

ఆంధ్రప్రదేశ్ కేంద్రీయ విశ్వవిద్యాలయం
ఆంధ్రప్రదేశ్ కేంద్రీయ విశ్వవిద్యాలయ
Central University of Andhra Pradesh
Jnana Seema, Ananthapuramu

School of Interdisciplinary and Applied Sciences

Department of Molecular Biology



Vidya Dadati Vinayam
(Education Gives Humility)

PG Diploma in Green Energy and Management

w.e.f. Academic Year 2025 - 2026

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Introduction to the Programme

This programme is designed to provide students with foundational knowledge and practical skills in renewable energy technologies, energy efficiency, and sustainable management practices. The programme addresses the growing global need for professionals capable of implementing environmentally friendly energy solutions and contributing to sustainable development.

The course focuses on a wide range of renewable energy sources, including solar, wind, and biomass. Students gain insights into energy conservation techniques, energy auditing, environmental management, and policy frameworks governing sustainable energy systems. Emphasis is placed on integrating technical knowledge with managerial and operational skills to ensure students can plan, implement, and monitor energy-efficient solutions across industries.

In addition to technical competencies, the programme encourages students to develop an understanding of the economic, social, and environmental implications of energy management. Through project work, case studies, and practical training, learners are equipped to meet the challenges of the green energy sector and contribute meaningfully to national and global sustainability initiatives.

The programme is suitable for recent graduates, working professionals, and individuals seeking career advancement in energy management, environmental planning, or renewable energy technologies. Graduates are prepared to work in energy consulting, sustainability projects, renewable energy companies, and government or regulatory agencies.

Programme Objectives

The primary objectives are:

- To impart foundational knowledge of renewable energy technologies, including solar, wind, biomass, and small-scale hydro power.
- To develop practical skills in energy auditing, efficiency improvement, and sustainable energy management.
- To create awareness of environmental regulations, energy policies, and sustainable development goals.
- To enhance problem-solving and decision-making skills for planning and implementing green energy solutions.
- To prepare students for professional roles in renewable energy projects, energy consulting, and environmental management sectors.
- To promote interdisciplinary understanding by integrating technical, managerial, and policy aspects of green energy and sustainability.
- To encourage research and innovation in green energy technologies and sustainable management practices.

Learning Outcomes

Upon successful completion of the programme, students will be able to:

- Understand renewable energy systems and their applications in different sectors, including industrial, commercial, and residential.
- Perform energy audits and recommend strategies to improve energy efficiency and reduce carbon footprint.
- Assess environmental impacts of energy projects and implement measures for sustainable energy use.
- Apply management principles for planning, monitoring, and optimizing energy systems and renewable energy projects.

- Navigate energy policies and regulations, understanding compliance requirements and sustainability frameworks.
- Develop project proposals and business plans for renewable energy initiatives, demonstrating economic feasibility and environmental benefits.
- Use modern tools and technologies for energy analysis, modeling, and management.
- Collaborate effectively in multidisciplinary teams to address energy and sustainability challenges.

Programme Structure

Semester– I						
Sl. No	Course Code	Title of the Course	Total Credits	Credits Distributions		
				L*	T*	P*
1.	PDGEM101	Solar Energy Systems	4	3	1	0
2.	PDGEM102	Wind Energy Technology	4	3	1	0
3.	PDGEM103	Energy Storage (Electrochemical Energy Conversion and Storage)	4	3	1	0
4.	PDGEM104	MOOC/NPTEL/SWAYAM	3	3	1	0
5.	PDGEM105	MOOC/NPTEL/SWAYAM	3	3	1	0
6.	PDGEM106	Internship	2	3	1	0
Total			20	20	0	0

Semester– II						
Sl. No	Course Code	Title of the Course	Total Credits	Credits Distribution		
				L*	T*	P*
1	PDGEM201	Energy Audit and Management	4	3	1	0
2	PDGEM202	Energy Economics and Policies	4	3	1	0
3	PDGEM203	MOOC/NPTEL/SWAYAM	3	3	1	0
4	PDGEM204	MOOC/NPTEL/SWAYAM	3	3	1	0
5	PDGEM205	Dissertation	6			
Total			20	12		

Dissertation & Viva voce is compulsory and have to submit to the department one week before second semester examination. Department faculty will allot a supervisor to each student at the end of first semester.

