

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

VI – Semester

Course Title: Installation, Maintenance & Monitoring of Renewable Energy Power Plant
(Course Code: 4366401)

Diploma programme in which this course is offered	Semester in which offered
Renewable Energy	Six

1. RATIONALE

Renewable energy plant consists of various types of components which requires Installation and Maintenance. Each and every component of plant plays an important role to prevent breakdown of Any Plant. Energy plants are also required monitoring system for efficient working of it. Many times engineering Diploma holder has to carry out or supervise Installation, Maintenance & Monitoring of various components or equipments of Renewable Energy Power Plant. This has also increased the demand of trained manpower to handle all equipments of plant. in this course Essential efforts are made to enable diploma pass out students to develop required skill for installation, Maintenance & Monitoring of plant to generate ecofriendly power.

2. COMPETENCY

The purpose of this course is to help the students to attain the following industry identified competency through various teaching learning experiences:

- **Installation, Maintenance and Monitoring of Renewable Energy Power Plant.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs.

- a) Understand installation of solar power plant
- b) Prepare maintenance schedule of wind power plant
- c) Trouble shooting chart of hydro power plant
- d) Understand renewable energy policies

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				Total Marks
L	T	P		Theory Marks		Practical Marks		
			C	CA	ESE	CA	ESE	
3	0	2	4	30	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment of the cognitive domain UOs required for the attainment of the COs.

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

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the Course Outcomes (Cos). Some of the PrOs marked ‘*’ are compulsory, as they are crucial for that particular CO at the ‘Precision Level’ of Dave’s Taxonomy related to ‘Psychomotor Domain’.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Identify the various components of solar PV system	I	2
2	Understand the installation procedure and set up solar PV system	I	2
3	Site visit of various types of solar power plant	I	2
4	Prepare maintenance schedule of solar PV system	I	2
5	Troubleshoot various faults in solar pv system	I	2
6	Identify various components of wind power plant	II	2
7	Understand the steps to install wind turbine	II	2
8	Prepare maintenance schedule of wind power plant	II	2
9	Troubleshoot various faults in wind power plant	II	2
10	Measure Earth resistance in wind energy power plant	II	2
11	Identify various component and understand installation steps of hydro power plant	III	4
12	Understand various renewable energy policies of government	IV	4

Note

- i. More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.
- ii. The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course required which are embedded in the COs and ultimately the competency.
- iii.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Understanding of concepts	20
2	Explanation of conclusion	20
3	Student attitude towards learning	20
4	Quality of term work	20
5	Timely completion of term work	20
Total		100

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to user in uniformity of practical's in all institutions across the state.

Common Instruments related to installation, maintenance and monitoring

Sr. No.	Equipment Name with Broad Specifications	PrO. No.
1	Solar PV modules, batteries, charge controller	1,3,5
2	Inverter, cable, junction box, dist.box, mounting accessories, Tool kit	1,3,5
3	Digital Multimeter	5,9
4	Digital earth tester	10
5	Solar trainer kit	1,5
6	Wind trainer kit	6,9
7	Digital Anemometer, wind vane, sensors	6,9

7. 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.

- a) Work as a leader/a team member(while doing a micro-project)
- b) Follow safety practices while using Electrical supply and electrical equipment.
- c) 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:

- 'Valuing Level' in 1st year
- 'Organization Level' in 2nd year
- 'Characterization Level' in 3rd year

8. 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)	Topics and Sub-topics
Unit –I Solar power plant	<ul style="list-style-type: none"> • Explain various components of solar power plant • Understand the installation procedure of diff. components • State the importance of maintenance • Prepare trouble shooting chart for solar plant 	<ul style="list-style-type: none"> • Site selection, Basics of installation and its requirements • Main components of solar power plant • Steps of solar panel installation and prerequisites • Assembling, fixing and precautions for mounting PV module structure • Installation of various components of PV system • Connection and interconnection of components and precautions • Earthing & lightening protection • Maintenance: preventive, Scheduled and unscheduled Maintenance of PV system • Periodic maintenance schedule • Reasons of faults & Trouble shooting of PV system components • Monitoring system and cyber security
Unit-II Wind power plant	<ul style="list-style-type: none"> • prepare maintenance chart of wind power plant • describe various faults in wind power plant • explain monitoring system in wind power plant 	<ul style="list-style-type: none"> • Site selection, Basics of Installation and its requirements • Main components of wind power Plant • Steps of wind turbine installation • Predictive maintenance • Maintenance of wind turbine • Safety regulations • Earthing and lightening protection • Fault analysis and Trouble shooting of wind power system • Monitoring of key components of wind power system • Control system of wind power plant using SCADA system

Unit-III Hydro Power Plant	<ul style="list-style-type: none"> • Identify the appropriate site • Explain various components of hydro power plant • Explain the need of maintenance • State the safe practices for hydro power plant 	<ul style="list-style-type: none"> • Basics of Installation and its requirements • Main components of hydro power electrical system • Installation of electrical equipment: switchboard, outfit, secondary ckt, transformer and its all accessories, high voltage electric equipment, bus bar, cable laying, auxiliary system motors • Lightning protection & grounding • Maintenance:- water intake, conduit system and equipment, Turbine and its auxiliaries, Generator and its auxiliaries, Transformer and switchyard, Emergency D.G set • Installation of safety monitoring system, computer monitoring system, video monitoring system, Condition monitoring system
Unit-IV Renewable Energy policies	<ul style="list-style-type: none"> • describe the various policies of government for renewable energy sector • Explain challenges and opportunities in renewable energy sector 	<ul style="list-style-type: none"> • Gujarat renewable energy policy-2023 • Gujarat solar power policy 2021 • Policy for development of small scale distributed solar projects 2019 • Gujarat wind power policy 2016 • Gujarat small hydel policy 2016 • Gujarat wind-solar hybrid policy 2018 • Challenges of renewable sector • Opportunities in renewable sector

