TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING

COURSE OUTLINES

OF

M. SC. ENGINEERING
IN
RENEWABLE ENERGY ENGINEERING (MSREE)

2070

1. INTRODUCTION

The Institute of Engineering (IOE), Tribhuvan University has initiated a two years (4-semester) M.Sc. Engineering in Renewable Energy Engineering (MSREE) from 2001. This master's program is offered under the Department of Mechanical Engineering, Pulchowk Campus, Institute of Engineering, Tribhuvan University, Nepal. The 2-year (4-semester) Master of Science program consists of a package of courses covering important areas for designing of various renewable energy technologies including solar PV, solar thermal, bio-fuel, biogas, improved cooking stoves, gasifiers, microhdro etc. It also emphasizes on energy planning, policy making and managing energy systems. This master program is designed to give students a focused, relevant and utilizable body of knowledge in renewable energy technologies suitable for people with an interest in starting and designing, planning as well as managing energy related projects. Graduates from the program will be prepared to work for government and non-governmental institutions, international organizations, corporations/industries, universities, research institutes, and entrepreneurial firms in the knowledge economy with capabilities to innovate, design, plan, implement, manage and formulate energy related policies.

2. ADMISSION REQUIREMENTS

2.1 Program entry requirements

In order to be eligible for admission for Master of Science Engineering in Renewable Energy Engineering (MSREE), a candidate must have:

- A Bachelors' Degree from a Four Year Engineering Program in Mechanical, Electrical, Electronics, Computer, Chemical, Civil, Agriculture and Industrial Engineering or Five Year Program in Architecture from Tribhuvan University and other recognized universities as well as degree equivalent to any of the aforementioned branches of engineering.
- Secure at least a minimum score as prescribed by the Faculty Board in the admission test conducted by the Institute of Engineering.

2.2 Entrance Test

The nature of entrance test will be decided by the Entrance Examination Board of the Institute of Engineering, Tribhuvan University, Nepal.

2.3 Selection

Candidate fulfilling the Program Entry requirements will be selected for admission on the basis of merit based on MSREE Entrance Test.

2.4 Categories of Students

Four categories of students are envisaged in this course and they are:

1. Regular fee paying students
2. Full Fee paying students
3. Sponsored students.

2.5 Duration of Study

A regular student should complete the course within four years. Each student must take a minimum of 60 credits. Students may take more than 60 credits but the excess credit will not be counted for.

3. COURSE STRUCTURE/SYSTEM

This Master Course focuses on the innovation, planning, designing, policy making and management of Renewable Energy technologies and formulating strategies. The program is structured with an objective to produce graduates who will have in-depth knowledge of renewable energy technologies planning, designing, implementing, analysis and formulating strategies so that they have capability to accept both technical and management responsibilities. An important influence is real life problem based learning including case studies and problem solving with quantitative and qualitative models including commercial modeling software.

The course structure is based on the Semester system. The detailed course structure, examination scheme, marks, etc. are listed in detailed course structure sheet.

Each Year is divided in first and second Semester. In first year first semester, five core courses are offered and in second semester, four courses are offered including Elective I and Elective II. Six different elective subjects are offered in second semester under Elective II and students can opt for one of them. The second year, first semester consists of three subjects including one group projects and two elective courses. Under Elective III, two subjects while eight subjects under elective IV from different fields are offered in this semester and students can opt for one of them for each category. Proposal defense will be conducted in second year first semester. The second year second semester is entirely allocated for dissertation work. The dissertation shall be individual's work and be extensive and normally field based. Students shall be encouraged to publish research papers in national and international journals as an outcome of their dissertation work.

4. COURSE OVERVIEW

Semester 1	Semester 2	Semester 3	Semester 4
Fundamentals of Thermal Engineering (4 Credit) *Core Technology course*	Research Methodology (4 Credit) *Core General Course*	Elective -III (4 Credit)	Dissertation / Thesis Work (16 Credit)
Fluid Mechanics with Engineering Applications (2 Credit) *Core Technology Course*	Energy Finance and Economics (4 Credit) *Core Management Course*	Elective -IV (4 Credit)	
Applied Sociology (2 Credit) *Core General Course*	Elective -I (4 Credit)	Group Projects (4 Credit)	

Renewable Energy Resources (4 Credit) *Core Energy Course*	Elective –II (4 Credit)		
System Mathematics (4 Credit) *Core General Course*			

Note:

1. Total Credit = 60 Credits.
2. Course work , directed study and projects = 44 Credits
3. Dissertation = 16 Credits
4. Depending on the interest of students only 2 electives are offered in each term. Minimum number of students in each elective should be 6.

