sector	3	3	1	0	4	40	3	60	100	
4	EG854ME	Hydropower Engineering and Development	3	3	1	0	4	40	3	60	100	
5	EG855ME	Elective I: (one to be taken)	4	3	1	1.5	5.5	40	3	60	100	
		1. Power Plant Technology										
		2. Power Transmission & Distribution										
		3. Power Systems Dynamics & Stability										
		4. Power System Control & Operations										
		5. Renewable Energy Technology										
		6. Maintenance and Refurbishment of Hydro Power Plant										
		Total	**16**	**15**	**5**	**1.5**	**21.5**	**200**		**300**	**500**	

Year II **Part A**

S.N.	Teaching Schedule							Examination Schedule			Total	Remarks
	Course Code	Course Title	Credit	L	T	P	Total	Theory				
								Assessment Marks	Final			
									Duration	Marks		
1	EG901ME	Energy Systems Modelling and Analysis	3	3	1	0	4	40	3	60	100	
2	EG902ME	Energy Strategy, Energy Policy & Regulations	3	3	1	0	4	40	3	60	100	
	EG903ME	Energy Project Development and Social Sector Management	3	3	1	0	4	40	3	60	100	
3	EG904ME	Group Projects	2	2	1	0	3	40	3	60	100	
4	EG905ME	Elective II: (one to be taken)	4	3	1	1.5	5.5	40	3	60	100	
		1. Human Resources Management										
		2. Electricity Economics and Planning										
		3. Energy Operations Management										
		4. Energy Efficiency and Audit										
		5. Reliability & Risk Analysis										
		6. Environ Impact Assessment										
		Total	**15**	**14**	**5**	**1.5**	**20.5**	**200**		**300**	**500**	

Year II **Part A**

S.N.	Teaching Schedule							Examination Schedule			Total	Remarks
	Course Code	Course Title	Credit	L	T	P	Total	Theory				
								Assessment Marks	Final			
									Duration	Marks		
1	EG951XY	Thesis Work / Research Work	16							100	100	
		Total	**16**									

12. COURSE OUTLINE

12.1 EG802ME: Energy Economics & International Energy Markets

Different types of energy and their conversion; perfect competition; energy demand and supply and their elasticities; monopoly national accounts; externalities and energy pollutions; time value of money and project evaluation techniques; supply and cost curves; marginal costs; short term costs; long range marginal costs; Energy derivatives: future and options for managing price risks; electricity and economics; economic pricing mechanisms.

12.2 EG803ME: Operation Research / Management Science

Introduction to Modeling for Decision; data management and analysis; regression analysis ; forecasting models for time-series; introduction to optimization; linear and multi-objective optimization models; interpreting solver results and sensitivity analysis; decision and risk analysis; expected value decision-making; Monte Carlo simulation; optimization and simulation; system modeling and simulations; modeling and simulating dynamic inventory models

12.3 EG804ME: Thermo-Fluid Engineering

Fluid mechanics and Machines: Basic equations of fluid for incompressible and compressible fluid with their applications, Basic flow field, streamlines, velocity potential, stream function, flow net, Open and close conduct flow. Turbine (impulse and reaction) principles, components, force calculation. Pumps and related theories

Thermal Engineering**:** Revision of properties of substances, control mass and control volume formulation of First Law of Thermodynamics, Steady state and unsteady state analysis and applications, Reversible and Irreversible process, entropy and enthalpy generation, Control mass and Control Volume formulation of Second Law of Thermodynamics, Combined Analysis, availability and irreversibility. Thermodynamic cycles, Revision of heat transfer models and Heat exchangers.
Application of thermo-fluid engineering

12.4 EG805ME: Energy Resources

Introduction to energy resources; Energy – the engine of development; estimation and evaluation of energy resources; Combustion fundamentals and theory, Environmental effects of energy; biomass energy resources; fossil fuels and fossil energy; nuclear energy; renewable energy resources; geothermal energy; hydropower energy; Solar energy; wind energy; ocean waves, tide, and thermal energy conversion; energy systems and sustainability metrics, Application of energy resources.

12.5 EG851ME: Energy System Planning

Energy balance; energy demand and supply; energy system analysis; a framework for national energy planning; knowledge on mathematical fundamentals; econometrics and optimization; familiarization with econometric models, input -output models; energy systems planning models

12.6 EG852ME: Energy Financial Management

Types of firms, raising capital, financial markets, dividend policy and cost of capital; understanding financial statements and their analysis; financial and cost accounting; financial forecasting; financial strategic planning and management control; time value of money and capital budgeting techniques; overview of financial management; understanding financial risk management such as futures, options and real options; knowledge about mergers, acquisitions and restructuring

12.7 EG853ME: Climate Change and Its Impact on Energy Sector

Climate change science: introduction to climate change, key indicators of global climate change and evidence, climate change models and scenarios. Climate change impacts, adaptation measures and risk analysis: climate change impacts, adaption measures and risk analysis in agriculture and food security, water resources and energy, climate induced disasters, forest and biodiversity, public health, urban settlement and infrastructure, cross-cutting sectors. Climate change mitigation: technological options for mitigating climate change such as carbon capture and storage, switching to more renewable energy and greater energy efficiency, cost effectiveness analysis of mitigation measures. Climate change policy: global and national policy on climate change, regulatory instruments and human behavior and social change.

