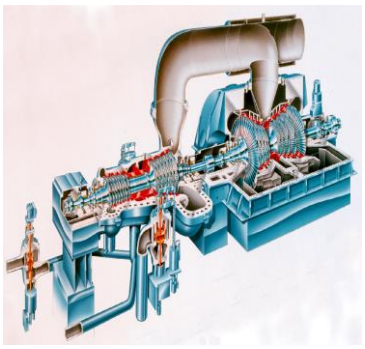
MEng/PG Diploma in Energy Technology






Handbook

Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

Contents

Master of Engineering/Postgraduate Diploma Programme in Energy Technology

INTRODUCTION :

The whole world faces a daunting array of energy & environment related challenges, which would be decisive factors in sustainable economic and industrial growth and technological innovations. There is a necessity for utilization of energy in a rational manner without overloading the carrying capacity of ecosystem and depriving the ingenuity of the future generation. In fact, sustainable development with a minimum environmental degradation has become the motto of energy engineering. The importance of these aspects has received a new momentum in the recent past with the concerns & mechanisms originated by international level activities such as ISO14000 on environmental aspects in the industrial sector, Montreal protocol and Kyoto protocol in relation to climate change.

Therefore the energy sector should never be analyzed in isolation but with interrelation to environment and society. For such analysis, a sound knowledge on all the related areas and associated skills are vital not only for technical aspects of energy but also for managing, advising and policy making in the sector, through well structured and planned educational framework. As such, the Postgraduate Programme in Energy Technology is developed with reference to synthesis of trends in sources, technologies and relevant environmental and social aspects. Detailed design aspects of energy systems and related issues are also incorporated in the programme. The knowledge and experience imparted by the Postgraduate programme will flow downwards to the technician level where operational & maintenance aspects of energy technology occur.

OBJECTIVES:

* Diffuse the fundamental knowledge and state of the art of the Engineering Science involved in Energy conservation & utilization.
* Provide an environment to foster the attainment of Research & Development targets related to the Energy sector.
* Enhance the knowledge of Engineers in contributing to national, regional & global energy environmental issue and clean & efficient technologies.

ENTRY REQUIREMENTS:

* The Degree of the Bachelor of the Science of Engineering of the University of Moratuwa in a relevant field of specialization, **OR**
* Any other Engineering Degree of at least four years duration in a relevant field of specialization, **OR**
* At least the Associate Membership of a recognized Engineering professional institute in a relevant field, with at least one year of appropriate experience, after obtaining such qualification.

  [More suitable for those with Mechanical or Chemical Engineering background, preferably employed in a relevant field]

EVALUATION :

* Written examinations.
* Continuous assessment of laboratory work.
* Continuous assessment of Assignment, Presentations, etc.
* Continuous assessment of Research Project through presentations and final evaluation of the dissertation. (MEng programme only)

DURATION :

