

Environment and Sustainability Solutions

4300003 – Study Material

Semester 1 Study Material

Detailed Solutions and Explanations

GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Semester - I

Course Title: Environment and Sustainability (Course Code: 4300003)

Diploma programme in which this course is offered	Semester in which offered
Chemical, Mechatronics, Computer	First
Civil, Environment, Mining, Architectural Assistantship, Mechanical, Automobile, Marine, Metallurgy, Fabrication, Electrical, Electronics and Communication, Instrumentation and Control, Bio Medical, Power Electronics, IT, Textile Manufacturing, Textile Processing, Textile Design, Printing, Plastics, Ceramics, CACDDM , Computer Science and Engineering.	Second

1. RATIONALE

For a country to progress, sustainable development is one of the key factors. Environment conservation and hazard management is of much importance to every citizen of India. Considerable amount of energy is being wasted. Energy saved is energy produced. Environmental pollution is on the rise due to rampant industrial mismanagement and indiscipline. Renewable energy is one of the answers to the energy crisis and also to reduce environmental pollution. Therefore this course has been designed to develop a general awareness of these and related issues so that the every student will start acting as a responsible citizen to make the country and the world a better place to live in.

2. COMPETENCY

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

- Adopt the sustainable practices to resolve the environment related issues.

3. COURSE OUTCOMES (Cos)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with this competency are to be developed in the student to display the following COs:

- a) Adopt relevant ecofriendly product in the given situation to protect ecosystem
- b) use relevant method of pollution reduction in the given situation
- c) Use of renewable resources of energy for sustainable development
- d) Use the relevant techniques in given context to reduce impact due to climate change Use relevant laws and policies for developing the sustainable environmental development

4. TEACHING AND EXAMINATION SCHEME

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

Teaching Scheme	Teaching Scheme	Teaching Scheme	Total Credits	Examination Scheme				
3	0	0	3	30*	70	0	0	100

- (*): Out of 30 marks under the theory CA, 10 marks are for assessment of the microproject 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 - Not Applicable

The following practical outcomes (PrOs) that are the sub-components of the 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' .

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..

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Prepare of experimental setup	20
2	Operate the equipment setup or circuit	20
3	Follow safe practices measures	10
4	Record observations correctly	20
5	Interpret the result and conclude	30
Total	Total	100

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED - (Not Applicable)

These major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practicals in all institutions across the state.

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 fulfil the development of this competency.

- a) Work as a leader/a team member.
- b) Follow ethical practices.
- 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:

- i. 'Valuing Level' in 1 st year
- ii. 'Organization Level' in 2 nd year.
- iii. 'Characterization Level' in 3 rd year.