4.1 Core and Elective Courses

The course consists of two types of courses: the Core Courses which deal with the fundamental theory and the Elective Courses which deal with the specific details of the course.

Similarly, conferences and seminars are organized time to time to make students abreast with the current happenings in energy world. Also students are encouraged to participate in various national and international conferences.

The core courses focus on the fundamentals of renewable energy technologies and research methodology. Elective courses chosen will enable students to focus their courses to their technical interests. In addition, required project works will provide hands-on real world experience.

4.2 Group Project Work

The purpose of the group project in second year, second semester is to provide an opportunity for the group of students to investigate, analyze and to provide possible solution to an existing energy related problems. The group project must be completed in the allocated term. The group project may be done in small group normally two to three students per group. Research proposal preparation will be done as well.

4.3 Dissertation /Master's Thesis

The main objective of Master's Degree Dissertation is to carry out original research work concerning energy related problems and solve those problems. Students are encouraged to publish articles in national and international journals.

5. CREDIT SYSTEM

The course curriculum is organized in the overall framework of Credit System. Each course has a certain number of credits which indicates the weightage. The number of credits depends on the contact hours for the course and its work load. Course with one credit weightage will have 15 lecture hours in a semester. The tutorial consulting and assessment hours will vary depending on the nature of the course. The total

Credit for the master's program is 60 credits.

6. EVALUATION SYSTEM

The evaluation system is based on the continuous assessment by the course teacher and the final examination. The students have to pass individually in the assessment as well as the final examination. The minimum pass marks for the assessment and final examination is 50%.

The percentage is calculated from the following criterion:

$$Total\ Percentage = \frac{\sum Credit \times Mark\ Obtained}{\sum Credits}$$

Depending upon the total percentage of the marks obtained, the following division shall be awarded:

Percentage	Division
>= 50 %	Pass
50 - < 65%	II
65-< 80%	I
80 and above	Distinction

7. COURSE CODE

Each course is identified by a code. Each course will have a three digit number with a prefix set of two capital letters. The prefix letters stands for the department offering the course (for example, ME signifies Department of Mechanical Engineering). In the three number central digits, the first digit denotes the level in which the course is offered. For example, the digit 8 and 9 indicate the first and second year respectively of the Master's level course. The second digit is used to designate the semester. The second digits from 1 to 50 are used for the course offered in the first and third semesters and 51 to 100 for the courses offered in the second and fourth semesters respectively.

8. INSTRUCTIONAL METHODS

Conventional lectures and seminars in the taught course components (core and elective courses) of the program are reinforced by other approaches to teaching and learning process:

- the use of case studies (video and text -based) to highlight key issues and management practices
- training by using electronic sources
- training in team work, group work, presentations and project management.

Each course is coordinated by a member of the faculty or the visiting faculty from outside who is expert in a given subject. The course faculty has the full responsibility for the conduction of the particular course. The courses comprise of lectures tutorials, laboratory works, group discussions and project works if applicable. The course contents are designed in such a way that considerable self-learning efforts should be used by the students.

Each student will be assigned a counselor. The main function of the counselor will be to guide the students throughout the
2- Year program.

9. QUALIFYING CRITERIA

To qualify for the Master of Science in Renewable Energy Engineering, the student must satisfactorily complete the program consisting of course work, directed study, group projects of 44 credits and an individual thesis of 16 credits.

10. REGISTRATION

Students must register for their course every semester. They must seriously attempt to complete the masters' program in 2 years. In all the four semesters, a total of 44 credits will be offered which will consist of core and elective courses. The credits for the thesis will be 16. The total credit for the complete program is 60.