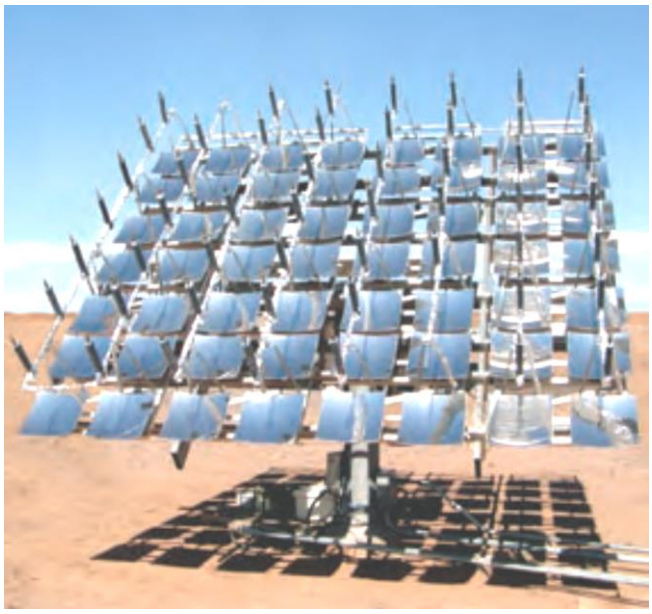
* Postgraduate Diploma

  12 Months – Part Time (Friday & Saturday)

* Master of Engineering

  24 Months – Part Time (Friday & Saturday)

  12-15 Months – Full Time

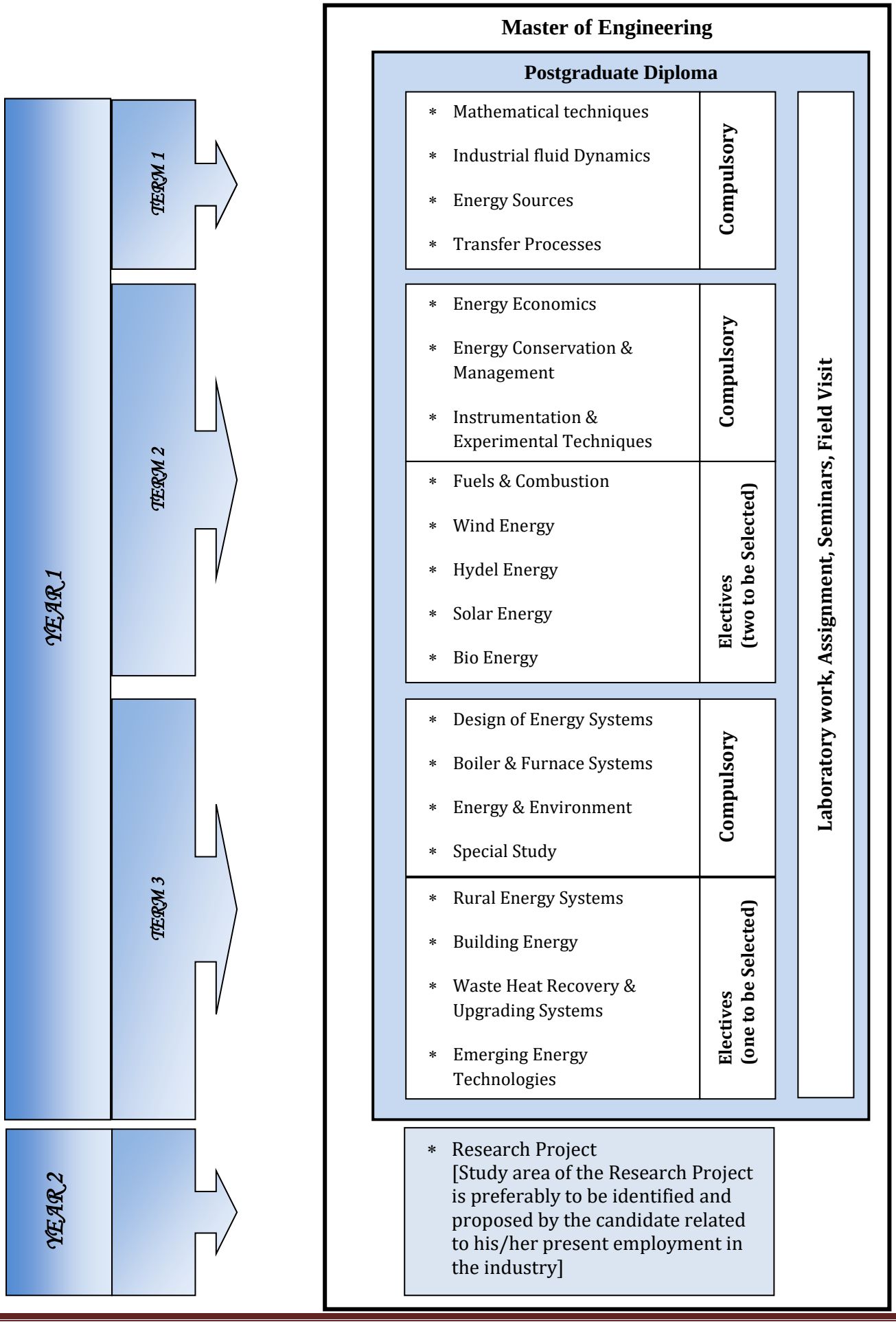


CURRICULUM :

The curriculum of the Postgraduate studies in Energy Technology is developed to enhance the knowledge and skills of the participants in many areas such as

- *Fundamentals of Energy Engineering which enhance the analytical abilities,*
- *Renewable Energies* such as Bio energy, Wind, Solar and Hydel Energy and Modern Energy Technologies which could contribute to reduce environmental degradation while improving energy security,
- *Waste Heat Recovery Technologies* which can be extensively applied in many local industries to increase the overall energy efficiency,
- *Energy Conservation and Management* that lead the engineers to gain the knowledge of energy auditing, energy conservation and management, not only to reduce cost of energy of their factories/organizations, but also to assist the nation building process,
- *Design of Energy Systems and Energy Economics* which strengthen the competence in solving practical problems and tackling crisis situations,
- *Building Energy* that covers air-conditioning and lighting systems, thermal comfort, heat transfer in building envelopes, energy efficiency,
- *Energy and Environment* that highlights the adverse effects of energy usage on environment together with technical and non-technical options available for mitigation.