8. UNDERPINNING THEORY

Only the major Underpinning Theory is formulated as higher level UOs of Revised Bloom's taxonomy in order development of the COs and competency is not missed out by the students and teachers. If required, more such higher level 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 Application and above level)	Topics and Sub-topics
Unit - I Ecosystem	<p>1a. Explain the Structure with components of the given Ecosystem</p> <p>1b. Explain Carbon, Nitrogen, Sulphur and phosphorus cycle for the given ecosystem.</p> <p>1c. Justify the need to conserve the given Ecosystem on the w.r.t. following points: carrying capacity of earth Biomes, Ecologically sensitive area</p> <p>1d. Explain the term biodiversity with its importance.</p> <p>1e. Illustrate the importance of IUCN red list in environmental engineering.</p> <p>1f. Calculate global ecological overshoot and virtual water requirement of given natural and man-made materials.</p>	<p>1.1 Structure and components of ecosystem</p> <p>1.2 Types of Ecosystem, changes in ecosystem</p> <p>1.3 Various natural cycles like carbon, Nitrogen, Sulphur, Phosphorus</p> <p>1.4 Ecosystem conservation, carrying capacity of earth, Biomes in India, (ESA)</p> <p>Ecologically sensitive areas</p> <p>1.5 Bio diversity, its need and importance, International Union for Conservation of Nature (IUCN) red list</p> <p>1.6 Concept of Ecological foot print, virtual water, global ecological overshoot</p>
Unit - II Pollution and its types	<p>2a. Explain the term, 'pollution and pollutant' in the given situation.</p> <p>2b. Classify the air pollution on the basis of its source</p> <p>2c. Use relevant equipment to control given type of air pollution.</p> <p>2d. Explain relevant techniques of treatment to deal with given type of water pollution.</p> <p>2e. Apply relevant techniques of Solid waste management based on its characteristics.</p> <p>2f. Explain drawbacks of noise pollution in given situation.</p> <p>2g. Describe the environmental degradation due to Plastic waste and E-waste</p>	<p>2.1. Definition of pollution and pollutant</p> <p>2.2. Air pollution, classification and its sources</p> <p>2.3. Air pollution control Equipments</p> <p>2.4. Water pollution, pollution parameters like BOD, COD, pH, Total suspended solids, Turbidity, Total Solids</p> <p>2.5. Waste water treatment like primary, secondary and tertiary</p> <p>2.6. Solid waste generation, sources and characteristics of Municipal solid waste</p> <p>2.7. Collection and disposal of Municipal waste and Hazardous waste</p> <p>2.8. Noise pollution- its effects, sources and measurement</p> <p>2.9. Plastic waste and its hazard</p> <p>2.10. E waste and its hazard</p>
Unit- III Renewable sources of energy	<p>3a. Justify the need of renewable energy adopting relevant energy policy in given situation.</p> <p>3b. Explain the working of the solar thermal and PV systems with sketch in given situation.</p> <p>3c. Justify the need of Advanced collector, Solar Pond, Solar water heater, Solar dryer in the given system.</p> <p>3d. Emphasize the importance of wind power in India</p> <p>3e. Select the relevant type of wind turbines in the given situation.</p> <p>3f. Identify the relevant types of Sources of biomass energy.</p> <p>3g. Draw the neat labelled diagram of simple biogas plant to explain its working.</p> <p>3h. Identify the sources of the energy generation for the given situation.</p>	<p>3.1 Need of Renewable energy and energy policy</p> <p>3.2 Solar energy: National solar mission</p> <p>3.3 Features of solar thermal and PV systems Advanced collector, Solar Pond, Solar water heater, Solar dryer, polycrystalline, monocrystalline and thin film PV systems</p> <p>3.4 Wind Energy: Growth of wind power in India</p> <p>3.5 Types of wind turbines - Vertical axis wind turbines (VAWT) and horizontal axis wind turbines (HAWT)</p> <p>3.6 Types of HAWTs - drag and lift types</p> <p>3.7 Biomass: Overview of biomass as energy source. Thermal characteristics of biomass as fuel</p> <p>3.8 Anaerobic digestion, Biogas production mechanism, utilization and storage.</p> <p>3.9 New energy sources: Geothermal energy, Ocean energy sources, Tidal energy conversion, Hydrogen energy</p>

Unit	Unit Outcomes (UOs) (4 to 6 UOs at Application and above level)	Topics and Sub-topics
Unit- IV Climate Change	<p>4a. Explain the term, 'climate change' in context of environment.</p> <p>4b. Describe the ill effects of Global warming due to various causes arising in the given situation.</p> <p>4c. Explain the term, 'greenhouse effect' with its causes.</p> <p>4d. Relate the impact of Ozone depletion in climate change due to its causes.</p> <p>4e. Justify the need of relevant Climate change management system to reduce the impact of climate change in the given context.</p>	<p>4.1 Identify Factors affecting climate change in given locality.</p> <p>4.2 Definition of climate change</p> <p>4.3 Global warming-causes, effect, process</p> <p>4.4 Greenhouse effect</p> <p>4.5 Ozone depletion</p> <p>4.6 Factors affecting climate change</p> <p>4.7 Impact and mitigation</p> <p>4.8 Climate change management</p>
Unit- VEnvironmental legislation and sustainable practices	<p>5.a Use relevant policy or law in relation with environment in given situation</p> <p>5.b Relate the relevant provision of given act in given situation.</p> <p>5.c Explain the necessity of the Environmental management system in given situation.</p> <p>5.d Use the principle of Rain water harvesting in the given situation.</p> <p>5.e Justify the necessity of Green building in India.</p> <p>5.f. Adopt the relevant rating system for energy calculation for the given building.</p> <p>5.g Explain the terms, 'Cradle to cradle concept' and 'Life cycle analysis'</p> <p>5.h Emphasize the importance of Carbon credit system in India.</p> <p>5.i Explain the importance of 5R concept.</p>	<p>5.1 Environmental policies in India</p> <p>5.2 Air act, water act, Environment protection act, wild life protection act, Forest conservation act, Biodiversity act</p> <p>5.3 Environmental management system: ISO 14000, definition and benefits</p> <p>5.4 Rain water harvesting</p> <p>5.5 Green building and rating system in India</p> <p>5.6 Cradle to cradle concept and Life cycle analysis</p> <p>5.7 Green label</p> <p>5.8 Carbon credit system its advantages and disadvantages</p> <p>5.9 Concept of 5R(Refuse, Reduce, Reuse, Repurpose, Recycle)</p> <p>5.10 Eco tourism: advantages and disadvantages</p>

