GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Renewable Energy & Emerging Trends in Electronics
(Course Code: 4361106**)**

Diploma programmer in which this course is offered	Semester in which offered
Electronics and Communication Engineering	Sixth

1. RATIONALE

Learning about Renewable Energy and Emerging Trends in Electronics is essential, as these fields play a crucial role in shaping the future of technology, sustainability, and global development. Comprehending sustainable energy sources like solar, wind, hydro, and geothermal energy is essential to mitigating climate change and minimizing the ecological consequences of energy generation. The field of electronics is dynamic and constantly evolving. The utilization of the newest technologies in electronics is facilitated by keeping up with new trends, thereby promoting innovation across a range of industries.

2. COMPETENCY

The course content should be taught and implemented to develop the required skills in the students so that they can acquire the following competencies:

- Technical proficiency in understanding renewable energy technologies and emerging electronic trends, honing their capabilities in energy systems and cutting-edge electronics

3. COURSE OUTCOMES (COs)

The theory should be taught and the practical should be carried out in such a manner that students can acquire required learning outcomes in the cognitive, psychomotor and affective domains to demonstrate the following Course Outcomes.

- Understand the fundamental principles of renewable energy systems and their applications
- Stay informed about current trends and innovations in Smart Materials and systems
- Gain knowledge of Emerging Trends in Electronic Components
- Develop basic idea of Trends in interfacing & Computing

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	
2	0	2	3	70	30*	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate the integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for 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 subcomponents of the COs. Some of the PrOs marked '' are compulsory, as they are crucial for that particular CO. These PrOs need to be attained at least at the 'Precision Level' of Dave's Taxonomy related to the 'Psychomotor Domain'*

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Understand the Block Diagram of a Home Solar rooftop system*	1	**2**
2	Study E-vehicle kit with various parts of electric vehicle & compare specifications of different EVs	1	**2**
3	Study wearable systems like Smart Watches, Smart glasses & wearable health monitoring systems	2	**2**
4	Understand the structure of a drone *	2	**2**
5	Understand the block diagram of a generic biometric system*	3	**4**
6	Study various AR-VR gadgets and technologies	3	**4**
7	Install Raspberry Pi OS on your SD card using Raspberry Pi imager, Setup and configure Raspberry Pi computer *****	4	**4**
8	Interface/Simulate LED, button and buzzer with Raspberry Pi	4	**2**
9	Interface PIR, temperature and humidity sensors with Raspberry Pi	4	**4**
10	Demonstrate a burglar alarm system using Raspberry Pi*	4	**4**
11	Getting started with machine learning using tools like machinelearningforkids/scratch/scikit-learn or TensorFlow *	4	**4**
12	Create a cartoon that smiles if you type nice things to it and cries if you type bad things to it. (Train, test and implement text classification machine learning algorithm using machinelearningforkids/scratch/scikit-learn or TensorFlow)	4	**4**
13	Make a dancing panda that gets shy and stops dancing if it sees you looking. (Train, test and implement image classification machine learning algorithm using machinelearningforkids/scratch/scikit-learn or TensorFlow)	4	**4**
14	Make a cartoon that learns to recognize Gujarati/other languages. (Train, test and implement sound classification machine learning algorithm using	4	**2**

	machinelearningforkids/scratch/scikit-learn or TensorFlow)		

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 in the COs and ultimately the competency.

Sr. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Lab Records	05
2	Question answer or Writing steps exercise	20
3	Execution of exercise	40
4	Observations/ Result /Printout	20
5	Viva voice	15
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

Sr. No.	Equipment Name with Broad Specifications	Pr. No.
1	Solar rooftop system	1
2	E-vehicle kit to study various parts of electric vehicle	2
3	Smart gadgets like smartwatches, goggles etc..	3
4	Drone	4
5	Biometric system	5
6	AR-VR gadgets	6
7	Raspberry Pi	7
8	Various Sensors and electronic components	8,9,10
9	Machine learning software and hardware system	11,12,13,14

7. AFFECTIVE DOMAIN OUTCOMES

- Development of positive attitudes, values, and motivations toward sustainable energy practices and technological advancements.
- Appreciation for the importance of renewable energy sources and the role they play in addressing environmental challenges.

- Cultivate a sense of responsibility and concern for the environment, emphasizing the impact of energy choices on ecosystems and global climate patterns.
- Foster an innovative mindset by recognizing the significance of emerging trends in electronics and their potential to revolutionize the energy landscape.

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 the development of the COs and competency. If required, more such higher-level UOs could be included by the course teacher to focus on the attainment of COs and competency.