OUTLINES OF COURSES

Year : I **Part : I**

Teaching Schedule				Examination Scheme				
				Theory			Total	Remarks
S. N.	Course Code	Course Title	Credit	Assessment Marks	Final			
					Duration hours	Marks		
1	801 ME	Fundamentals of Thermal Engineering	4	40	3	60	100	
2	802 ME	Fluid Mechanics with Engineering Applications	2	40	3	60	100	
3	803 ME	Applied Sociology	2	40	3	60	100	
4	804 ME	Renewable Energy Resources	4	40	3	60	100	
5	805 ME	System Mathematics	4	40	3	60	100	
Total			**16**	**200**	**15**	**300**	**500**	

Year : I **Part : II**

Teaching Schedule				Examination Scheme		Total	Remarks
				Theory			
S. N.	Course Code	Course Title	Credit	Assessment	Final		

				Marks	Duration hours	Marks		
1	851 ME	Research Methodology	4	40	3	60	100	
2	852 ME	Energy Finance and Economics	4	40	3	60	100	
3	853 ME	Elective I	4	40	3	60	100	
4	854 ME	Elective II	4	40	3	60	100	
Total			**16**	**160**	**12**	**240**	**400**	

Eletive I

Eletive II
- Renewable Energy Systems Technology
- Solar Thermal Technology
- Solar PV Technology
- Micro-hydro
- Bio gas Technology
- Bio fuel Technology
- Wind Energy Technology

Year : II **Part : I**

Teaching Schedule				Examination Scheme				
				Theory		Total		Remarks
S. N.	Course Code	Course Title	Credit	Assessment Marks	Final Duration hours	Marks		
1	902 ME	Elective III	4	40	3	60	100	
2	903 ME	Elective IV	4	40	3	60	100	
3	901 ME	Group Project	4	100	-	-	100	
Total			**12**	**180**	**6**	**120**	**300**	

Elective III
- Project Planning and Management
- Operations Research/Management Science

Elettive IV
- New Renewable Energy Technologies (NRETs)

Environmental Impacts and Climate Change
Energy Planning and Management
Energy Auditing, Analysis and Conservation
System Integration
Human Resource Management and Communication Skills
Design and Manufacturing
Instrumentation and Measurement System

Year : II **Part : II**

Teaching Schedule				Examination Scheme		Total	Remarks
S. N.	Course Code	Course Title	Credit	Theory			
				Assessment Marks	Final Marks		
1	951 ME	Thesis	16	40	60	100	

Approved by: IOE Faculty Board 2070-12-3

Year: I Part: I

801 ME: Fundamentals of Thermal Engineering (4 Credit)

Laws of Thermodynamics, Basics of Heat Transfer, Heat Exchangers, Combustion Process, Fuel Conversion Efficiency, Emission Control and Analysis, Applications of Thermodynamic Processes and Heat Transfer for Renewable Energy Devices.

802 ME: Fluid Mechanics with Engineering Applications (2 Credit)

Basic Equations of Fluid for Incompressible and Compressible Fluid with their Applications, Basic Flow Field, Streamlines, Velocity Potential, Stream Function, Flow Net. Similitude and Dimensional Analysis. Turbine (Impulse and Reaction) Principles, Components, Force Calculation. Pumps and related Theories.

803 ME: Applied Sociology (2 Credit)

Basic Concepts of Applied Sociology, Structures, Roles of Community, Socio- economic Impacts due to Development of Energy, Gender and Ethnic issues, Applications of Sociology with Reference to Energy.

804 ME: Renewable Energy Resources (4 Credit)

Classifications of Energy Resources, Conventional and Non-conventional Energy Resources, Fossil Fuels, World Energy Scenarios, Potential of Different Sources of Energy in Nepal, Supply and Demand of Energy in World, Asia, South Asia and Nepal

Renewable Energy Resources: Solar Energy, Biomass/Bio-energy, Energy Generation from Waste, Micro hydropower, Wind Energy, Geothermal Energy, Wave Energy, Tidal Energy, OTEC**,** Fuel-cell, Nuclear Energy and Hydrogen Energy

Energy Policy of Nepal, Energy Supply and Demand Side Management, Subsidy Policy for Renewable Energy in Nepal, Service and Subsidy Delivery Mechanism, Carbon Trading, CDM, Marketing and Non-marketing Approach.