Note : The UOs need to be formulated at the 'Application Level' and above of Revised Bloom's Taxonomy' to accelerate the attainment of the COs and the competency.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
Unit No.	Unit Title	Teaching Hours	R Level	U Level	A	Total Marks
I	Ecosystem	08	6	6	2	14
II	Pollution and its types	10	4	6	6	16
III	Renewable sources of energy	10	4	6	6	16
IV	Climate Change	08	4	6	4	14
V	Environmental legislation and sustainable practices	06	5	3	2	10
Total	Total	42	12	28	30	70

Legends: R=Remember, U=Understand, A=Apply and above (Revised Bloom's taxonomy) Note : This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions 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 vary slightly 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 conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- a) Prepare specification of some renewable sources of energy.
- b) Undertake micro-projects in teams
- c) Give seminar on any relevant topic.
- d) Undertake a market survey of different green materials.
- e) Prepare showcase portfolios.
- f) Prepare report on various issues related to environment and sustainable development
- g) Publish a research paper on themes related to environment and sustainable development.
- h) Compare the pollution (water, air and noise) data of various cities with standard values as laid by pollution control board.
- i) Undertake some small mini projects on various issues related to environment and sustainable development.
- j) Submit a report on visit to an energy park
- k) Prepare power point on clean and green technologies
- l) Submit a report on visit to garbage disposal system in your city/town.
- m) Submit a report on analysis of the life cycle of any one or two eco-friendly product/s.
- n) Calculate ecological footprint using various calculator available on web with a report recommending ways and means to reduce ecological footprint.
- o) Give seminar on relevant topic.
- p) Undertake micro-projects.

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) Massive open online courses (MOOCs) may be used to teach various topics/sub topics.
- b) Guide student(s) in undertaking micro-projects.
- c) 'L' in section No. 4 means different types of teaching methods that are to be employed by teachers to develop the outcomes.
- d) About 20% of the topics/sub-topics which are relatively simpler or descriptive in nature is to be given to the students for self-learning , but to be assessed using different assessment methods.
- e) With respect to section No.10 , teachers need to ensure to create opportunities and provisions for co-curricular activities .

f) Guide students on how to address issues on environment and sustainability

- g) Guide students for using data manuals.
- h) Guide students for using data manuals.
- i) Arrange visit to nearby industries and workshops for understanding various sources of pollution.
- j) Use video/animation films to explain various processes related to environment and sustainable development
- k) Use different instructional strategies in classroom teaching.
- l) Write the report on properties of various eco-friendly construction materials like Stone, aggregate of different sizes, timber, lime, bitumen, Bricks, tiles, precast concrete products, Water proofing material, Termite proofing material, Thermal insulating material, plaster of Paris, paints, distemper, and varnishes.
- m) Display various technical brochures of recent projects/themes related to environment and sustainable development
- n) Visit the Pollution control board office and its various projects to demonstrate the various practices adopted for control of Pollution

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-project are group-based. However, in the fifth and sixth semesters, it should be preferably be individually undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should not exceed three.

The micro-project could be industry application based, internet-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 total duration of the micro-project should not be less than 16 (sixteen) student engagement hours during the course. The student 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) Natural cycles : Build a Chart showing different natural cycles like Carbon, Nitrogen, Sulphur and phosphorus cycle.)
- b) Solar Energy: Build a model of Solar water heater/Solar cooker
- c) Wind energy: Build a model of wind mill
- d) Best out of waste : Build useful items from waste materials like used plastic bottles, discarded pens etc.
- e) Compare the pollution (water, air and noise) data of various cities with standard values as laid by pollution control board.
- f) Surf different websites related environment and sustainable development, Pollution control.
- g) Prepare energy audit report of any residential building.
- h) Collect relevant information about the software used in pollution control.
- o) Visit to ongoing project and study various aspects related to environment and sustainable development