Unit	Unit Outcomes(UO)	Topics & Subtopics
Unit - I **Renewable Energy Systems and Applications**	Students will be able to 1a. Describe and prioritize renewable energy 1b. Discuss different types of Renewable Energy Sources 1c. Explain Emerging renewable energy technologies & innovations 1d. Explain Solar Photovoltaic effect & Principle of photovoltaic conversion, 1e. List the different types of Solar Cell 1e. Understand the Block Diagram of a Home Solar rooftop system 1f. Illustrate a Block diagram of an electric vehicle & EV architecture 1g. Describe the types of EV 1h. Discuss different Energy sources for EV 1i. Know hybrid energy sources	1.1 Introduction to Renewable Energy and its Importance 1.2 Types of Renewable Energy Sources- • Solar • Wind • Hydroelectric • Biomass • Geothermal 1.3 Emerging Trends in Renewable Energy- • tidal wave • solar thermal • hydrogen 1.4 Introduction to Solar Cell, Photovoltaic effect, Principle of photovoltaic conversion 1.5 Types of Solar Cells- • Silicon • Monocrystalline Silicon • Polycrystalline • Thin Film • Amorphous Silicon • Cadmium Telluride • Copper Indium Gallium Selenide 1.6 Block diagram of Solar rooftop system 1.7 Introduction to Electric Vehicle Technology and its Types- • Battery Electric Vehicle (BEV) • Hybrid Electric Vehicle (HEV) • Plug-in Hybrid Electric Vehicle (PHEV)

		• Fuel Cell Electric Vehicle (FCEV) 1.8 Energy sources for EV: • Battery • Fuel Cell • Ultracapacitor • Flywheel • Regenerative Braking • Hybrid Energy Sources
Unit – II Smart Materials and Systems	Students will be able to 2a. Understand Nanotechnology 2b. List Nanotechnology applications 2c.Know various wearable technologies 2d. Explain UAVs or drones 2e. Discuss the applications of UAVs or drones 2f. Describe the working principle of a drone 2g. Describe the Block diagram of a drone and its major components 2h. Understand various Smart Systems 2i. Illustrate Block diagrams of Smart Systems like water pollution monitoring, Street light control and monitoring, Health monitoring and homes & Gadgets	2.1 Introduction to Nanotechnology 2.2 Applications of Nanotechnology 2.3 Wearable Technology: Smart Watches and Smart glasses, or wearable health monitoring system 2.4 Introduction to UAVs or drones and their applications 2.5 Working principle of drone 2.6 Major components of drone 2.7 Smart System Examples self-driving cars, artificial pancreas, Internet of Things (IoT), M2M-enabled advanced manufacturing robots 2.8 Smart Systems Case Study • Water pollution monitoring • Smart Street light control and monitoring • Smart Health Monitoring • Smart Homes & Gadgets
Unit-III Emerging Trends in Electronic Components	Students will be able to 3a. Understand organic electronics 3b. Compare between Inorganic and Organic electronics 3c. Explain the advantages of Organic electronics 3d. Explain different types of organic components: OLED, OFET, OPVD 3e. Understand Biometrics 3f. Explain Biometric systems and their basic block diagram 3g. Understand AR/VR,	3.1 Introduction to Organic and Inorganic Electronics 3.2 Characteristics & Differences 3.3 Advantages of Organic Electronics 3.4 Different types of organic components: • Organic LED (OLED) • Organic FET(OFET) • Organic Photovoltaic devices (OPVD) 3.5 Introduction to Biometrics 3.6 Biometric system: sensor module, basic building block of generic biometric system,

	industry perspectives and opportunities 3h. Explain AR/VR core technology and discuss its applications	database module, matching module 3.7 Introduction to AR/VR- Industry perspectives and opportunities 3.8 AR/VR Core Technology, Experience and Applications
Unit IV: Trends in interfacing & Computing	Students will be able to 4a. Understand the Block diagram of Raspberry Pi 4b. Install Raspberry Pi OS on your SD card using Raspberry Pi Imager 4c. Setup and configure Raspberry Pi computer 4d. Interface LED, button and buzzer with Raspberry Pi 4e. Interface PIR, temperature and humidity sensors with Raspberry Pi 4f. Compare Types of machine learning techniques: supervised, unsupervised, and reinforcement learning 4g. Illustrate Python programming language, Python libraries like NumPy, pandas, keras etc. for data manipulation 4h. Implement machine learning algorithms using machinelearningforkids /scratch/scikit-learn/ TensorFlow	4.1 Getting Started with Raspberry Pi 4.2 Installation and setup of Raspberry Pi computer using Raspberry Pi imager on SD card 4.3 Control various electronic components using Scratch/python on the Raspberry Pi • LED • button • buzzer and sensors - • PIR • temperature • humidity 4.4 Introduction to Machine Learning and its Types- • Supervised • Unsupervised • Reinforcement 4.5 Basics of Python for Machine Learning using libraries like NumPy, pandas, keras etc. 4.6 Introduction to ML tools for machine learning implementations • Machinelearningforkids • Scratch • scikit-learn • TensorFlow