12.8 EG854ME: Hydropower Engineering and Development

Power situation; Types and classification; Power Regulation: Definition and meaning of terms like firm power, secondary power, mean & peak load, utilization and factors, power variation, power grids; Planning & layout of hydropower projects: Site selection of hydropower, requirement of hydropower projects, reservoir regulation, layout of hydropower projects; Water retaining structure: dams, choice of dams, design of dam, foundation principle; Regulatory structure: intake, design of intake structure, hydraulic tunnels, design of settling basin, forebay and surge tank, design of forebay, penstock; Spillway: function of spillway, cavitation and erosion, design of silting basin; Hydro-electric machine: hydro mechanical installation, types of turbines, performance characteristics of hydraulic turbines, selection of turbine and specification, introduction of bulb turbine, draft tube, pumps, generators and type, governers; Power Development Policy and Rules: survey licenses, power purchase agreement

12.9 EG855ME (Elective-1):

12.9.1 Power Plant Technology

Compression Ignition and Steam turbine based thermal power plants: Boilers and steam cycle, type of boilers, boiler mountings and accessories, boiler operation, feed water treatment, fuel handling, air path and energy conservation, stack gas path and clean up, handling of products of combustion. Types and principles of operation: Steam nozzles, types of steam turbines and the operation and field of application of gas turbines. Operation and selection of different types of turbines for hydro power plants Current and future trend of technologies: for different types of solar thermal power plants, and solar thermal refrigeration and air conditioning

12.9.2 Renewable Energy System Technology

Solar Thermal System**:** Solar radiation and its characteristics, basic principles and performance of flat plate and solar concentrators, application of active and passive solar thermal systems, Solar PV System: Fundamentals of solar cells, types of solar cells and their fabrication. Application of photovoltaic systems, Micro Hydro: micro hydro power system, site selection, transmission and installation. Wind Energy: Principle of wind energy generation, resource assessment, types of systems and applications. Geothermal Energy: Geophysics, available technology, harnessing geothermal resource. Others: Hydrogen energy, fuel-cells, energy generation from waste, hybrid energy generation systems. Energy Supply and Demand side Management, Environmental Impact Assessment of Renewable Energy Technologies, Carbon trading.

12.9.3 Maintenance and Refurbishment of Hydro Power Plant

Introduction to maintenance engineering, Types of maintenance, Maintenance tools (fault tree analysis and failure mode, effects and criticality analysis etc.), Condition based maintenance, Reliability- centered maintenance, Total productive maintenance. Maintenance practices in power plants in Nepal.

12.9.4 Power System Dynamics and Stability

Introduction to power system dynamics & stability in the operation and design of system Synchronous machine, Exciter and voltage regulators; Function of speed governing systems, Transient Stability; State equation for multi-machine system with one axis model and simulation , Dynamic stability .

12.9.5 Power System Control and Operation

Introduction to power system control and operation; Real Power -Frequency Control, Basics of speed governing mechanism and modeling; Integration of economic dispatch control with LFC; Reactive Power -Voltage Control; Commitment and Economic Dispatch; Computer control of power system; Network topology – state estimation – security analysis and control.

12.9.6 Power Transmission and Distribution

This subject is offered from as inter disciplinary electives from Masters of Science in Power Systems offered by Department of Electrical Engineering.

12.10 EG901ME: Energy Systems Modeling and Analysis

Top down and bottom up approaches in energy systems modeling; scenario analysis in energy systems modeling; different energy modeling frameworks; LEAP; MARKAL; MAED; MESSAGE; TIMES etc; development of energy systems modeling framework and energy analysis

12.11 EG902ME: Energy Strategy, Energy Policy & Regulations

Defining strategy, levels at which strategy operates, Strategic Decision Making and Approaches to Strategic Decision making, Mission and Purpose, Objectives and Goals, Strategic Business Units, Corporate Planning Process, Strategy Formulation and Choice of Alternatives: Strategies — Modernization, Diversification, Integration, Merger, Take-over and Joint Venture strategies, Turnaround-divestment and Liquidation strategies, of Strategic Choice — Industry, competitor and SWOT analysis; Importance of Energy policy, Energy Resource tradeoff; Oil markets and fuel switching; Energy sector economics; Relevant policy mechanism for energy policy, Existing energy policy, Policy drivers and actors, Policy analysis: Establishing evaluative criteria: efficiency, effectiveness, equity, political acceptability, ease of implementation, process values, legal challenges, adaptability, robustness, Regulatory Impact Analysis: Assumption in policy formulation, Evaluating analytical tools , Renewable Fuel Standard; Sensitivity and scenario analysis; Policy design for implementation; Renewable and carbon regulation: Planning Implications from the Interactions between Renewable, Energy Policies and Carbon Regulation

