Post Graduate Diploma in Renewable Energy and Energy Management

Course Structure
(2018-2019 Session)

Distance Mode

Centre for Open and Distance Learning
Tezpur University
http://www.tezu.ernet.in/tu_codl/

Academic Support

Department of Energy
Tezpur University

Post Graduate Diploma in Renewable Energy and Energy Management Programme Syllabus, Academic Council Approval: AC.30/2017/3/3.3 dated 16th November, 2017

Course structures and Syllabus for the Post Graduate Diploma in Renewable Energy and Energy Management Programme

The PG Diploma Programme in Renewable Energy and Energy Management consists of the following;

(a) Course on energy environment interaction, renewable energy sources and energy management
(b) Specialized courses on solar energy, biomass energy, wind and hydro energy to expose the learner on these courses about the principles, conversion systems, and applications
(c) Specialized courses on energy management and energy efficiency in thermal and electrical utilities to enhance the domain knowledge
(d) Project work, where special emphasis is placed on the application of the knowledge gain in the theory courses in areas of renewable energy and energy management depending on the choice of learner.

Program Educational Objectives (PEOs)

(a) To prepare the learners for successful career in energy industry, energy service companies, energy utilities and consultancy agency
(b) To produce specialized manpower strong in understanding, designing on technologies and systems, energy efficiency in utilities, and capable in technological solutions required for industry, entrepreneurship development
(c) To enhance the knowledge and understanding of the working professional on energy conversion process, energy efficiency and make use of the enhanced knowledge in their domain of work.
(d) To produce energy professional who are sensitive to and well aware of, the energy issues and concerns, and who can apply their specialized knowledge for the sustainable development.

First Semester			
Course code	**Course Name**	**CH**	**Credits**
DRE 110	Energy Resources and Environment	12	4
DRE 111	Solar Energy	12	4
DRE 112	Biomass Energy	12	4
DRE 113	Wind and Hydro Energy	12	4
		Total credits	**16**
Second Semester			
DRE 210	Energy Management and Auditing	12	4
DRE 211	Energy Efficiency in Utilities and Industries	12	4
DRE 212	Project work	24	8
		Total credits	**16**

Credit Requirements: Total credits requirement: 32

Duration: Minimum duration of the course: 2 semesters
Maximum duration of the course: 4 semesters

Eligibility Qualification: B.E. /B. Tech. or M.Sc. in Physics and Chemistry

Course code	Course Name	CH	Credits
DRE 110	Energy Resources and Environment	12	4

Module I: Energy Resources

Unit 1: Energy Resources

1.1 Overview of World and India energy scenario
1.2 Energy use patterns
1.3 Energy and development linkage
1.4 Energy sources classification

Unit 2: Conventional Energy Resources

2.1 Coal-sources, formation, properties and conversion
2.2 Petroleum-sources, genesis, properties and uses
2.3 Natural gas- sources, genesis, properties and uses

Unit 3: Renewable Energy Resources

3.1 Renewable energy resources
3.2 Renewable energy systems
3.3 Economics of renewable energy conversion systems

Module II: Ocean Energy Sources and Systems

Unit 1: Ocean Thermal Energy Conversion

1.1 Ocean thermal energy conversion principles
1.2 Conversion systems and technologies
1.3 Economic and environmental aspects

Unit 2: Tidal Energy

2.1 The causes of tides
2.2 Tidal energy conversion
2.3 Tidal current/stream power
2.4 World tidal power sites

Unit 3: Wave Energy

3.1 Wave energy and power
3.2 Wave energy conversion principles
3.3 Energy extraction devices and technologies
3.4 Economic and environmental aspects

Module III: New Energy Sources and Systems

Unit 1: Hydrogen Energy

1.1 Production methods
1.2 Storage and transportation of hydrogen
1.3 Economics of Hydrogen production and applications

Unit 2: Geothermal Energy

2.1 Basics of geological process and geothermal resources

2.2 Dry rock and hot aquifer analysis
2.3 Utilization of geothermal resources
2.4 Geothermal fields in India

Unit 3: Magneto hydrodynamic (MHD) energy conversion

3.1 Principle of operation
3.2 Open cycle and closed cycle systems
3.3 Features of MHD Systems and critical issues

Module IV: Energy and Environment Interactions

Unit 1: Environment concerns of energy extraction

1.1 Environment effects of energy extraction, conversion and use
1.2 Sources of pollution; primary and secondary pollutants.
1.3 Consequences of pollution and pollution control methods
1.4 Environmental laws on pollution control