All lectures and tutorials, assignments, laboratory work, seminars, etc. will normally be conducted in a three term academic year on Fridays and Saturdays. Those who proceed to the M.Eng. degree will be required to do a Research Project in the second year.


YEAR 1
TERM 1
TERM 2
TERM 3
YEAR 2
Master of Engineering
Postgraduate Diploma
* Mathematical techniques
* Industrial fluid Dynamics
* Energy Sources
* Transfer Processes
Compulsory
* Energy Economics
* Energy Conservation & Management
* Instrumentation & Experimental Techniques
Compulsory
* Fuels & Combustion
* Wind Energy
* Hydel Energy
* Solar Energy
* Bio Energy
Electives (two to be Selected)
* Design of Energy Systems
* Boiler & Furnace Systems
* Energy & Environment
* Special Study
Compulsory
* Rural Energy Systems
* Building Energy
* Waste Heat Recovery & Upgrading Systems
* Emerging Energy Technologies
Electives (one to be Selected)
Laboratory work, Assignment, Seminars, Field Visit
* Research Project
[Study area of the Research Project is preferably to be identified and proposed by the candidate related to his/her present employment in the industry]

First Year: PG Diploma Component

❖ Term 1:

Duration: 14 Weeks

Compulsory Courses:

Course	Credits	Evaluation	
		Final	Continuous Assessment
ME5001 Mathematical Techniques	03	75%	25%
ME5002 Industrial Fluid Dynamics	03	50%	50%
ME5003 Energy Sources	03	75%	25%
ME5004 Transfer Processes	03	50%	50%

Total Credit Requirement in Term 1 = 12

❖ Term 2:

Duration: 14 Weeks

Compulsory Courses:

Course	Credits	Evaluation	
		Written Exam.	CA
ME5020 Energy Economics	2.5	75%	25%
ME5021 Energy Conservation and Management	03	75%	25%
ME5022 Instrumentation and Experimental Techniques	1.5	75%	25%

Elective Courses (Two to be selected):

Course	Credits	Evaluation	
		Written Exam.	CA
ME5023 Fuels and Combustion	03	50%	50%
ME5024 Solar Energy	03	50%	50%
ME5025 Wind Energy	03	50%	50%
ME5026 Bio-Energy	03	50%	50%
ME5027 Hydel Energy	03	50%	50%

Total Credit Requirement in Term 2 = 13

❖ Term 3:

Duration: 14 Weeks

Compulsory Courses:

Course	Credits	Evaluation	
		Written Exam.	CA
ME5040 Design of Energy Systems	03	75%	25%
ME5041 Boiler and Furnace Systems	1.5	75%	25%
ME5042 Energy and Environment	2.5	75%	25%
ME5090 Special Study	05	-	100%

Elective Courses (One to be Selected):

Course	Credits	Evaluation	
		Written Exam.	CA
ME5043 Waste Heat Recovery and Upgrading Systems	03	50%	50%
ME5044 Building Energy	03	50%	50%
ME5045 Rural Energy Systems	03	50%	50%
ME5046 Modern Energy Technologies	03	75%	25%

Total Credit Requirement in Term 3 = 15

Total Credit Requirement for PG Diploma: 40 Credits

<u>Second Year: M.Eng Research Project</u>

MEng Project	Credits	Evaluation	
		Written Exam.	CA
ME5090 Research Project	20	-	100%

Total Credit Requirement for MEng: 40 + 20 Credits = 60 Credits

SYLLABI :

ME 5001 - Mathematical Techniques

Partial differential equations – classification, modelling, solutions using Fourier series, Fourier transform; Numerical methods – finite difference methods, finite element methods, solutions of ordinary and partial differential equations, applications using computer software; Optimisation – Non-linear optimisation involving multivariate function, dynamic programming; Methods of applied statistics – sampling, hypothesis tests, basic ideas of linear models, time series modelling.