12.12 EG903ME: Energy Project Development and Social Sector Management

Definition and scopes of project, Technical design, Financing, Contracting, Implementation and performance monitoring; Implementation plan for top management, Planning budget, Procurement procedures, Construction, Measurement and Verifications, Conflict Management; Social Management

The course will also cover emerging methods, principles and practices in energy/power project procurement, including Public-Private-Partnerships, carbon project management, and Clean Development Mechanism, etc.

12.13 EG905ME (Elective-2): 4 Credits

12.13.1 Human Resources Management

Introduction to human resource management; Environmental context: New economic policy, technological, socio-economic and political, legal environment structural reforms, their implication for HRM in Nepal; Introduction to strategy and strategic management- The Paradigm shifts in people Management, Emergence of Human Resource Management as a distinct model of people management, Human Resource Planning: recruitment , selection , training & development ; Human Resource Development; HRD Development in Nepal; Labor Performance management and appraisal: Compensation/rewards system; Labor management- Industrial relations, law on industrial relations, characteristic features of industrial relations in Nepal, collective bargaining; Trade unions and trade unionism: Theories of trade unions, trade union law, trade unionism in Nepal, issues and problems, employees associations, managerial unionism

12.13.2 Electricity Economics and Planning

Nature of Planning in Electricity Sector and the Hierarchy of Electricity Planning Models, Electricity Demand Forecasting: Electric Load Representation, Different Approaches for Forecasting, Short Term Demand Forecasting Models, Long Term Demand Forecasting Models, Electricity Demand Side Management: Economic Operation of Power System, Short-term Economic Dispatch, Unit Commitment, Mid-term Scheduling, Hydro-Thermal Scheduling, Generation Planning Techniques: Electricity Generation Technologies, Levelized bus-bar cost analysis, Screening Curve Analysis: Thermal and Hydropower Plants, Key Indices of Power System Reliability and their Calculations, Linear, Mix Integer and Dynamic Programming approach to Planning, Traditional Generation Expansion Planning Models, Integrated Resource Planning Models, Dealing with Uncertainties in Capacity Expansion Planning, Electricity Pricing Theory and Approaches: Objective of Electricity Pricing, Marginal Cost Pricing, Theory of Peak Load Pricing, Buyback rates of Electricity Produced by Independent Power Producers, Deregulation of Electric Utilities**:** Issues and Approaches, Performance Evaluation of Electric Utilities using DEA

12.13.3 Energy Efficiency and Audit

Energy management: need for energy management and energy conservation, energy management process, principles of energy management, Energy auditing: auditing techniques, preliminary and detail energy audit, energy audit tools & instruments, preparation of audit format, energy audit report writing, Boilers energy audit: fuels and combustion process, factors affecting combustion efficiency, combustion equation, boiler efficiency measurement, energy saving opportunities in boiler, Building Energy Audit: building heat gain, types of heating, ventilating and air-conditioning, chilled water storage, thermal insulation, and solar passive architecture; Electrical system audit: understanding utility bill, tariffs, demand charges, ordinary a.c. motors, energy efficient motors, load cycling of motors, power factor improvement, demand management, energy efficient lighting system, energy saving opportunities, Furnaces: types of furnaces, performance evaluation of furnace, fuel economy measures; Compressor**:** types of compressor, compressor selection, monitoring performance, energy saving opportunities in compressed air network

12.13.4 Reliability & Risk Analysis

Reliability concept: reliability function, failure rate, mean time between failures, mean time to failure , a priori and a posteriori concept; mortality curve; useful life availability, maintainability; system effectiveness; Reliability data analysis: time to failure distributions, exponential ,normal gamma, Weibull, ranking of data, probability plotting techniques, hazard plotting; Reliability prediction models : series and parallel models, reliability based design approach, standby systems , application of Baye's theorem, cut and tie set method , Markov analysis , fault tree analysis , limitations. Reliability management: reliability testing, reliability growth monitoring, non parametric methods, reliability and life cycle costs, reliability allocation, replacement mode, reliability methods. Risk assessment: definition and measurement of risks, element of risk assessment, analysis techniques, risk reduction resources, industrial safety and risk assessment.

12.13.5 Environment Impact Assessment

Purpose and aims of EIA; EIA administration and practice; concept of associated assessment processes; key elements of the EIA process; undertaking an EIA; role of public participation; stages that follow EIA; the costs and benefits of undertaking EIA; and understanding of the strengths and limitations of EIA.

12.14 EG951XY Dissertation / Thesis work