Unit 2: Energy use and climate change

2.1 Global warming
2.2 Greenhouse gas emission, impacts, mitigation.
2.3 Causes of global, regional and local climate change

Unit 3: Emissions and control methods

3.1 Sources of emissions
3.2 Effect of operating and design parameters on emission
3.3 Control methods; exhaust emission test procedures

Unit 4: Socio-Economic aspects of Energy resources

4.1 General concepts
4.2 Socio-economic impacts
4.3 Security of supply and use
4.4 Environmental and ethical concerns

Unit 5: International treaties and convention on environmental mitigation

5.1 United Nations Frameworks Convention on climate change (UNFCCC)
5.2 Various convention and treaties at international level aiming at CO_2 mitigation

Suggested Reading References

[1] RA Ristinen and J J Kraushaar, *Energy and The Environment*, second edition, John Willey & Sons, New York, 2006.
[2] JW Twidell and AD Weir, Renewable Energy Resources, ELBS, 2006.
[3] GN Tiwari and MK Ghoshal, Fundamental of Renewable Energy Sources, Narosa, New Delhi, 2007.
[4] NH Ravindranath, UK Rao, B Natarajan, P Monga, Renewable Energy and Environment-A Policy Analysis for India, Tata McGraw Hill.
[5] R Narayan and B. Biswanathan, Chemical and Electrochemical Energy Systems, University Press (India) Ltd. 1998.

Course code	Course Name	CH	Credits
DRE 111	Solar Energy	12	4

Module I: Solar Energy and Solar Radiation

Unit 1: Solar Energy and Solar Radiation

1.1 Significance and availability of solar energy
1.2 Sun and solar spectrum; Radiation, Irradiance, Insolation
1.3 Sun-earth relation: Solar angle, Sun path diagram, Solar constant

Unit 2: Solar radiation estimation and prediction

2.1 Extra-terrestrial insolation on a horizontal surface
2.2 Measurement of terrestrial solar radiation on horizontal and tilted surface
2.3 Prediction of terrestrial solar radiation data
2.4 Estimation of average solar radiation and clear-sky radiation

Unit 3: Equipment to measure solar radiation

3.1 Introduction to solar radiation measurement devices
3.2 Basic design and working principles: Pyranometer, Pyrheliometer, solarimeter
3.3 Issues and challenges of solar radiation measurement accuracy

Module II: Solar Thermal Energy

Unit 1: Solar thermal conversion

1.1 Basics of solar thermal conversion
1.2 Classification of solar thermal conversion
1.3 Flat plate collector (FPC) theory: energy balance equation, heat loss factor, collector efficiency factor, heat removal factor
1.4 Parameters affecting the performance of FPC

Unit 2: Solar thermal systems

2.1 Fundamental of solar water heating system: Closed loop, Open loop, Passive, Active
2.2 Evacuated tube collector, concentrating solar collector
2.3 Solar dryer, solar desalination system
2.4 Solar thermal power generation

Unit 3: Solar cooling technology

3.1 Basic principle of solar cooling
3.2 Solar cooling systems: Vapor compression, Absorption refrigeration cycle, Ammonia-water system
3.3 Solar passive cooling system

Unit 4: Solar thermal energy storage

4.1 Types of thermal energy storage
4.2 Thermochemical energy storage
4.3 Properties and materials: Sensible heat storage, latent heat storage

Module III: Solar Photovoltaic Energy

Unit 1: Photovoltaic energy conversion

1.1 Photovoltaic effect; solar cell: theory and working principle and equivalent circuit
1.2 Solar cell properties, IV Characteristics, performance analysis
1.3 Different solar cell technologies: crystalline silicon, amorphous silicon, thin film, organic, multi-junction
1.4 Issues and challenges in solar cell technology

Unit 2: Photovoltaic system and technology

2.1 Photovoltaic module and array
2.2 Balance of system
2.3 Photovoltaic system configurations
2.4 Off-grid and grid connected photovoltaic system
2.5 Batteries: types and characteristics

Unit 3: Power electronics for photovoltaic system

3.1 Control unit for PV system
3.2 Basic switching devices
3.3 Inverter
3.4 Net metering and gross metering
3.5 Grid interface of photovoltaic system

Unit 4: Photovoltaic System Installation

4.1 Site assessment for photovoltaic system
4.2 Mounting of photovoltaic system
4.3 System protection
4.4 Maintenance and troubleshooting

