GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)

Semester VI

Course Title: Major Project

(Course Code: 4366406**)**

Diploma programme in which this course is offered	Semester in which offered
Renewable Engineering	6th Semester

1. RATIONALE

The Major Project in the Diploma in Renewable Engineering provides students with a platform to apply their knowledge and technical skills to real-world challenges faced by industries, research organizations, or society. Students identify or build upon problems, typically initiated in 5th semesters, and work under the guidance of academic or industry mentors to develop innovative, economically, and technically viable solutions. This course simulates an industrial experience, encompassing problem-solving, project assembly, testing, troubleshooting, and comprehensive documentation. With regular seminars to enhance communication skills and monitor progress, the course fosters competencies like entrepreneurship, start-up development, grant acquisition, and intellectual property protection, aligning with the vision of self-reliance and sustainable innovation.

In the field of Renewable Engineering, effective guide allocation and project planning are crucial for ensuring impactful and innovative outcomes. At the start of the sixth semester, a project orientation session is conducted by the project coordinator to guide students in selecting project topics that address real-world renewable energy challenges. This session includes discussions on continuing work from the fifth semester or choosing new topics, forming teams, and assigning mentors. A detailed list of guides, highlighting their expertise in areas such as solar energy systems, wind turbine technologies, or hybrid renewable solutions, is shared with students and uploaded to the institutional website. Students are encouraged to select guides whose specializations align with their project goals, ensuring optimal mentorship. This planning process aims to equip students with the necessary direction and support to develop innovative, technically feasible, and sustainable solutions in renewable engineering.

2. COMPETENCY:

I. Technical Problem-Solving
- Ability to analyze and address real-world challenges in renewable energy through innovative and technically feasible solutions.

II. Project Development Skills
- Proficiency in planning, assembling, testing, troubleshooting, and documenting renewable energy projects.

III. Research and Analytical Skills
- Competence in identifying and building upon industry or societal problems and conducting thorough analysis for sustainable solutions.

IV. Entrepreneurial Mind-set
- Skills in start-up development, grant acquisition, and intellectual property protection to foster entrepreneurial ventures in renewable energy.

V. Collaboration and Leadership
- Ability to work effectively in teams, formulating strategies and managing responsibilities to achieve project goals.

VI. Adaptability to Industry Practices
- Practical exposure to industrial methodologies and tools relevant to renewable energy systems, enhancing industry readiness.

VII. Communication Proficiency
- Expertise in presenting ideas, writing reports, and participating in seminars to convey technical solutions effectively.

VIII. Sustainability Focus
- Deep understanding of sustainable innovation practices in renewable energy technologies and their economic viability.

IX. Mentorship Utilization
- Capability to leverage the expertise of academic and industry mentors to enhance project outcomes.

X. Self-Reliance and Innovation
- Commitment to the principles of self-reliance and sustainable innovation, aligning with national and global energy goals.

3. COURSE OUTCOMES

CO.1 Identify real-world renewable energy challenges and propose innovative, sustainable, and technically viable solutions.

CO.2 Design, assemble, and test renewable energy systems or components to achieve desired technical and economic performance.

CO.3 Demonstrate teamwork, report writing, and presentation skills through seminars and effective communication of project outcomes.

CO.4 Explore entrepreneurial opportunities by integrating start-up initiatives, grant proposals, and intellectual property strategies.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
0	0	4	2	0	0	50	50	100

Legends: *L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, CA - Continuous Assessment; ESE - End Semester Examination.*

5. Major Equipment/Instruments Required

This major equipment with broad specifications is a guide to procure them by the administrators to use in the laboratory dedicatedly made for the project work.

- Solar panels (monocrystalline/polycrystalline)
- Solar charge controllers
- Solar inverters
- Battery storage systems
- Small wind turbines
- Wind charge controllers
- Anemometers (for wind speed measurement)
- Multimeters, oscilloscopes, and signal generators
- Power supplies and energy meters
- Microcontrollers (Arduino, Raspberry Pi, etc.)
- DC-DC converters and inverters
- Infrared thermometers
- Pyranometers (for solar irradiance measurement)
- Clamp meters and load testers
- Gearboxes, shafts, and bearings for wind energy systems
- Structure and mounting kits for solar panels
- Simulation software (MATLAB/Simulink, HOMER, or PVSyst)
- CAD software for design (AutoCAD, SolidWorks)
- Lithium-ion batteries or lead-acid batteries
- Battery management systems (BMS)
- Soldering kits and wiring tools
- Prototype development kits (breadboards, connectors)
- Testing jigs and calibration tools

6. AFFECTIVE DOMAIN OUTCOMES

The following sample Affective Domain Outcomes (ADOs) are embedded in many of the above-mentioned COs and PrOs. More could be added to fulfill the development of this course competency.