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN:

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R	U	A	Total Marks
I	Renewable Energy Systems and Applications	**8**	**8**	**6**	**4**	**18**

II	Smart Materials and Systems	**6**	**4**	**8**	**4**	**16**
III	Emerging Trends in Electronic Components	**6**	**8**	**4**	**4**	**16**
IV	Advanced Trends in Computing Applications	**8**	**4**	**8**	**8**	**20**
		28	**24**	**26**	**20**	**70**

Legends: R = Remember **U** = Understand; **A** = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from the above table.

10. SUGGESTED STUDENT ACTIVITIES

- Prepare and submit a report on Renewable Energy Megaprojects (Large-Scale Solar and Wind Installations) of Smart City
- Visit a nearby renewable energy power plant and report documentation.
- Prepare a PowerPoint presentation on drone technology.
- Prepare a PowerPoint presentation on advanced technologies in Electric vehicles.
- Prepare a PowerPoint presentation on AR/VR.

11. SUGGESTED PROJECT LIST

- IoT sensors-based electronic circuits on renewable energy assets, such as solar panels and wind turbines, monitor performance, weather conditions, and maintenance needs
- Burglar Alarm using Raspberry Pi
- Line follower robot using Raspberry Pi
- Weather station using Raspberry Pi
- Train, test and implement image classification machine learning algorithm using machinelearningforkids /scratch/scikit-learn or TensorFlow
- Train, test and implement text classification machine learning algorithm using machinelearningforkids /scratch/scikit-learn or TensorFlow
- Train, test and implement sound classification machine learning algorithm using machinelearningforkids /scratch/scikit-learn or TensorFlow

12. SUGGESTED LEARNING RESOURCES

- "Renewable Energy: Power for a Sustainable Future" by Godfrey Boyle, 3rd Edition(2012)
- "Renewable and Sustainable Energy Reviews" Elsevier Journal Open Access.
- "Introduction to Biometrics" by forwarded James Wayman Anil K . Jan, Arun A Ross Kartik Nandkumar
- "Organic Electronics an Introduction" by Dr Sanjay Tiwari Professor & Head SOS in Electronics & Photonics Pt. Ravishankar Shukla University, Raipur
- The Official Raspberry Pi Beginners Guide by 5th Edition by Gareth Halfacree

- https://cfdflowengineering.com/working-principle-and-components-of-drone/#:~:text=The%20basic%20components%20of%20a,at%20each%20of%20these%20components
- Drones For Dummies 1st edition by Mark LayFay published by For Dummies

13. SOFTWARE/LEARNING WEBSITES

- Coursera - "Introduction to Renewable Energy" by The University of Queensland
- https://machinelearningforkids.co.uk
- https://www.raspberrypi.org/
- https://www.tensorflow.org/
- https://scikit-learn.org/

14. PO-COMPETENCY-CO MAPPING:

Semester VI	**EC Engineering Renewable Energy & Emerging Trends in Electronics (Course Code:** 4361106**)**						
	POs						
Competency & Course Outcomes	**Basic and Discipline-specific knowledge**	**Problem analysis**	**Design/ development of solutions**	**Engineering Tools, Experimentation and Testing**	**Engineering Practices for society, sustainability and environment**	**Project Management**	**Life-long learning**
Competency	It creates bridges between renewable energy and emerging electronics, interdisciplinary knowledge to develop innovative solutions, contributing to the evolution of sustainable energy practices and leveraging cutting-edge electronic technologies for enhanced efficiency, ensuring a well-rounded skill set for future challenges in the dynamic intersection of these fields.						
Course Outcomes CO1 Understand the fundamental principles of renewable energy sources	3	1	1	1	1	1	2
CO2 Stay informed about current trends and innovations in Smart and autonomous systems	3	3	3	3	2	3	3
CO3 Analyze the design and operation of advanced electronic components in emerging fields Develop basic applications in Advanced computing	3	1	1	1	2	1	3
CO4 Develop basic applications in Advanced computing	3	3	3	3	2	3	3

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

15. COURSE CURRICULUM DEVELOPMENT COMMITTEE

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