GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Dyeing Technology - I
(Course Code: 4332803)

Diploma programmes in which this course is offered	Semester in which offered
Textile Processing Technology	Third

1. RATIONALE

The polytechnic graduates are required to supervise operations of fibre, yarn and fabric and their dyeing & printing processes in industry. They should have basic knowledge and skills to handle dyeing and printing processes. This course provides the knowledge regarding basic dyeing technology of natural fibre fabrics. It also provides the clear concept of physical and chemical properties of various dyes and auxiliaries related to the dyeing of natural fibre fabrics and newly invented dyes to enable them to apply according to their characteristic.

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,

- **Use relevant dyes, chemicals, dyeing equipment for natural fibres and fabrics.**

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) Select dyeing auxiliaries and machineries with the concepts of dyeing technology.
b) Use relevant dyeing method for dyeing of cellulosic materials with soluble dyes.
c) Use relevant dyeing method for dyeing of cellulosic materials with insoluble dyes.
d) Develop azoic and pigment dyeing on cellulosic materials.
e) Produce colour on silk and wool using specified dyes.

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	4	5	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. required
1	Dye Cotton yarn fabric with Direct dyes	II	02
2	Give After treatment to direct dyed material	II	02
3	Dye cotton with hot brand Reactive dyes by exhaust methods	II	04
4	Dye cotton with cold brand Reactive dyes by exhaust methods	II	04
5	Dye cotton with vinyl sulphone Reactive dyes by exhaust methods	II	02
6	Dye cotton with Reactive dyes by CPB method	II	04
7	Dye cotton with Reactive dyes by PDC method	II	04
8	Dye cotton with Reactive dyes by PDS method	II	04
9	Dye cotton with vat dye by I_N method	III	04
10	Dye cotton with vat dye I_W method	III	04
11	Dye cotton with vat dye I_K method	III	04
12	Dye cotton with vat dye with pigmentation process	III	02
13	Dye cotton with Solublised vat dye	III	02
14	Dye cotton with sulphur dye	III	02
15	Dye cotton azoic colour	IV	02
16	Apply pigment colour on cotton fabric	IV	02
17	Dye wool with acid and basic dye	V	04
18	Dye silk with acid and basic dye	V	04
	Total Hours		56

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

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
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	Dye Pots: 250 ml, 500 ml	All
2	Glass rod / Steel rod	All
3	Beaker: 100 ml, 250 ml, 500 ml	All
4	Measuring Cylinder of capacity 10 ml, 25 ml, 100 ml	All
5	Water bath	1-5, 9-11, 13-17
6	Electric Iron: 230V, 1000W	All
7	Laboratory Pressure Steamer: 30 psi and 150°C	8
8	Laboratory Drying, Curing and Setting Chamber: Temperature upto 220°C, working width - 450mm, length 1.7 meter, heater capacity - 8/16/24 kilo-watt	7,12,14
9	Laboratory Padding Mangle: Horizontal	6,7,8,12,14
10	Digital weighing balance: 0.02 gm accuracy (100 gm)	All

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 **Textile Dyeing**	1a. Describe dyeing terminology 1b. Differentiate dyes according to their dyeing methods and properties. 1c. Describe chemistry between dyes and fibre. 1d. Describe with sketch the procedure to operate the given dyeing machine. 1e. Enlist various faults obtained in dyeing machines and suggest the remedies.	1.1 Terminology of Dyeing: Dye, Dyeing, Pigment, Percent Shade, Self-Shade, Compound Shade, Material to liquor ratio (M:L R), Percent exhaustion, Affinity, Substantivity, Standing bath, Topping, Stripping, different fastness properties etc. 1.2 Classification of Dyes according to their Application method 1.3 Mechanism of Dyeing:- Adsorption, Diffusion, Fixation 1.4 Principle, construction and Working of : 1.4.1 Jigger Dyeing Machine 1.4.2 Winch Dyeing Machine 1.4.3 Package Dyeing Machine 1.4.4 Padding Mangle 1.5 Merits and Demerits of above dyeing machineries.
Unit – II **Water Soluble dyes**	2a. Describe the procedure to dye with direct dye with affecting parameters. 2b. Describe the procedure to dye with reactive dye with affecting parameters. 2c. Explain the batch, semi-continuous and continuous methods for dyeing the given fabric. 2d. Identify problems with remedies for the given dyed fabric. 2e. Describe the after-treatment for the dyed fabric.	2.1. Direct dye and Reactive dye: 2.1.1 Properties 2.1.2 Types 2.1.3 Parameters affecting dyeing 2.1.4 Reactive systems in reactive dye 2.1.5 Classification of reactive dyes 2.2. Application methods: 2.2.1 Batch wise dyeing 2.2.2 Semi continuous dyeing 2.2.3 Continuous dyeing 2.3. After treatments: 2.3.1 Washing 2.3.2 Soaping 2.3.3 Stripping 2.3.4 To improve washing fastness of direct dyed cotton
Unit– III **Water Insoluble Dyes**	3a. Describe the procedure to dye with vat dye with affecting parameters. 3b. Describe the procedure to dye with Suphur dye with affecting	3.1 Vat dye: 3.1.1 Classification 3.1.2 Vatting. 3.1.3 Dyeing 3.1.4 Oxidation

	parameters. 3c. Explain the batch, semi-continuous and continuous methods for dyeing the given fabric. 3d. Identify problems with remedies for the given dyed fabric.	3.2 Application methods: 3.2.1 Leuco vat 3.2.2 Vat acid 3.2.3 Pigmentation. 3.2.4 Batch wise dyeing 3.2.5 Semi continuous dyeing 3.2.6 Continuous dyeing 3.3 Dyeing with Solublised Vat Dye 3.4 Sulphur dye: 3.3.1 Classification 3.5 Application methods: 3.5.1 Batch wise dyeing 3.5.2 Continuous dyeing 3.6 Problems and remedies in dyeing
Unit– IV **Surface Dyeing**	4a. Describe relevant treatment for the given material. 4b. Describe the procedure to develop azoic colour on the given material. 4c. Suggest the rectification for the stated faults in the azoic dyed material. 4d. Describe the relevant pigmentation process for the given fabric.	4.1 Treatments: 4.1.1 Naptholation 4.1.2 Diazotisation 4.1.3 Coupling 4.1.4 After treatment 4.2 Application methods: 4.2.1 Batch wise dyeing 4.2.2 Semi continuous dyeing 4.2.3 Continuous dyeing 4.3 Stripping, faults and their remedies. 4.4 Pigment: 4.4.1 Application process 4.4.2 Batch and continuous methods
Unit– V **Dyeing of Wool and Silk**	5a. Choose relevant preparation process before printing for the given fabric. 5b. Describe the procedure to develop prints with specified dyes on silk with direct style 5c. Describe the procedure to develop prints with specified dyes on wool with direct style .	5.1 Dyeing with acid dye: 5.1.1 Factors affecting dyeing 5.1.2 Principles 5.1.3 Exhaust dyeing method 5.2 Dyeing with basic dye: 5.2.1 Factors affecting dyeing 5.2.2 Principles 5.2.3 Exhaust dyeing method 5.3 Stripping 5.4 Faults obtained in dyeing and their remedies

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	Textile Dyeing	10	4	4	6	14

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
II	Water Soluble Dyes	10	4	6	8	18
III	Water Insoluble Dyes	10	4	6	6	16
IV	Surface Dyeing	06	2	4	4	10
V	Dyeing of Wool and Silk	06	2	4	6	12
Total		**42**	**16**	**24**	**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) Survey market for various dyes, pigments, auxiliaries and chemicals. Compare them based in dyeing methods, fastness properties, and ecological aspects and costing.
b) Collect information about novel dyeing techniques.
c) Prepare table for various ingredients used in dyeing of cotton with their role in dyeing process.
d) Prepare table for various ingredients used in dyeing of wool with their role in dyeing process.
e) Prepare table for various ingredients used in dyeing of silk with their role in dyeing process.

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) **Dyed sample collection:** Visit textile dyeing industries/market shops and collect at least 20 to 30 various dyed samples of cotton/silk/wool fabrics. Classify them with respect to shade.
b) **Cost of dyeing:** Calculate the cost of dyeing with respect to price of dye and chemicals of any two dyeing methods for cotton.
c) **Shade matching:** Collect dyed samples from dye house. Using any class of dye match the shade in laboratory. Present the same with recipe.
d) **Dyeing parameters:** Choose any one dyeing process, and change any one dyeing parameter for dyeing process. Prepare a sample report with observations.
e) **Dyeing faults:** Visit industries and collect sample of faulty dyeing and find remedies to rectify the same. Present report.
f) **Sample book:** Prepare a sample book of dyes samples of cotton, silk and wool with various dyes.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Chemistry of Dyes and Principles of Dyeing (VOLUME-II)	Dr. V. A. Shenai	Sevak Publication
2	Technology of Dyeing (VOLUME-VI)	Dr. V. A. Shenai	Sevak Publication
3	Bleaching, Mercerising & Dyeing of Cotton Material	R. S. Prayag	Shree J. Printers, Pune
4	Dyeing and Chemical Technology of Textile fibre	E. R. Trotmann	Hodder Arnold, London
5	Cotton Piece Dyeing	S. V. Gokhale	Ahmedabad Textile Industry's Research Association
6	Handbook of Textile Processing Machinery	R. S. Bhagwat	Colour Publication PVT. LTD., Mumbai

S. No.	Title of Book	Author	Publication with place, year and ISBN
7	Chemical Technology in the Colouration of Textiles VOL – 1	S. R. Karmakar	Colour Publication PVT. LTD., Mumbai

14. SOFTWARE/LEARNING WEBSITES

a) www.nptel.iitm.ac.in
b) https://ndl.iitkgp.ac.in
c) www.textileschool.com
d) www.textileguide.chemsec.com
e) www.textileassociationindia.org
f) https://textilechemrose.blogspot.com
g) www.textilelearner.blogspot.com

15. PO-COMPETENCY-CO MAPPING

Semester III	Technology of Printing – I – 4332804						
	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) Select dyeing machineries with the concepts of dyeing technology	3	1	-	2	-	1	3
CO b)Use relevant dyeing method for dyeing of cellulosic materials with soluble dyes	3	2	1	2	-	2	3
CO c) Use relevant dyeing method for dyeing of cellulosic materials with insoluble dyes	3	1	1	2	-	2	3
CO d) Develop azoic and pigment dyeing on	3	2	1	2	3	2	3

cellulosic materials							
CO e) Produce colour on silk and wool using specified dyes.	3	2	1	2	3	2	3

*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 M Pandya	Dr. SSG, Surat	9428409925	ridpandya@gmail.com
2	Mr. C R Madhu	RCTI, Ahmedabad	9879889712	crm4chemistry@gmail.com
3	Ms. R D Pachauri	RCTI, Ahmedabad	9624106881	2468rashmi@gmail.com