ME 5002 - Industrial Fluid Dynamics

Introduction; Fluid flow analysis techniques; Governing equations in fluid mechanics - conservation of mass, momentum and energy, constitutive relations; Flow through bounded systems – circular and non-circular sections, curved ducts, frictional losses, fitting and valve losses, leakage flow, complex fluid flow systems; Industrial ventilation – active and passive ventilation, ventilating devices; Agitation – types of agitators, flow patterns, design parameters, dimentional analysis; Fluid machinery – classifications, pumps, turbines, fans and blowers, basic performance characteristics, hydraulic losses, cavitation, noise; Particle mechanics – motion of particles, flow through packed bed of particles, fluidisation, fluid conveying, particle separation; Industrial flow and pressure measurements – devices, theory and design aspects; Design aspects and numerical modelling of typical industrial applications – flow in stacks/chimneys, cyclone separators, dust extraction systems, fan & blower design and testing, duct design, industrial drying systems.

ME 5003 - Energy Sources

Fossils and minerals – World energy resources from oil, gas, coal and nuclear and their availability, development of resources, technologies of conversion, environmental aspects; New and renewable energies – characteristics of renewable sources, solar, wind, biomass, hydel, geothermal, OTEC, resources and availability, current technologies of conversion, environmental aspects; Energy storage systmes.

ME 5004 - Transfer Processes

Fundamentals of heat transfer; Conduction – steady and unsteady state, multi-dimension systems, analytical & numerical solutions and charts, typical industrial applications; Convection – estimation of convective heat transfer coefficients, laminar and turbulent flow, dimensional analysis, empirical correlation, two phase flow; Radiation – basic laws, black-body radiation, radiation in black and grey enclosures with non-participating medium, gas radiation, applications to boiler and furnace systems; Mass transfer – laws and definitions, diffusion and convective mass transfer, film theory, interface flow, dimensional analysis, empirical correlation, industrial applications.

ME 5020 - Energy Economics

General background; Local energy scenario; Availability of different sources; Supply and demand projection; Integrated energy planning; Energy pricing;

Financial evaluation of projects; Environmental impact assessments, Project financing options; Energy sector restructuring; Related policy issues.

ME 5021 - Energy Conservation and Management

Introduction – basic approaches, benefits & trends; Energy conservation programme – organisation, energy auditing, analysis, formulation of energy management options, economic evaluation, implementation & control; Energy conservation technologies – conservation in energy intensive industries, steam generation & distribution systems and electrical systems, demand-side management, co-generation, total energy schemes, thermal insulation, energy storage; Economic evaluation of conservation technologies; Analysis of typical applications.

ME 5022 - Instrumentation & Experimental Techniques

Measuring techniques and instrumentation for temperature, pressure, velocity, flow rates, solar radiation, sound, chemical composition; Controllers – working principles, selection; Data logging; Signal conditioning

ME 5023 - Fuels and Combustion

Classification of fuels – solid, liquid & gaseous; Characteristics of fuels – factors related to energy & environment; Thermodynamics of combustion – first and second law analysis, degradation of thermodynamic potential in combustion systems, estimation of heats of formation & reaction; Kinetics of combustion – definitions & laws, kinetics of combustion of typical fuels; Kinetically controlled combustion – characteristics, analysis, self ignition & quenching phenomena; Diffusionally controlled combustion – characteristics, analysis; Premixed flames; Droplet combustion and solid particle combustion analysis; Combustion systems in boilers, furnaces & kilns, combustion chambers, stability of flames;

ME 5024 - Solar Energy

Solar Geometry – introduction to sun-earth angles & charts, calculation of shading; Solar radiation – definitions, availability, measurements & instrumentation, estimation through correlations, statistical analysis; Solar Thermal systems – concentrating and non-concentrating collectors, theory of flat plate collectors – characteristics to radiation, thermal losses, performance analysis, transient behaviour; Applications – typical heating & cooling systems, drying systems; Introduction to system design methods – charts & utilisability concept; Solar Photovoltaic systems – basic theory of photo-electricity, characteristics of solar cells and of systems with storage, system sizing for typical applications; Case studies.

ME 5025 - Wind Energy

Characteristics of wind – wind shear, turbulence, wind measurements and energy estimation, site selection; Wind energy conversion systems – classifications, applications, basic sub-systems and components, design parameters, aerodynamics of drag and lifting translators, operational characteristics; Theory of wind turbine rotors – aerodynamics of wind rotors, aerodynamic losses, wake modelling, performance characteristics and rotor design; Control systems; Load matching; Wind farms; Water pumping systems; Electricity generating system; Structural dynamics and design; Energy storage systems; Maintenance; Environmental aspects; Case studies.