Module IV: Solar Photocatalysis and Economics of Solar Energy

Unit 1: Basics of Solar Photocatalysis

1.1 Mechanism of photocatalysis
1.2 Solar detoxification and operation of solar detoxification plant
1.3 Factor affecting solar photocatalysis
1.4 Application of solar photocatalysis

Unit 2: Solar thermal economic analysis

2.1 Market of solar thermal system
2.2 Cost variable with design adaptation
2.3 Life cycle cost analysis of solar thermal system

Unit 3: Economics of Photovoltaic system

3.1 Simple payback period, Net Present Value
3.2 Annualized cost analysis, Life cycle cost analysis
3.3 Off-grid and grid connected PV systems cost analysis

Suggested Reading References

[1] Duffie J. A. and Beckman W. A. (2013); Solar Engineering of Thermal Processes, John Wiley.

[2] Solanki C. S. (2009); Solar Photovoltaics: Fundamentals, Technologies and Applications, Prentice-Hall of India Pvt. Limited.
[3] Goswami D Y, Frank Kreith and J F Kreider, Taylor & Francis (1999), Principles of Solar Engineering, Taylor & Francis, USA.
[4] Garg H.P. and Prakash S (1997), Solar Energy: Fundamental and Application, Tata McGraw Hill, New Delhi.
[5] Kreith F. and J. F. Kreider, (1978), Principles of Solar Engineering, McGraw Hill.

Course code	Course Name	CH	Credits
DRE 112	**Biomass Energy**	**12**	**4**

Module I: Biomass as Energy Source

Unit 1: Introduction
1.1 Biomass availability and energy source
1.2 Fossil fuel reserve and depletion
1.3 Environmental issues

Unit 2: Biomass as source of Energy
2.1 Renewable carbon source and biomass
2.2 Energy potential of biomass
2.3 Classification of biomass

Unit 3: Biomass as fuel
3.1 Physicochemical characteristics of biomass as fuel
3.2 Thermal characteristics of biomass as fuel
3.3 Biomass conversion routes: biochemical, chemical and thermo-chemical

Unit 4: Biomass production
4.1 Photosynthesis
4.2 Photosynthesis efficiency of C_3, C_4 and CAM plants
4.3 Climatic and Environmental factors

Unit 5: Energy plantation
5.1 Overview on energy plantation
5.2 Basis of selecting the plants for energy plantation
5.3 Waste land utilization through energy plantation

Module II: Biomass Energy Conversion Processes

Unit 1: Biochemical conversion of biomass for energy production
1.1 Anaerobic digestion, biogas production mechanism
1.2 Types of digesters, installation, operation and maintenance of biogas plants
1.3 Biogas plants manure-utilization and manure values.
1.4 Biogas utilization and storage
1.5 Biogas for motive power generation etc.

Unit 2: Chemical conversion of biomass for energy production
2.1 Chemical conversion processes
2.2 Hydrolysis and hydrogenation

Unit 3: Physical conversion processes
3.1 Importance of Physical conversion processes
3.2 Dewatering and drying
3.3 Size reduction, densification, and separation

Module III: Thermal Conversion of Biomass

Unit 1: Thermal Conversion: Combustion

1.1 Fundamentals and concepts
1.2 Combustion in excess oxygen and oxygen deficient atmosphere
1.3 Environmental issues

Unit 2: Thermal Conversion: Pyrolysis and liquefaction

2.1 Fundamentals
2.2. Pyrolysis, Carbonization, Charcoal production
2.3. Liquefaction process and methods

Unit 3: Thermal conversion: Gasification

3.1 Fundamentals
3.2 Biomass gasification-different types, design issues
3.3 Power generation from gasification

Module IV: Biofuel production and Utilization

Unit 1: Liquid biofuel

1.1 Biodiesel – the mechanism of transesterification, fuel characteristics of biodiesel, technical aspects of biodiesel engine utilization
1.2 Alcohol production from biomass- types of materials of alcohol production-process description, utilization

Unit 2: Synthesis biofuel

1.1 Fundamentals
1.2 Modern Biofuel, oxygenated fuel
1.3 Bio-refinery

Unit 3: Biomass based power generation

3.1 Modern biofuel based power generation
3.2 Village level electrification
3.3 Off-grid and grid connected biomass based power generation