***L:** Lectures, ***T:** Tutorials, ***P:** Practical

- Note:** 1. MOOCs are chosen by the student based on the availability of the courses offered on SWAYAM & other related platforms as suggested/recommended by the Department.
2. The desired changes may be made by the Department in the programme structure as and when necessary with the prior approval of the BOS.

Credit Distribution

Semester	Total Credits
Semester-I	20
Semester-II	20
Total	40

Important Information to the Student

- Eligibility:
 - CUAP/ non-CUAP students pursuing/completed any PG/PhD Programmes can enroll for PG Diploma Programme offered by the University.
 - Non-CUAP students shall have to appear for an Entrance Examination conducted by the University.
 - A student can enroll for as many PG Diploma Programmes as he/she wishes.
- The minimum duration for completion of any Postgraduate Diploma Programme is two semesters (one academic year).
- Maximum duration to compete the programme is two years.
- A student should have minimum 75% attendance in classes, seminars, practical/ lab in each course of study without which he/she will not be allowed for the Semester-end examinations.
- All theory courses in the programme shall have Continuous Internal Assessment (CIA) component of 40 marks and a Semester-end examination component of 60 marks. The minimum pass marks for a course is 50%.
- The student has to appear 3 CIA tests of 15 marks each per semester in each course from which the best 2 performances shall be considered for the purpose of calculating the marks. A record of the continuous assessment is maintained by the department. The remaining 10 marks are awarded based on participation and performance in:
 - Assignments
 - Class presentations
 - Seminars
 - Quizzes
- A student should pass separately in both CIA and the Semester-end Examination.
- Semester-end examination shall consist of objective type questions, descriptive type questions, short answer questions and case studies or any others.
- A student failing to secure the minimum pass marks in the CIA is not allowed to take the semester-end examination of that course. She/He has to redo the course by attending special classes for that course and get the pass percentage in the internal tests to become eligible to take the semester-end examination.
- Students failing a course due to lack of attendance should redo the course.

Semester - I

Course Code: PDGEM101	(Core Course) Solar Energy Systems	L	T	P	C
Credits: 4 Total Hours: 60		3	1	0	4

Course Objective

This course highlights about the solar energy, solar energy conversion principles, fundamentals about semiconductors and their application for solar cell fabrication and solar characterization

Learning Outcomes

Students will have complete understanding about the solar energy and their conversion principles – solar cell fundamentals – solar cell fabrication and characterization techniques.

Unit I: Properties of Semiconductor

12 Hours

Semiconductors - crystals structures, atomic bonding, energy band diagram – direct & indirect bandgap- p & n doping and carrier concentration - Hall Effect in semiconductors – Intrinsic & extrinsic semiconductor - compound semiconductors - diffusion and drift of carriers, continuity equation – optical absorption – carrier recombination -Effect of temperature.

Unit II: Semiconductors for Solar Cell

14 Hours

Silicon: preparation of metallurgical, electronic and solar grade Silicon - Production of single crystal Silicon: Czokralski (CZ) and Float Zone (FZ) method – imperfections – carrier doping and lifetime - Germanium - compound semiconductors: growth & characterization - amorphous materials – Transparent conducting oxides-Anti-reflection principles and coatings – organic materials

Unit III: Device fabrication

14 Hours

Semiconductor junctions: Schottky barriers, MIS, P-N junction, p-i-n junction and its properties Homo & hetero junction solar cells, multi junction solar cells- Fabrication techniques: Diffusion, thin film technology- physical vapour deposition (PVD)- Electro-Deposition-Molecular beam epitaxy (MBE)- Metal organic chemical vapour deposition (MOCVD)- Plasma enhanced chemical vapour deposition (PECVD)- Organic and Nano tech solar cells – contact & grid metallization.