ME 5026 - Bio-Energy

Assessments of biomass resources, availability and potential, energy plantation; Fuel characteristics of biomass; Biomass conversions; Bio-fuels – combustion characteristics; Direct heating; Thermochemical convesion – pyrolysis, carbonization, gasification, liquefaction, densification; Biochemical conversion – Biogas, ethenol; Conventional and new biomass energy conversion devices & technologies – household & community combustion systems, industrial & commercial applications, Stirling cycle engines, Biogas digestors, gasifiers, integrated gasification combined cycle, direct fired biomass fuelled steam power plant, biomass co-firing in energy systems, sizing, design and performance characteristics; Environmental aspects.

ME 5027 - Hydel Energy

Resource estimation, technologies, performance characteristics and cost of energy associated with Small Hydro, Wave and Tidal energy systems.

ME 5040 - Design of Energy Systems

Introduction; Models and modelling - general concepts of modelling, classification of models, Modelling of thermal systems - modelling of thermal equipment, behaviour of processes and thermodynamics properties; Modelling of renewable energy systems; System simulation – steady and unsteady state simulation; Optimisation – calculus methods of optimisation, search methods, linear models and linear programming, non-linear programming and its application, dynamic programming and its application, geometric programming; Probabilistic approaches to design.

ME 5041 - Boiler & Furnace Systems

Boilers - classification, configurations based on type of fuel and others, types of burners and working mechanisms, thermo-hydraulic analysis, water treatment, controls; Furnaces – configurations, batch and continuous function modes, refractories, fuels and burners, heat transfer analysis, controls.

ME 5042 - Energy and Environment

Types and sources of wastes; Waste as a resource; Methods of treatment and disposal; Waste minimisation and recycling; Air pollution – energy generating activities, impact assessment and impact mitigation; Water pollution - waste water treatment and disposal; Integrated solid waste management; Environment impact assessment related to energy projects. Transport Energy/Emission, indoor air pollution

ME 5090 - Special Study

A study on a special topic leading to the formulation of the research project to be carried out in the second year.

ME 5043 - Waste Heat Recovery and Upgrading Systems

Introduction; Classification – sources and levels of waste heat; Evaluation of heat content; Methods/equipment of waste heat recovery - recuperators, run-around coils, regenerators, heat pumps, heat

pipes; Fundamentals of exergy analysis – theory, typical application; Heat exchangers – classification, analysis, performance comparisons, industrial applications of liquid to liquid, gas to liquid and gas to gas heat exchnagers; Theory of heat exchanger assembly; Heat and power integration – basics, stream networks, tabular methods, stream splitting, process retrofit, installation of heat pumps and heat engines; Heat pumps – classification, mechanical compression, thermo-mechanical and chemical heat pumps, working fluids, application of technologies, case studies.

ME 5044 - Building Energy

Introduction – energy use in buildings, factors effecting energy use, energy conservation options; External factors – climate, shading, sizing of shading devices; Thermal comfort – variables, comfort indices, comfort zones, assessment; Building air-conditioning systems – components, performance characteristics, conservation and controlling strategies; Building lighting systems – lighting fundamentals, visual performance, calculation of lighting levels, day lighting, energy efficient lighting, application through software; Heat transfer in building envelopes – basics, governing equations, thermal networks, finite difference and state space solutions, modelling and simulation of building internal climate & energy use, application through software.

ME 5045 - Rural Energy Systems (48 hrs)

Energy demand for rural community, Cooking & Drying applications, Rural Electrification, Energy supply options, Economic analysis of rural energy systems, social impacts

ME 5046 - Modern Energy Technologies (48 hrs)

Both Conversion and Utilization technologies: Advanced thermodynamics cycles, Clean Coal Technologies, Fuel Cells, Modern Renewable Energy Technologies, Cleaner Production, Transport System, Lighting, cooking, heating.

COURSE FEES:

*	Tuition fees :	PG Diploma	-Rs. 275,000/=
		MEng. Registration – an additional	- Rs. 75,000/=
*	Other Fees :	Registration Fee (First Year)	- Rs. 2,000/=
		Registration Fee (Second Year)	- Rs. 2,000/=
		Examination Fee	- Rs. 500/=
		Re-Examination Fee	- Rs. 1000/=
		(Additional Rs. 100/= per subject)	
*	Libraray Deposit :	Normal Deposit	- Rs. 2,500/= per book, up to 6 books
		Deposit with guarantee	- Rs. 7,500/= for 6 books
		Concessionary Deposit*	- Rs. 2,500/= for 2 books

REGISTRATION :

- Selected candidates may register for the PG Diploma or the MEng Degree.

RESOURCE PERSONS:

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Notes: