GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Environmental Textile Chemistry
(Course Code: 4352801)

Diploma program in which this course is offered	Semester in which offered
Textile Processing Technology	5th Semester

1. RATIONALE

This course is designed to provide students with a comprehensive understanding of the environmental challenges faced by the textile industry and the management strategies and techniques used to mitigate these challenges. The textile industry is one of the largest polluting industries globally, with significant negative impacts on the environment and public health. Therefore, managing the environmental impact of textile production is critical for sustainable development. The course will enable students to explore and understand the various management techniques and strategies used by textile companies to minimize their environmental impact. Through this course, students will be equipped to become responsible and informed professionals in the textile industry.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competency,

- Identify & summaries the environmental impact of textile production and the need to manage this impact effectively.

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:

- **Apply the principle of Environment & energy management in textile wet processing.**
- **Solve the problems related to water & energy utilization.**
- **Use relevant effluent treatment method in textile wet processing.**
- **Identify occupational health safety measure, various hazards and restate global textile law.**
- **Apply the sustainable innovative technique for environment management in textile wet processing**

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	
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 Cos. *Some of the **PrOs** marked **'*'** (in pprox.. Hrs column) are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Require
1.	Determine Total Solids, Total Dissolved Solids (TDS), Suspended Solids in a given sample of water	2	4
2.	Find out the alkalinity in a given sample of water	2	4
3.	Determine total hardness of a given sample of water.	2	4
4.	Find out chloride content in a given sample of water.	2	4
5.	Find out Biochemical Oxygen Demand (BOD) of a given sample of an effluent.	2	4
6.	Determine Chemical Oxygen Demand (COD) of a given sample of an effluent.	2	4
7.	Prepare the sketch of effluent treatment plant for Textile wet processing unit.	3	4
8.	Study the concept of RO for water purification.	3	4
9.	Study the standard norms and characteristics of effluent in textile wet processing unit.	3	4
10.	Study the principle of Ion-exchange (Na+) process and prepare a neat & clean sketch.	3	4
11.	Report on effect of chemicals on water pollution – Research case study	4	4
12.	Study the Material safety data sheet (MSDS) of dyes (any 2 dye samples) related to textile industries.	4	2
13.	Study the Material safety data sheet (MSDS) of chemicals (any 2 chemical samples) related to textile industries.	4	2
14.	Study energy utilization in wet processing industry.	2	2
15.	Study occupational health hazards in Textile industry case study.	4	4
	Total Hours		54

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 experimental set-up.	20
2	Performing the experiment.	20
3	Follow safe practices.	10
4	Record observations correctly.	20
5	Interpret the result and conclude.	20
6	Submission of report in time	10
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by th4e administrators to usher in uniformity of practicals in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Porcelain disc	1
2.	Pipette: 10 ml, 25 ml	1-6
3.	Burette	2-4
4.	Burette stand	2-4
5.	Conical flasks, 250 ml	2-4
6.	Dye Pots: 250 ml, 500 ml	5,6
7.	Glass rod / Steel rod	1-6
8.	Beaker: 100 ml, 250 ml, 500 ml	1-6
9.	Measuring Cylinder of capacity 10 ml, 25 ml, 100 ml	1-6
10.	Laboratory Drying, Curing and Setting Chamber: Temperature upto 220°C, working width - 450mm, length 1.7 meter, heater capacity - 8/16/24 kilo-watt	1-6
11.	Digital weighing balance: 0.02 gm accuracy (100 gm)	1-6

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) Practice good housekeeping
c) Maintain tools and equipment.
d) Follow ethical practices.

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.

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 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 different levels)	Topics and Sub-topics
Unit – I Energy and Environment Management in Textile Industry	1a. Determine sources of energy use in textile 1b. Need of renewable energy use 1c. Scope of replacement of present energy pattern 1d. Understand energy policies to ensure resource sustainability 1e. Explain carbon foot print	1.1 Importance of Environment & Energy management in wet processing 1.2 Sources of energy 1.3 Introduction to Green energy 1.4 Concept of Carbon footprint 1.5 Concept of Life cycle Assessment 1.6 Eco Labels: Importance & types and its advantages 1.7 Certifications for environment protection like Oeko-Tex (Confidence in Textiles), GOTS, OHSAS
Unit – II Water & Steam Utilization and its distribution	2a. Describe quality of water for wet processing. 2b. Describe various purification process for water. 2c. Explain control of water in textile mill and its reuse. Explain properties of different types fuels 2d. Describe the steam distribution and utilization	2.1 Water utilization 2.2.1 Analysis of impure water 2.2.2 Water Purification: Precipitation & Ion exchange 2.2.3 Water utilization in various textile wet Processes: Bleaching, Dyeing, Printing and Finishing 2.2.4 Conservation of Water and its re-use 2.2 Steam utilization in textile 2.2.1 Steam and its properties 2.2.2 Steam utilization textile wet processes:(Bleaching, Dyeing, Printing and finishing 2.2.3 Conservation of Steam and its reuse

Unit – III **Effluents and** **its Treatment**	3a. Describe characteristics of effluents in textile industry. 3b. Describe Filtration Technology 3c. Explain process, chemistry and technology for effluent treatment	3.1 Characteristics of effluent and composite effluent from various sections of textile wet Processing. 3.2 Tolerance limits of effluent 3.3 COD and BOD of effluent 3.4 Filtration Technology: Microfiltration, Ultra Filtration, Nano Filtration, Reverse Osmosis 3.5 Effluent treatment plant for Textile processing industry 3.6 Physical Treatment, Chemical treatment and Biological Treatment
Unit – IV **Occupational health safety and Hazards**	4a. Analyze Occupational safety in textile processing 4b. Explain various hazards in textile wet processing 4c. Summarize material safety data sheets	4.1 Health issues in textile processing industry 4.2 Safety aspects in Textile processing industry 4.3 Various Hazards in Textile wet processing and their remedies (Mechanical, Chemical and Electric) 4.4 Material safety data sheets
Unit – V **Developments in Energy Efficient and Eco-Friendly Processes**	5a. State the concept of clean technology for textiles 5b. Explain recent innovations in ecofriendly practices in textile industry	5.1 Concept of Clean technology for Textile Processing, 4R Technology and Zero Discharge 5.2 Recent Innovations in textile processing industry like application of Supercritical CO_2, Plasmatechnology, Biotechnology, Nanotechnology.

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	Energy and Environment Management in Textile Industry	08	04	04	02	12
II	Water & Steam Utilization	12	04	08	08	20
III	Effluents and its Treatment	10	04	06	08	18
IV	Ecology and health aspects of textile Industry	06	02	04	02	08
V	Developments in Energy Efficient and Eco- Friendly Processes	06	04	02	06	12
Total		**42**	**20**	**22**	**28**	**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:

i. Do literature survey for different types of effluent treatment plant.
ii. Collection and Study of different water analysis reports from different sources.
iv. Prepare the data sheet for various Eco-labels in textiles
iv. Collect data of effluent produced at end of each textile wet processes and make a Power point Presentation on it.

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) Encourage students to refer different websites for having a deeper understanding of the subject.
g) Assign unit wise assignment to group of 4 to 5 students.
h) Use of video, animations, to explain concepts, facts and application related to printing.

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 (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, 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 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) write a report on salient provisions of water act, Air act, Environment protection act.

(b) Water consumption of Process: Visit any wet processing unit and collect information of any two processing machines for their water consumption per day. Calculate the quantity of water consumption per kg of garment for the complete process. Present your report.

(c) Steam consumption of Process: Visit any wet processing unit and collect information of any two processing machines for their steam consumption per day. Calculate the quantity of steam consumption per kg of garment for the complete process. Present your report.

(d) Draw and explain different type of boiler used in textile industry. (Lancashire, Water Tube)

(e) Prepare a report on heat recovery in textile wet processing Industry.

(f) prepare a short report on environmental impact assessment methodology.

(g) Prepare a list of Do's and don't for the manufacture of eco-friendly textiles, ecofriendly alternatives and ecofriendly processing.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Environmental Science	S.C. Sandra	New central book agency, Kolkata 2004, ISBN:81-7381-404-X
2	Ecology and Environment (12th Edition)	P.D. Sharma	Rastogi publication, Meerut, 2005, ISBN:978-93-5078-068-8
3	Cleaner production in Textile wet processing	Dr. Prasad Modak	United Nation Publication, 1996,ISBN:92-8071608-5
4	Energy Management and Efficiency for Process Industries	Rossiter and Jones	John Wiley and Sons New Jersey US, 2015, ISBN:978-1-118-83825-9
5	Eco friendly Textiles: Challengesto the Textile Industry	Textiles Committee, Mumbai	Textiles Committee, Mumbai 1996
6	Environmental Issues - Technology Options for Textile Industry	Chavan R B, Radhakrishnan J	IT Delhi Publication, 1998.
7	Energy Conservation in Textile Industries	Kalyanaraman. A.R	SITRA 1995 (Revised
8	Ecology and textiles	Shenai V.A.	Shenai V.A.

14. SOFTWARE/LEARNING WEBSITES

- http://fashioninganethicalindustry.org/resources/feibulletin/
- info@fashioninganethicalindustry.org
- http://creativecommons.org/licenses/by-nc-sa/3.0/.
- http://ec.europa.eu/environment/ecolabel/documents/factsheet_textiles.pdf
  www.orcad.com/resources/orcad-downloads

15. PO-COMPETENCY-CO MAPPING

Semester V	Environment Textile Chemistry						
	Pos						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Use relevant dyes, chemicals, dyeing equipment for natural fibres and fabrics						
Course Outcomes CO a)	3	1	1	1	3	1	2
CO b)	1	2	2	2	2	1	1
CO c)	1	2	1	1	2	1	1
CO d)	1	2	--	--	3	1	2
CO e)	--	--	1	--	3	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

S. No.	Name and Designation	Institute	Contact No.	Email
1)	Mr. R. D. Joshi Lecturer	R. C. Technical Institute, Sola, Ahmedabad	8849021612	rdjrcti@gmail.com
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