Unit IV: Characterization and Analysis

12 Hours

Device isolation & analysis - Ideal cell under illumination- solar cell parameters short circuit current, open circuit voltage, fill factor, efficiency; optical losses; electrical losses, surface recombination velocity, quantum efficiency - measurements of solar cell parameters; I-V curve & L-I-V characteristics, internal Quantum yield measurements – Effects of series and parallel resistance and Temperature - Loss analysis.

Unit V: Thermo-photovoltaics

8 Hours

Thermo photovoltaic principles - thermophotovoltaic materials and device fabrication – thermo photovoltaic device characterization and analysis – Thermophotovoltaic power systems

References :

1. Semiconductors for solar cells, H. J. Moller, Artech House Inc, MA, USA, 1993.
2. Fundamentals of Solar Cells: PV Solar Energy Conversion, Alan L Fahrenbruch and Richard H Bube, Academic Press, New York, 1983
3. Solar Cells: Operating principles, Technology and Systems Applications, Martin Green, UNSW, Australia, 1997.
4. Solar Cells and their Applications, Larry D Partain (ed.), John Wiley and Sons, Inc, New York, 1995.
5. J. Nelson, The physics of solar cells, Imperial College Press, 2006.
6. Photovoltaic Materials, Richard H Bube, Imperial College Press, 1998
7. Practical Photo voltaics: Electricity from Solar Cells, by Richard Komp, ISBN:9780937948118, Publisher: Aatec Publications, Publication Date: February 2002.
8. Bauer, Thomas, "Thermophotovoltaics: Basic Principles and Critical Aspects of System Design" Springer (2012).
9. Solar Cell Array Design Handbook, H S Rauschenbach, Van Nostrand Reinhold, 1997.

Course Code: PDGEM102	(Core Course) Wind Energy Technology	L	T	P	C
Credits: 4 Total Hours: 60		3	1	0	4

Course Outcome

Understanding the fundamentals of wind energy technology

Able to design and analyze the existing and innovative blade profile

Able to assess the performance of the wind turbine

Understanding about the selection of sites and installation of turbines

Unit I: Fundamentals of Wind Energy

12 Hours

Nature of atmospheric winds- Wind resource characteristics and assessment– Anemometry, speed frequency distribution, effect of height, wind rose, Weibull distribution, atmospheric turbulence, gust wind speed, effect of topography. Influence of Reynolds’s number, actuator disc, Betz coefficient.

Unit II: Conceptual and Component Design

14 Hours

Classification of wind turbines, Rotor Diameter, Machine Rating, Rotational Speed, Blades, Power Control, Pitch Bearings, Rotor Hub, Gearbox, Generator, Mechanical Brake, Yaw Drive, Tower, Foundations. Tip Speed Ratio (TSR), Choice of the Number of Blades, Relationship of TSR and Coefficient of Performance (Cp), TSR in Field Conditions

Unit III: Mechanics & Dynamics

8 Hours

Review of Fluid Flow Concepts, Airfoil terminology, Blade element theory, Blade design, General Principles Primer (stress, strain, vibrations), Rotor Dynamics, Sources of loads, Types of loads, Aero Servo Elasticity in Wind Turbines. Primer on Fatigue, Fatigue in Wind Systems

Unit IV: Wind Turbine Performance

14 Hours

Power v/s Energy, Power Contained in Wind, Effective Useable Energy from Wind Turbine, Practical Limits of Energy Output, Net Power Output from the Turbine, Important Rules for Wind Turbines, Power Curve, Wind-turbine Performance Measurement, Aerodynamic Performance Assessment, Dynamics, Estimation of Energy Capture, and The Performance Curves.

Unit V: Wind Farm and Wind Energy Economics

12 Hours

Onshore, offshore wind energy, wind farms, design of wind farms, Project Development, Visual and Landscape Assessment, Noise, Electromagnetic Interference, Ecological Assessment, Finance Engineering Economics Basics, Wind Turbine Cost Analysis,

Text Books

1. Steve Parker, “Wind power”, Gareth Stevens Publishing, 2004.
2. Freris L.L., Wind Energy Conversion Systems, Prentice Hall 1990.
3. Spera D.A., Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering, ASME Press, NY 1994.

Course Code	(Core Course) Energy Storage (Electrochemical Energy Conversion and Storage)	L	T	P	C
PDGEM103		3	1	0	4

Course Outcome:

Enrich knowledge on basics of energy conversion & storage

Gain know-how battery and fuel cell functioning

Gain knowledge on fabrication technology of battery and fuel cells

Aware about the storage of renewable energy using battery

The aim of this course is to give a broad view of electrochemical energy conversion and storage devices. The basics of these devices and their merits and demerits will be taught. At the end of this course, the students will have a thorough knowledge on what are primary and secondary batteries, important of super capacitors and fuel cells.

Unit I: Introduction

14 Hours

Electrochemical cell, electro motive force, free energy changes and emf, concentration of the reactants on EMF, effect of cell temperature, derivation of number of electrons involved in a cell reaction, thermodynamic calculations, electrochemical series-equilibrium potential, Nernst equation-Battery types – primary and secondary batteries and examples - theoretical voltage, capacity, energy & specific energy, power & specific power.

Unit II: Primary batteries

10 Hours

Dry cells-zinc/carbon battery, alkaline primary batteries, Zn/air, Lithium batteries, reserve batteries: principle, components, construction, characteristics, applications, and problems associated with the systems.

Unit III: Secondary Batteries

10 Hours

Principle, construction, components, merits and demerits of lead acid, nickel-cadmium, nickel- metal hydride, lithium-ion batteries-Possible applications.

Unit IV: Supercapacitors

12 Hours

Introduction to supercapacitors, types of supercapacitors, Ragone plot, similarities and differences between supercapacitors and batteries, electrode interface & double layer capacitors-redox capacitors-construction and performance evaluation, materials for supercapacitors and technology development – typical examples.

Unit V: Fuel Cells

14 Hours

Introduction to fuel cells, merits and demerits, comparison to batteries & internal engines, types of fuel cells, EMF of fuel cells, Nernst equation, efficiency, current versus potential issues, fuel cell reaction kinetics, ORR, MOR, selection of fuel, electrode, electrolyte and membranes-fuel cell charge transport, fuel cell mass transport, fuel cell characterization, fuel cell losses, hydrogen - oxygen fuel cell, PEMFCs, DMFCs, PAFCs, molten carbonate fuel cells, SOFCs and Biofuel cells.

Text Books

1. Barak, Electrochemical Power sources, I.E.E. series Peter Peregrinus Ltd. Steverage, U.K 1980 reprint 1997.
2. J.O.M. Bockris& A.K.N. Reddy, Modern Electrochemistry, Plenum Press, 1996.

References

1. A.J. Bard & L.R. Faulkner, Electrochemical Methods Fundamentals and Applications, John Wiley & Sons. 2nd Edition, 2001.
2. B.E. Conway, Electrochemical supercapacitors: scientific fundamentals and technological applications, Kluwer Academic / Plenum publishers, New York, 1999.
3. T.R. Crompton, Batteries reference book, Newners, 3rd Edition, 2002.

Course Code	(Core Course) Bioenergy and Biofuels Conversions	L	T	P	C
PDGEM104		3	1	0	4

Course outcome:

After studying this subject, students would be able to measure the extent of biochemical growth types of biochemical interactions for living processes.

Ability to analyze the microbial growth kinetics

The student can design a fermenter for the bioprocessing of different products.

The student can scale up the bioprocess for large scale production

The students can monitor the bioprocess for higher production efficiency

Unit 1: Introduction to Energy **12 Hours**

Major sources of energy: primary and secondary energy sources, energy scenario, prospects/need of alternate energy sources, common forms of energy, conventional and non-conventional energy sources; energy from biomass/coal; environmental aspects of energy utilization-conventional energy resources and their importance, Nexus between energy, environment and sustainable development.