805 ME: System Mathematics (4 Credit)

Linear System, Non Linear System and Stability, Probability and Statistics, Mathematical Programming/Optimization Techniques, System Modeling and Simulations, Forecasting, Geographical Information System.

Year: I Part: II

851 ME: Research Methodology (4 Credit)

Types of Research, Defining Research Problem, Research Design, Sampling, Measurement and Scaling Technique, Methods of Data Collection, Processing and Analysis, Testing of Hypothesis, Analysis of Variance, Multivariate Analysis Technique, Proposal Writing, Thesis Writing, Preparation of Research Paper.

852 ME: Energy Finance and Economics (4 Credit)

Energy Organization, Energy Finance, Cost and Revenue, Financial Statement Analysis of Energy Firms, Capital Budgeting, Benefit Cost Analysis, Financing Renewable Energy Projects, Carbon Trading, CDM, Market and Non-market approaches.

853 ME: Elective I (4 Credit)

Elective I: Renewable Energy Systems Technology

Biomass Technologies (Improved Cook Stoves, Briquette Making Machines, Gasifiers, Bio-fuel Technologies, Biogas Plant), Solar Thermal Devices (Application of Active and Passive Solar Thermal Systems, Flate and Solar Concentrator Type Devices, Design of Solar Water Heater, Solar Dryer and Solar Cooker), Solar PV System (Application of Photovoltaic Systems, Design of Solar PV Appliances), System Design of Micro hydro Power System, Design and Feasibility of Wind Energy Generation, Available Harnessing Geothermal Resource Technology, OTEC Devices, Wave Power Extraction Devices, Tidal Power Generation Devices, Fuel-cells, Hybrid Energy Systems, Environmental Impact Assessment of Renewable Energy Technologies.

854 ME: Elective II (4 Credit)

Elective II: Micro-hydro

Hydrology and Site Survey, Layout Design and Selection of Components, Installing, Commissioning and Testing, Repair and Maintenance, MHP Project Evaluation, Policies and MHP Plants Identified in Nepal, Grid Connection, New Researches for Microhydropower and its Components.

Elective II: Bio-fuel Technology

Solid Biomass (Wood and Non-wood Solid Biomass Fuel Energy): Introduction, Solid Biomass Resources (Fuel Wood, Agricultural Residues, Animal Residues), Solid Biomass Fuel Conversion and Utilization, Environmental, Economical and Social Impact of Biomass.

Liquid Biomass (Bio-fuel Energy): Introduction, Bio-fuel Resources and Production, Bio-ethanol, Bio-diesel, Bio-hydrocarbons, Bio-fuel Conversion and Application, Environment Impact of Bio-fuels.

Gaseous Biomass Fuel (Biogas Energy): Introduction, Advantages of Biogas, Limitation of Biogas, Economics of Biogas Plant Installation in Nepal, Design Concept and Parameters of Biogas Plant, Quality Control of Biogas Plant, Biogas in relation to Environment, Ecology, Health and Sanitation

Wood and Non-wood Solid Biomass Fuel Resources, Wood and Non-wood Solid Biomass Fuel Conversion and Utilization, Design of Biomass Energy Technologies, Degradation of Lignocelluloses, Modification and Optimization Techniques, New Researches Opportunities.

Elective II: Solar Thermal Technology

Flat Plate Solar Collectors, Concentrating Collectors and Shallow Solar Collectors, Design of Solar Heating, Passive Heating, Cooling, Drying Systems, Performance of Solar Thermal Devices, Modifications required in Solar Thermal Devices, System Design of Solar Thermal Devices for Specific Purposes, New Researches for Solar Thermal Devices.

Elective II: Solar PV Technology

System Design of Solar PV Systems including Solar Home System, Institutional Solar PV System, Solar Pumping System, Solar Mini-grid System, Integration of Solar PV into National Grid, Solar-wind Hybrid System, Solar-Biomass Hybrid System, Testing of Solar PV system Components, New Researches for Solar PV and its components.