Suggested Reading References

[1] Mukunda HS. *Understanding Clean Energy and fuels from biomass*. Wiley-India Pvt. Ltd, 2011
[2] Pandey A. *Hand book of plant-based bio-fuel*. CRC Press, Taylor & Francis, 2008
[3] Mital KM. *Biogas Systems, Principle and Applications*. New Age International Ltd. 1996
[4] Rai GD. *Non-conventional energy sources*. Khanna Publication, 2001
[5] Ravindranath NH. Hall DO. *Biomass, Energy and Environment, A developing country perspective from India*. Oxford University Press, 1995

Course code	Course Name	CH	Credits
DRE 113	**Wind and Hydro Energy**	**12**	**4**

Module I: Wind Energy Resource Assessment

Unit 1: Introduction to Wind Energy

1.1 History of wind energy
1.2 Current status and future prospects
1.3 Wind Energy growth and potential in India

Unit 2: Wind Energy Resource Assessment

2.1 Power available in the wind
2.2 Measurement of wind: Ecological indicator, Anemometers and wind directions
2.3 Wind regimes analysis, Time and Frequency distribution
2.4 Local effects, wind shear, Turbulence and acceleration effects
2.5 Betz limit for maximum power coefficient

Unit 3: Statistical Analysis of Wind Speed

3.1 Wind speed statistics: mean wind speed, variance, standard deviation
3.2 Statistical model for wind data analysis: Weibull distribution
3.3 Energy estimation of wind regimes, capacity factor

Module II: Wind Energy Conversion Systems

Unit 1: Wind Turbine

1.1 Types of rotors: Horizontal and Vertical axis wind turbine
1.2 Power and torque characteristics, Power coefficient and tip speed ratio characteristics
1.3 Characteristics of wind rotor
1.4 Wind pump and Wind electric generator
1.5 Wind turbine applications

Unit 2: Aerodynamics of wind turbine

2.1 Airfoil, lift and drag characteristics
2.2 Aerodynamic theories; axial momentum theory and blade element theory
2.3 Strip theory; rotor design and performance analysis

Unit 3: Wind energy conversion systems

3.1 Wind electric generators: Induction and synchronous generator
3.2 Tower, rotor, gearbox, power regulation, safety mechanisms
3.3 Grid integration
3.4 Wind pumps, limitations and performance analysis

Module III: Hydro-power Systems

Unit 1: Introduction to Hydro-power systems

1.1 Introduction to hydropower,
1.2 Status of hydropower Worldwide and India
1.3 Advantages and disadvantages of hydropower
1.4 Optimization of hydro-thermal mix

Unit 2: Hydro-power Plants

2.1 Classification of hydropower plants
2.2 Small hydropower systems: Overview of micro, mini and small hydro systems
2.3 Selection of site for hydroelectric plant
2.4 Hydrological cycle, Hydrographs and Flow duration curve

Unit 3: Elements of Hydroelectric Power Plant

3.1 Catchment area and reservoir
3.2 Dam, Spillways, Conduits, Surge Tanks, Draft Tubes

3.3 Power house

Unit 4: Components of Hydropower Plants

4.1 Hydraulic turbines: Classifications, Types and Operational Aspects

4.2 Hydro-turbines working principles: Francis, Pelton, Kaplan and Propeller Turbine

4.3 Turbines efficiency and selection criteria

Unit 5: Hydropower plant development

5.1 Run-of-the-river and storage schemes; diversion structures

5.2 Pumped hydro storage power plants

Module IV: Wind and Hydro-power: Economics and Environment

Unit 1: Wind energy systems: Environment and Economics

1.1 Environmental benefits and issues of wind energy applications

1.2 Economics of wind energy

1.3 Factors influence the cost of energy generation: Site specific parameters, machine parameters

Unit 2: Hydropower plant: Environment and Economics

2.1 Environmental aspect of large and small hydro power plants

2.2 Economics: cost structure, Initial and operation cost

2.3 Potential of hydro power in North East India

Unit 3: Power Plant Economics and Economic Loading of Power Stations

3.1 Different types of tariff structures

3.2 Economics of power generation

3.3 Interconnection of power generation plants

3.4 Economic loading of inter connected power plants

Suggested Reading References

[1] Mathew S. *Wind Energy: Fundamentals, Resource Analysis and Economics*. Springer, 2006

[2] Jiandong T. *Mini hydropower*. John Wiley, 1997

[3] Wagner H. Mathur J. *Introduction to Hydro Energy Systems: Basics, Technology and Operation*, Springer, 2011

[4] Nag P K. *Power Plant Engineering*, 3rd Edition, Tata McGraw Hill, 2008.