Unit 2: Biomass for Bioenergy **10 Hours**

Biomass as energy resources; Availability of the feedstock, compositional analysis and properties of feedstock, bio-energy potential and challenges, Classification and estimation of biomass; Concept of solid and liquid fuels, Source and characteristics of biofuels: Biodiesel, Bioethanol, Biogas. Types of biomass energy conversion systems - waste to energy conversion technologies.

Unit 3: Bioenergy Conversion Processes **14 Hours**

Origin of Biomass, Hydrocarbon Family, Biomass Conversion Process, Direct Combustion of Biomass (Incineration), Thermochemical Conversion of Biomass, Biochemical Conversion, Fermentation, Gaseous Fuels from Biomass, Applications of Biomass Energy Conversion Processes, Biodiesel via transesterification, Bio-alcohols via fermentation, Biogas via Anaerobic digestion, Bio-hydrogen processes: direct/indirect photolysis, photo fermentation, and microbial electrolysis-cell, Thermochemical process for Bioenergy: Incineration, Gasification, Pyrolysis and its types, Plasma arc technology, Hydrothermal gasification, Hydrothermal liquefaction, and Hydrothermal carbonization.

Unit 4: Biorefineries and Biofuels **14 Hours**

Biorefineries; Process synthesis and design, Bioreactors for biofuels, Biogas plants and types of biogas plants, Integration of biochemical conversion processes, types of biorefineries, biorefinery feedstocks and properties, Biofuels: Biodiesel, Biooil, Biochar, Bioethanol, biohydrogen, Biomethane, Organic Commodity Biochemicals, Integrated Biorefinery, thermochemical processing of biomass, Bio-oil refining: bio-oil refining and its conversion to fuels, novel membrane reactors for bio-oil refining; Fuel cells and other renewables; Algal biorefineries; Case studies in biorefineries.

Unit 5: Biofuels Standards and Energy Economy **10 Hours**

Physical and chemical characteristics of biofuels, Bio blends - Indian and International standard specifications, Adaptation of biofuel in various applications, Biofuel economy, Biofuel roadmap of India, Policy issues, Regulatory issues and economic impact; Entrepreneurship in biofuel - Prospects & Challenges, Case studies.

References

1. Bailey, J. E., & Ollis, D. F. (2018). Biochemical engineering fundamentals. McGraw-Hill.
2. Shuler, M. L., & Kargi, F., (2006). Bioprocess Engineering Basic Concept Pearson Education, Inc.
3. Cornish-Bowden, A. (2013). Fundamentals of enzyme kinetics. John Wiley & Sons.
4. Liu, S. (2020). Bioprocess engineering: kinetics, sustainability, and reactor design. Elsevier.
5. Doble, M., Kruthiventi, A. K., & Gaikar, V. G. (2004). Biotransformation and bioprocesses. CRC Press.

Semester – II

Course Code	Energy Audit and Management	L	T	P	C
PDGEM201		3	1	0	4

Course Outcome:

To provide understanding on ECA-2001 and its features

Need for energy audit and method of its execution

The role of energy and material balance calculation in energy auditing

To study the energy conservation opportunities in various thermal utilities

Energy conservation in electrical utilities

Unit 1: ECA-2001 & Energy Audit and Management

14 Hours

Salient features of the ECA-2001, Key definitions, Powers and functions of BEE, State designated agencies, Schemes of BEE under ECA 2001, Need for energy audit, Types of energy audit, Identification of energy conservation (ENCON) opportunities, Technical and economic feasibility, Classification of ENCON measures, Energy audit report, Understanding of energy costs, Benchmarking, Plant energy performance, Fuel and energy substitution, Instruments and metering for energy audit.

Unit 2: Material and Energy Balance

09 Hours

Introduction, Components of material and energy balance, Basic principles of materials and energy balance, Classification of processes, Levels of material balance, Material balance procedure, Energy balance, Facility as an energy system, Energy analysis and Sankey Diagram.

Unit 3: Energy Conservation in Thermal Utilities: Furnace, Boilers, Steam Systems

14 Hours

Furnaces: Classification, general fuel economy measures in furnaces, excess air and heat distribution losses, temperature control, draft control, case studies.