- Work as a leader/a team member (while doing a micro-project)
- Follow safety practices while using Electrical supply and electrical equipment.
- Follow ethical practices.
- Adhere to safety protocols to ensure the safe installation and maintenance of system.
- Practice environmental friendly methods and processes. (Environment related)

The ADOs are best developed through the laboratory/field-based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

I. 'Valuing Level' in 1st year
II. 'Organization Level' in 2nd year.
III. 'Characterization Level' in 3rd year.

7. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of Revised Bloom's taxonomy that are formulated for development of the COs and competency. If required, more such UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different levels)	Topics and Sub-topics
Unit -I Identification of Renewable Energy Challenges	**1a**. Analyze real-world renewable energy challenges using systematic research methods. **1b**. Propose innovative, sustainable, and technically viable solutions for identified problems.	**1.1** Overview of global and local renewable energy challenges. **1.2** Identifying and analysing real-world problems in solar, wind, and hybrid systems. **1.3** Research methodologies for renewable energy problem-solving. **1.4** Proposal preparation for innovative solutions with sustainability focus.
Unit 2: Design and Development of Renewable Energy Systems	**2a.** Design renewable energy systems considering technical and economic feasibility**.** **2b.** Assemble and test renewable energy systems to meet desired performance standards **2c.** Troubleshoot faults and ensure system reliability and safety.	1 2 **2.1** Principles of designing renewable energy systems (solar, wind, hybrid). **2.2** System assembly: components, tools, and techniques. **2.3** Testing procedures for performance validation and troubleshooting. **2.4** Safety standards and economic feasibility of renewable energy systems.

Unit 3: Communication and Documentation in Renewable Engineering	**3a.** Demonstrate teamwork and collaboration in executing project tasks. **3b.** Prepare detailed technical reports and project documentation. **3c.** Deliver effective presentations to communicate project outcomes.	**3.1** Teamwork and collaborative project execution. **3.2** Techniques for effective report writing and documentation. **3.3** Presentation skills for seminars and project demonstrations. **3.4** Feedback incorporation and progress tracking through reviews
Unit 4: Entrepreneurship and Innovation in Renewable Energy	**4a.** Develop entrepreneurial strategies for renewable energy projects. **4b.** Explore funding opportunities and intellectual property protection for innovations. **4c.** Align project work with national and global sustainability goals.	**4.1** Basics of entrepreneurship in renewable energy. **4.2** Start-up planning and grant acquisition strategies. **4.3** Intellectual property rights and patent filing in renewable energy innovations. **4.4** Linking project outcomes to self-reliance and sustainable development goals.

Note: *The departmental SSIP (Student Startup Innovation Policy) team will review each project to evaluate its suitability for the SSIP scheme. If a project is deemed viable, the respective student group, with guidance from the departmental SSIP coordinator, must apply for grants for startup development and/or patent filing through SSIP or other relevant funding agencies.*

8. SCOPE AND TYPES OF PROJECTS

Scope of Projects

- **Relevance to Renewable Engineering Field:** Projects should focus on addressing current issues in renewable energy, such as energy efficiency, system optimization, sustainability, or cost-effectiveness. The scope should align with the latest developments in renewable energy technologies, including solar, wind, biomass, hydro, or hybrid systems.
- **Practical Application of Skills:** The project scope should challenge students to apply their knowledge in real-world scenarios, utilizing skills such as problem-solving, system integration, data analysis, and prototyping. Students should aim to develop solutions that integrate renewable energy solutions with current industry practices or societal needs.
- **Scalability and Feasibility:** The project should consider the scalability of solutions to both small-scale and large-scale applications. Students must analyze whether the proposed solution is practically feasible in terms of resources, technology, and economics, considering available infrastructure and budget constraints.

- **Sustainability Focus:** Projects should prioritize sustainability, with an emphasis on creating solutions that are environmentally friendly, energy-efficient, and economically viable in the long term. This can include the use of alternative materials, reducing carbon footprints, or enhancing renewable energy adoption.