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Solar power plant	16	10	20	--	30
II	Wind power plant	10	10	5	--	15
III	Hydro Power Plant	10	8	7	--	15
IV	Renewable energy policies	6	7	3	--	10
Total		42	35	35	--	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy)

Note: This specification table provides general guidelines to assist students for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions to assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may slightly vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related **co-curricular** activities which can be undertaken to accelerate the attainment of the various outcomes in this course. Students should perform following activities in group (or individual) and prepare reports of about 5 pages for each activity. They should also collect/record physical evidences for their (student's) portfolio which may be useful for their placement interviews:

- a) Present seminar on various topics from course content
- b) Arrange workshops and hands on practices to install solar pv system
- c) Arrange an expert sessions from industry persons
- d) Group discussion on current scenario of renewable energy sector.

The student should be encouraged to get their work assessed by the concerned teacher progressively during the term and at the end of the term the whole work should be submitted to the concerned teacher.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a) Guide student(s) in undertaking micro-projects.
- b) Show animation/ video related to course content.
- c) Take a Visit of nearby renewable energy power plant

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The duration of the micro project should be about **14-16 (fourteen to sixteen) student engagement hours** during the course. The students ought to submit micro-project by the end of the semester to develop the industry-oriented COs.

A suggestive list of micro-projects is given here. This has to match the competency and the COs. Similar micro-projects could be added by the concerned course teacher:

- a) Create a model of small solar pv system
- b) Create a model of small wind power plant
- c) Prepare maintenance schedule of various renewable energy power plant
- d) Prepare chart of various faults and its trouble shooting
- e) Prepare a report on visit of nearby renewable energy power plant

13. SUGGESTED LEARNING RESOURCES

Sr. No .	Title of Book	Author	Publication with place, year and ISBN
1	Rooftop solar pv(installation & maintenance)	National Instructional Media Institute	National Instructional Media Institute,Chennai First Edition : July 2024
2	Solar panel installation technician	Electronics sector skills council of india(essci)	ESSCI First edition july 2022
3	Best Practices for Operation and Maintenance of Photovoltaic and Energy Storage Systems	National Renewable Energy Laboratory	NREL/TP-7A40-73822 Technical report 2018 3 rd Edition golden co.
4	Guidelines for the operation and maintenance of rooftop solar photovoltaic systems	Steve Williams, Chris Hewett	Solar Energy UK December 2021,
5	Practical operation & maintenance (O&M) manual on solar pv system	Ing.Marina, D.K.Agortimevor	GIZ Green People's Energy Project,april 2023
6	Use, installation and maintenance of renewable energy system	Miguel A. Sanz-Bobi <i>Editor</i> Springer International Publishing Switzerland	2014 ISSN 1865-3529 ISSN 1865-3537 (electronic),ISBN 978-3-319-03223-8

7	Wind Power Plants Control Systems Based on SCADA System	Khairy Sayed, Ahmed G. Abo-Khalil, and Ali M. Eltamaly	Springer Nature Switzerland AG 2021
8	Installation of Electro mechanical Equipment Technical Guidelines for the,Development of Small Hydropower Plants	United nations industrial development organisation	SHP/TG 004-2: 2019

14. SOFTWARE/LEARNING WEBSITES

- <https://nimi.gov.in/pmsuryaghar/RooftopSolarPVTrainerNSQF4.0.pdf>
- <https://www.essc-india.org/participant-handook/English/Embedded Analyst.pdf>
- <https://www.nrel.gov/docs/fy19osti/73822.pdf>
- <https://solarenergyuk.org/wp-content/uploads/2021/12/Solar-Energy-UK-Rooftop-OM-best-practice-Second-edition.pdf>
- https://gruene-buergerenergie.org/wp-content/uploads/Practical-Operation-Maintenance-Manual_Final.pdf
- <https://www.manualslib.com/manual/2783090/Enair-E70pro.html>
- <https://prescinto.ai/blog/scada-in-wind-and-solar-importance>
- https://www.iitr.ac.in/Departments/Hydro/RenewableEnergy Department/static/special_publ/vol_3.pdf
- <https://cea.nic.in/wp-content/uploads/2020/04/chapter-6.pdf>
- <https://www.sciencedirect.com/science/article/pii/S1474667015326343>
- <https://www.scribd.com/document/306149583/Teachers-Manual-Diploma-Hydropower-Engineering>
- <https://guj-epd.gujarat.gov.in/Home/GujaratREPolicy>

15. PO-COMPETENCY-CO MAPPING:

Semester VI	Installation, Maintenance & Monitoring of Renewable Energy Power Plant (Course Code:)						
	POs						
Competency & Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7
		Basic & Discipline specific knowledge	Problem Analysis	Design/development of solution	Engineering Tools, Experimentation & Testing	Engineering practices for society, sustainability & environment	Project Management
Competency	Operate and maintain Renewable Energy Power Plant						
Course Outcomes							
Co1.understand installation of solar power plant	2	2	1	2	3	1	1
Co2.prepare maintenance schedule of wind power plant	1	1	--	2	2	--	1
Co3.trouble shooting in hydro power plant	1	--	--	--	2	--	--
Co4.understand renewable energy policies	2	--	--	--	2	--	--
	1.5	1.5	1	2	2.25	1	1

Legend: '3' for high, '2' for medium, '1' for low and '-' for no correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

No.	Name and Designation	Institute	Contact No.	Email
1.	Shri R S Zampda	AVPTI, Rajkot	9737000036	zampda.ranjeet@gmail.com