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Renewable Energy Technologies: A Practical Guide for Beginners	Solanki, Chetan Singh	PHI Learning, New Delhi, 2010 Print Book ISBN: 9788120334342 eBook ISBN: 9789354437151
2	Ecology and Control of the Natural Environment	Izrael, Y.A.	Kluwer Academic Publisher eBook ISBN: 978-94-011-3390-6 Softcover ISBN: 978-94-010-5499-7
3	Green Technologies and Environmental Sustainability	Singh, Ritu, Kumar, Sanjeev	Springer International Publishing, 2017 eBook ISBN 978-3-319-50654-8
4	Environmental Noise Pollution and Its Control	G.R. Chhatwal, M. Satake, M.C. Mehra, Mohan Katyal, T. Katyal, T. Nagahiro	Anmol Publications, New Delhi ISBN: 8170411378 ISBN: 8170411378
5	Wind Power Plants and Project Development	Earnest, Joshua & Wizelius, Tore	PHI Learning, New Delhi, 2011 ISBN-10: 8120351274 ISBN-13: 978-8120351271
6	Renewable Energy Sources and Emerging Technologies	Kothari, D.P. Singal, K.C., Ranjan, Rakesh	PHI Learning, New Delhi, 2009 ISBN-13 - 978-8120344709
7	Environmental Studies	Anandita Basak	Pearson Publications ISBN 8131785688, 9788131785683 ISBN: 9788131721186, 8131721183 University Press ISBN: 9788173718113 ISBN-10: 8173716080 ISBN-13: 978-8173716089
8	Environmental Science and Engineering	Aloka Debi	Orient Longman ISBN-10: 8125027351 ISBN-13: 978-8125027355
9	Coping With Natural Hazards: Indian Context	K. S. Valadia	Mc Graw Hill Publications ISBN-10 : 0071181857 ISBN-13 : 978-0071181853
10	Introduction to Engineering and Environment	Edward S. Rubin	

14. SOFTWARE/LEARNING WEBSITES

- a) www.nptel.iitm.ac.in
- b) www.khanacademy.org
- c) http://www1.eere.energy.gov/wind/wind_animation.html
- d) http://www.nrel.gov/learning/re_solar.html

- e) http://www.nrel.gov/learning/re_biomass.html
- f) <http://www.mnre.gov.in/schemes/grid-connected/biomass-powercogen/>
- g) <http://www.epa.gov/climatestudents/>
- h) <http://www.climatecentral.org>
- i) <http://www.envis.nic.in/>
- j) <https://www.overshootday.org/>
- k) <http://www.footprintcalculator.org/>
- l) <https://www.carbonfootprint.com/calculator.aspx>

15. PO-COMPETENCY-CO MAPPING

Legend: '3' for high, '2' for medium, '1' for low or '-' for the relevant correlation of each competency, CO, with PO/ PSO

Environment and Sustainability (Course Code: PO 1 & Basic & Specific Knowledge Outcomes) Semester II										
and Sustain-ability (Course Code: PO 1 & Basic & Specific Knowledge Outcomes)		and Sustain-ability (Course Code: PO 2)		and Sustain-ability (Course Code: PO 3)		and Sustain-ability (Course Code: PO 4)		and Sustain-ability (Course Code: PO 5)		
Competency	PO 1	Competency	Discipline	PO 3	PO 4	PO 5	PO 6	PO 7	PSO 1	PSO 2
& Course Outcomes	Basic & specific knowledge edge	Competency	PO 2	Design/ Problem Analysis	Engineering development of solutions	Tools, Experimentation & Testing	Engineering practices for society, sustainability & Testing	Project Management	Life-long learning	Environment & Maintenance planning & design
- Adopt the sustainable practices to resolve the environment related issues a. Adopt relevant ecofriendly product in the given situation to protect ecosystem	- Adopt the sustainable practices to resolve the environment related issues 2	- Adopt the sustainable practices to resolve the environment related issues 1	- Adopt the sustainable practices to resolve the environment related issues 1	- Adopt the sustainable practices to resolve the environment related issues -	- Adopt the sustainable practices to resolve the environment related issues 2	- Adopt the sustainable practices to resolve the environment related issues 1	- Adopt the sustainable practices to resolve the environment related issues 1	- Adopt the sustainable practices to resolve the environment related issues 2	- Adopt the sustainable practices to resolve the environment related issues 2	

	Environment and Sustainability (Course Code:)								
Semester II)))))))))
b. use relevant method of pollution reduction in the given situation	2	2	1	1	2	-	2	2	2
c. Use of renewable resources of energy for sustainable development	2	2	2	1	2	2	1	2	2
d. Use the relevant techniques in given context to reduce impact due to climate change	2	2	2	1	2	1	2	2	2
e. Use relevant laws and policies for developing the sustainable environmental development	2	2	2	1	1	1	1	2	2

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	Dr. Jayesh Shah	Ass. Dean GTU, Pacific School of Engineering, Surat	9825436342	jayesh.shah.23021971@gmail.com
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NITTTR Resource Persons

S. No	Name and Designation	Dept.	Contact No.	Email
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