[5] Rai H C. Power Plant Engineering, IK International Publishing House Pvt Ltd. 2012

Course code	Course Name	CH	Credits
DRE 210	**Energy Management and Auditing**	**12**	**4**

Module I: Understanding of Energy forms and cost

Unit 1: Fundamental of Energy and importance

1.1 Commercial and primary energy resources, Energy generation schemes

1.2 Energy pricing, energy security, energy conservation and its importance

1.3 Electricity tariff, load management and maximum demand control

Unit 2: Energy and its various forms

2.1 Thermal energy contents of fuel, heat capacity, sensible and latent heat, heat transfer

2.2 Stoichiometric air-fuel ratio, flue gas analysis

Unit 3: Cost and Optimization analysis of Energy

3.1 Understanding energy costs, bench marking, energy performance index

3.2 Understanding energy used pattern, system efficiencies, input energy requirements optimization

Module II: Energy Management and Auditing

Unit 1: Energy management and auditing concept

1.1 Concept of energy management programme

1.2 Energy auditing services; basic components of an Energy audit

1.3 Types of energy audit, Industrial, commercial and residential audit planning

Unit 2: Energy conservation and auditing

2.1 Fuel & energy substitution

2.2 Energy conservation act and its features

2.3 Duties and responsibilities of energy managers and auditors

2.4 Energy audit instruments/ tools

Unit 3: Energy management and Action Planning

3.1 Energy management systems, Management commitment and energy conservation policy

3.2 Energy performance assessment: Data collection and management, analysis of data, baseline and benchmarking, Estimation of energy savings potential

3.3 Action planning, training planning

Module III: Energy Balance and Monitoring

Unit 1: Material and Energy Balance

1.1 Basic Principles, Sankey diagrams

1.2 Material balances for different processes

1.3 Energy balances, heat balances

Unit 2: Methods and procedure of Energy Balance

2.1 Methods for preparing process flow chart

2.2 Procedure to carry out the material and energy balance in different processes

Unit 3: Monitoring and Targeting

3.1 Defining monitoring & targeting, elements of monitoring & targeting

3.2 Data and information-analysis, various techniques

3.3 Energy consumption, production, cumulative sum of differences (CUSUM), case studies

Module IV: Electrical and Thermal Energy Management

Unit 1: Electrical Energy Management

1.1 Reactive power management

1.2 Energy conservation in domestic and industrial sectors

1.3 Energy conservation in lighting, motors, pumps and fan systems

Unit 2: Thermal Energy Management

2.1 Energy conservation in boilers and Furnaces

2.2 Waste heat recovery

2.3 Thermal insulation

Unit 3: Energy conservation options in buildings

3.1 Energy conservation in buildings, building heating and cooling load management

3.2 Buildings code, solar passive and green building concepts

Module V: Financial analysis and Project Management

Unit 1: Financial analysis and techniques

1.1 Financial analysis techniques: simple payback period, return on investment, net present value, internal rate of return, cash flows and sensitivity analysis

1.2 Financing options, energy performance contracts and role of ESCOs

Unit 2: Project Management and methods

2.1 Project definition and scope, technical design and financing

2.2 Project planning techniques: CPM and PERT, case studies

Suggested Reading References

[1] Doty S. and Turner W. C. (2012); *Energy Management Handbook*, Eighth Edition, Fairmont Press

[2] Kreith F. and West R.E. (1996); *Handbook of Energy Efficiency*, First edition, CRC Press

[3] Thumann A. Mehta D.P (2008); *Handbook of Energy Engineering*, Sixth Edition, Fairmont Press

[4] Bureau of Energy Efficiency (BEE) (2016); *Study material for Energy managers and Auditors Examination:* Paper I to IV

[5] Thumann A. Niehus T. and Younger W. J, (2012); *Handbook of Energy Audits,* Ninth Edition, CRC Press

Course code	Course Name	CH	Credits
DRE 211	**Energy Efficiency in Utilities and Industries**	**12**	**4**