Boilers: Types, analysis of losses, performance evaluation, boiler blow down, energy conservation opportunities, FBC boilers, case studies.

Steam system: Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery systems, identifying opportunity for energy saving, case studies.

Unit 4: Energy Conservation in Thermal Utilities: Insulation and refractories

14 Hours

Insulation and refractories: Insulation type and application, economic thickness of insulation, heat savings and application criteria, refractory-types, selection and application of refractories, case studies.

Waste heat recovery: Availability and reversibility, first and second law efficiency, classification, advantages and applications, commercially viable heat recovery devices, saving potential, case studies.

Unit 5: Energy Conservation in Electrical Utilities

09 Hours

Electrical systems and bill analysis : Electricity billing, electrical load management, maximum demand control, Energy conservation opportunities in Lighting systems, Electric motors, VCR and VCR systems, HVAC & refrigeration system, Fans & blowers, Pumps, case studies.

Text Books:

1. Albert Thumann, Terry Niehus, William J. Younger, HandBook of Energy Audits, River Publishers, 9th Edition.
2. Larry C. Witte, Philip S. Schmidt, David R. Brown, Industrial Energy Management and Utilization, 1st Edition, Springer Publication, 1988.
3. Stephen A. Roosa, Steve Doty, Wayne C. Turner, Energy Management Handbook, River Publishers, 9th Edition, 2018.
4. Giuliano Dall'O', Green Energy Audit of Buildings, Springer Publication, 2013.
5. Ian M. Shapiro, Energy Audits and Improvements for Commercial Buildings, Wiley Publication, 2016.
6. F W Pyne, P gm Energy Conservation Manual, Fairmount Proem, INC. P.O. Box 14227 Atlanta, A30224

Reference Book:

1. Carig B, Saith, Energy Management Principles, applications, benefit and saving, Per n Presss, Newyork
2. D Patrick and SW Fardo, Energy conservation, Prentice Hall, INC Engleweek Cliffs (NJ) 7632
3. Davida, Fuels of opportunity, characteristics and uses in combustion systems, Edition-2004, Publisher-Elsevier Ltd., UK

Course Code	Energy Economics and Planning	L	T	P	C
PDGEM202		3	1	0	4

Course Outcome:

To enable students, undertake financial feasibility evaluation studies of energy technologies and to discuss various issues involved and techniques used in energy planning. It is also envisaged to provide relevant inputs on energy- economy-environment interaction related policy studies

Unit 1: 12 Hours

Relevance of financial and economic feasibility evaluation of energy technologies and systems, Basics of engineering economics, financial evaluation of energy technologies, social cost benefit analysis.

Unit 2: 12 Hours

Case studies on techno-economics of energy conservation and renewable energy technologies, Energy demand analysis and forecasting.

Unit 3: 12 Hours

Energy supply assessment and evaluation, Energy demand – supply balancing, Energy models, Energy – economy interaction, Energy investment planning and project formulation.

Unit 4: 12 Hours

Energy pricing, Policy and planning implications of energy – environment interaction, clean development mechanism, Financing of energy systems,

Unit 5: 12 Hours

Energy policy related acts and regulations, Software for energy planning

Text Books :

1. M. Kleinpeter, Energy Planning and Policy, John Wiley & sons, 1995.
2. R. Codoni, H. Park and K.V. Ramani, Integrated Energy Planning: A Manual, Vols. I, II & III. Asian and Pacific Development Centre, Kuala Lumpur, 1985.
3. J. Parikh, Energy Models for 2000 and Beyond, Tata McGraw Hill Publishing Company Limited, 1997.
4. M. S. Kumar, Energy Pricing Policies in Developing Countries: Theory and Empirical Evidence, International Labor Organization, 1987.
5. M. Munasinghe and P. Meir, Energy Policy Analysis and Modeling, Cambridge University Press, 1993.
6. A. V. Desai, Energy Planning, Wiley Eastern Ltd., 1990. H.Campbell and R.Broron, Benefit-Cost Analysis, Cambridge University Press, 2003.
7. C. S. Park, Contemporary Engineering Economics, Prentice Hall Inc., 2002.