Types of Projects

1. **Energy Audits and Efficiency Improvements:**
    - Conducting audits of existing renewable energy systems or buildings and proposing improvements for efficiency. Projects might involve optimizing the performance of solar panels, wind turbines, or energy storage systems.
2. **Hybrid Renewable Energy Systems:**
    - Designing and developing hybrid systems that integrate multiple renewable energy sources (e.g., solar and wind) to provide a more reliable and consistent energy supply. This can include the design of smart grids and energy management systems.
3. **Energy Storage Solutions:**
    - Developing innovative energy storage solutions to enhance the efficiency and reliability of renewable energy systems, such as batteries, supercapacitors, or pumped hydro storage.
4. **Smart Grid Technology:**
    - Exploring and developing smart grid technologies that optimize the distribution and use of renewable energy. Projects may involve designing control systems, communication networks, or automation for managing energy flow in a grid.
5. **Waste-to-Energy Systems:**
    - Researching and developing systems that convert organic waste materials (e.g., agricultural, food, or industrial waste) into usable energy, such as biogas, bioethanol, or bioelectricity.
6. **Microgrid Design and Optimization:**
    - Designing and testing microgrids that can operate independently or in conjunction with the main grid. Projects can involve the integration of renewable energy sources, energy storage, and load management for off-grid communities or remote areas.
7. **Solar Water Heating Systems:**
    - Developing solar-powered water heating systems for domestic or industrial use, with a focus on improving efficiency, cost-effectiveness, and ease of installation and maintenance.
8. **Biomass and Bioenergy Conversion Technologies:**
    - Designing systems to convert biomass (wood, agricultural residue, etc.) into energy, either through combustion, gasification, or anaerobic digestion. These projects could involve optimizing processes for higher energy output and lower emissions.
9. **Environmental Impact Studies and Renewable Energy Solutions:**
    - Conducting studies on the environmental impact of renewable energy installations, including the effect of wind farms on local wildlife or solar installations on land use.

Propose solutions to minimize ecological disruptions while maximizing energy generation.

10. **Renewable Energy for Smart Cities:**
    - Researching how renewable energy solutions can be integrated into the infrastructure of smart cities. Projects could involve designing systems that optimize energy use, reduce waste, and integrate renewable resources like solar panels, electric vehicles, and IoT devices into urban planning.

9. ASSESSMENT OF PROJECT WORK

The Project Guide, Program Coordinator, and/or Project Evaluation Committee will evaluate the project through four distinct seminars, each assessed based on the provided rubrics. These seminars will be conducted during the fifth semester, and continuous assessment (CA) will account for 50 marks, following the prescribed assessment format. The remaining 50 marks will be assigned through the End Semester Examination (ESE), conducted by GTU. In cases where separate independent projects are undertaken for both the 5th and 6th semesters, the assessment criteria may be slightly adjusted by the project guide, program coordinator, or project evaluation committee to accommodate the specific requirements of each semester's project.

Seminar 1: Project Topic Selection & Initial Research (15 Marks)
Seminar 2: Conceptual Design & Methodology (15 Marks)
Seminar 3: Project Implementation & Prototype Development (20 Marks)
Final Evaluation (End-Semester Exam - 50 Marks)

The final evaluation will be based on the overall completion and demonstration of the project, along with a written exam that tests theoretical knowledge and practical understanding of renewable energy systems, project design, and implementation strategies.

10. SOFTWARE / LEARNING WEBSITES

SOFTWARE

1. **AutoCAD**
2. **MATLAB/Simulink**
3. **HOMER Energy** –
4. **PVsyst**
5. **WindPro**
6. **SketchUp**

LEARNING WEBSITE

1. **Coursera** - https://www.coursera.org/
2. **edX** - https://www.edx.org/
3. **MIT OpenCourseWare** - https://ocw.mit.edu/
4. **NPTEL** - https://nptel.ac.in/
5. **Energy.gov** - https://www.energy.gov/
6. **IRENA** - https://www.irena.org/

7. **Solar Energy International (SEI)** - https://www.solarenergy.org/
8. **The Green Energy Institute** - https://greenenergy.institute/
9. **Renewable Energy World** - https://www.renewableenergyworld.com/
10. **FutureLearn** - https://www.futurelearn.com/

11. PO-CO MAPPING

CO \ PO	DESCRIPTION	PO1: Basic & Discipline-Specific Knowledge	PO2: Problem Analysis	PO3: Design/Development of Solutions	PO4: Engineering Tools, Experimentation & Testing	PO5: Engineering Practices for Society, Sustainability & Environment	PO6: Project Management	PO7: Life-Long Learning
CO1	Identify real-world renewable energy challenges and propose innovative, sustainable, and technically viable solutions.	3	1	2	2	3	1	1
CO2	Design, assemble, and test renewable energy systems or components to achieve desired technical and economic performance.	2	3	3	3	2	2	1
CO3	Demonstrate teamwork, report writing, and presentation skills through seminars and effective communication of project outcomes.	1	2	2	2	1	3	2
CO4	Explore entrepreneurial opportunities by integrating start-up initiatives, grant proposals, and intellectual property strategies.	1	1	2	1	2	2	3

12. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Person

Sr. No.	Name and Designation	Institute	Contact Number	Email ID
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