Module I: Thermal and Electrical Energy

Unit 1: Fuels and Combustion

1.1 Properties of Fuel: Oil, Coal and Gas; Storage, handling and preparation of fuels

1.2 Principles of combustion; combustion of Oil, Coal, and Gas

1.3 Stoichiometric air fuel ratio, Theoretical and excess air

Unit 2: Electrical systems

2.1 Introduction of Electrical systems, Tariff and economic considerations

2.2 Electrical load management; Maximum demand management

2.3 Role of Power factor and its improvement

2.4 Electric Power systems analysis

2.5 Energy Efficient Technologies in Electrical Systems

Module II: Energy Efficiency in Mechanical Utilities I

Unit 1: Energy conservation in boilers

1.1 Boiler systems, types of boilers

1.2 Combustion in boilers
1.3 Performances evaluation; analysis of losses
1.4 Energy conservation opportunities

Unit 2: Steam Systems

2.1 Steam properties
2.2 Steam pipe sizing and designing
2.3 Steam traps: Operation and maintenance, performance assessments
2.4 Energy conservation opportunities

Unit 3: Furnaces

3.1 Types and classifications of different furnaces
3.2 Performance analysis of furnaces; Analysis of losses
3.3 General fuel economy measures in furnaces; Case study
3.4 Energy conservation opportunities

Unit 4: Waste Heat Recovery

4.1 Classifications and applications
4.2 Benefits of waste heat recovery
4.3 Commercial waste recovery systems, Case study

Module III: Energy Efficiency in Mechanical Utilities II

Unit 1: Compressed Air systems

1.1 Compressor types and performance; Compressed air systems components
1.2 Efficient operation of compressed air systems, Systems capacity assessment
1.3 Energy conservation opportunities

Unit 2: HVAC and Refrigeration systems

2.1 Types of Refrigeration systems; Common Refrigerant and Properties
2.2 Compressor types and applications
2.3 Performance assessment of Refrigeration plants
2.4 Energy conservation opportunities

Unit 3: Fans and blowers

3.1 Types, Performance evaluation, efficient system operation, Capacity selections
3.2 Performance assessment of fans and blowers
3.3 Energy conservation opportunities

Unit 4: Pumping systems and cooling towers

4.1 Types, Performance evaluation, efficient system operation
4.2 Energy conservation opportunities in pumping systems
4.3 Introduction to cooling towers; cooling tower performance, efficient system operation
4.4 Energy conservation opportunities in cooling towers

Unit 5: Insulations and Refractories

5.1 Purpose of insulations, Types and applications
5.2 Calculation of insulation Thickness; Economic thickness of insulations
5.3 Types and properties of refractories; uses of refractories

Module III: Energy Efficiency in Electrical Utilities

Unit 1: Electric Motors

1.1 Motor Types, Characteristics, Efficiency
1.2 Energy Efficient Motors
1.3 Factors affecting Energy efficiency of a motor
1.4 Soft starters, Variable speed drives

Unit 2: Lighting systems

2.1 Basic terms of lighting systems; Lamp and Luminaries types, recommended illumination level
2.2 Methodology of lighting systems energy efficiency study
2.3 Cast study, Energy conservation opportunities

Unit 3: DG Set systems

3.1 Introduction, Selection and capacity factor, Operational parameters
3.2 Performance assessment of DG Systems
3.3 Energy conservation opportunities

Suggested Reading References

[1] Energy Efficiency in Thermal Utilities, 2016, BEE guide book
[2] Energy Efficiency in Electrical Utilities, 2010, BEE guide book
[3] Turner WC. Energy Management Handbook, 5th Edition, The Fairmont Press, 2005
[4] Capehart, Turner, Kennedy. Guide to Energy Management. Fifth Ed. The Fairmount Press, 2006.
[5] Thumann, Younger. Handbook of Energy Audit. Sixth Ed. The Fairmount Press, 2003.

Course code	Course Name	CH	Credits
DRE 212	**Project Work**	**24**	**8**

Students will be encouraged to choose a topic from the broad area of Renewable Energy and Energy Management for the project work during the end of First Semester and the project work will start in the second semester. Special emphasis will be given on the application of the knowledge gained through the theory courses in executing the project work. The work may be carried out in the energy specific industry, energy utilities, or through field survey or in appropriate laboratory specialized in the field of energy studies. In case student carries out the project work in any specific industry or outside laboratory other than Tezpur University, a senior level expert from the Industry/laboratory may act as an External Supervisor along with one faculty member from the Department of Energy, Tezpur University as an Internal Supervisor. On completion of the project work, the student shall submit a thesis to the Centre for Open and Distance Learning (CODL), Tezpur University for examination. The project work/thesis shall be evaluated by a committee constituted by CODL with an external examiner and/or internal examiners. The candidate has to appear an open Viva-voce examination for defending his/her thesis.

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