Elective II: Biogas Technology
Microbial Activities and Pathways in Anaerobic Digestion, Biogas Production in cold Climate, Design Concept and other Parameters of Domestic and Large Size Biogas Plant, Modifications and Optimization Techniques, New Researches Opportunities.

Elective II: Wind Energy Technology
Basics of Wind Power Technology, Wind Machine Fundamentals, Wind Energy Resource Analysis, Wind Energy System Design, Wind Power Systems, Solar-Wind Hybrid System, Legal Issues, Modification and Optimization Techniques, New Researches Opportunities.

Year: II Part: I

901 ME: Group Project (4 Credit)
Group Project Works (as per BE Background), Research Proposal Preparation and Presentation, Sample Research Paper Preparation.

902 ME: Elective III (4 Credit)
Elective III: Project Planning and Management
Basics of Project Management, Project Identification, Planning, Formulation and Appraisal, Project Organization and Implementation, Project Monitoring, Controls and Information Systems, Decision & Risk analysis, Project Evaluation and Auditing, Contract Management, Quality and Value Management.

Elective III: Operations Research/Management
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, System modeling and Simulations, Modeling and Simulating Dynamic Inventor Models.

903 ME: Elective IV (4 Credit)
Elective IV: New Renewable Energy Technologies
Geothermal Energy: Application, System Design
Ocean Thermal Energy Conversion: Application, System Design
Hydrogen Energy: Fuel-cell, Storage Technique, Modification
Bio-Hydrogen: Production, Optimization Techniques
Wave Energy: Application, System Design
Tidal Energy: Application, System Design
Nuclear Energy: Application and Design of Fission Techniques, Research in Fusion,
New Research Opportunities for New Renewable Energy Technologies

Elective IV: Environmental Impacts and Climate Change
Local, Regional and Global Environmental Impacts, Quantitative Tools for Environmental Problem Solving, Air Pollution, Water Pollution, GHGs Emission, Radioactivity, Radiation Balance, Impacts and Consequences of Climate Change, Climate Change Mitigation and Adaptation, Carbon Trading, CDM, Market and Non-market Approach.

Elective IV: Energy Planning and Management
Basics of Energy Planning, Concepts of Energy Planning for Microeconomic and Macroeconomic Systems, Energy Demand Analysis and Demand Projection, Energy Supply Analysis and Supply Projection, Energy Option Evaluation and Policy Analysis.

Elective IV: Energy Auditing, Analysis and Conservation
Energy Auditing Technique, Use of Renewable Energy in Place of Fossil and/or Traditional Energy, Use of Energy Efficient Technologies/Machineries, Energy conservation in Industries, Energy Conservation in Buildings, Co-generation, Electrical Energy Conservation, Electrical Energy Demand and Load Management, Energy conservation in Lighting System.

Elective IV: System Integration
Application of Integrated Systems, Simulation of Integrated Systems, Optimization Methods, Applications of Optimization Techniques, Design of Integrated Village Power Systems**.**

Elective IV: Design and Manufacturing
Sketch and Working Drawing, Jigs and Fixtures, Analysis of Metal Forming Processes, Design of Product for Economical Production, Failure Theories, Safety Factors and Reliability.

Elective IV: Instrumentation and Measurement System
Basic instrumentation in Electrical Engineering and Electronics, Instrument Fundamentals, Electrical measurement, Transducers, Microprocessor based Instrumentation, Motion and Dimensional Measurements, Force Torque and Shaft Power Measurement, Heat Flux and Temperature, Flow and Pressure Measurement

Elective IV: Human Resource Management and Communication Skills
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, Human Resource Planning: Recruitment, Selection, Training and Development, HRD Development in Nepal, Labor Performance Management and Appraisal, Compensation/Rewards System, Labor Management-Industrial Relations, 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, Roles of Communication Skills.

Year: II Part: II

951 ME: Thesis (16 Credit)
Proposal Defense, Mid-Term Defense, Pre-Defense and Final Defense of Research Work, Dissertation/Thesis with New Innovations, Minimum One Research Paper Based on Dissertation (Published/Accepted)