GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: **Theory of Dyeing**
(Course Code: 4362803)

Diploma program in which this course is offered	Semester in which offered
Textile Processing Technology	6th

1. RATIONALE

The polytechnic graduates are required to supervise dyeing operations of fibre, yarn & fabric as per requirements in industry. They should have basic knowledge and skills to handle the dyeing operations for different textiles as per the production requirements. This course provides in depth knowledge and skills regarding fundamental dyeing behavior of different dyes on various textiles and dyeing rate. It also provides the clear concept of physical chemistry involved during dyeing of textiles. This course also provides the information about novel dyeing approach.

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 knowledge and skills to conduct dyeing of different textiles as per physical & chemical properties of fibres and dyes.**

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:

i. Evaluate fundamentals of dyeing.
ii. Elaborate physical chemistry in dyeing.
iii. Explain different dye-fibre interactions.
iv. Analyze behavior of dyes in dyeing.
v. Analyze dyeing mechanism of textiles.

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	To study the effect of organic acid (Acetic acid) and inorganic acid (Sulphuric acid) on rate of dyeing of acid dyes on nylon fabric.	I	2
2	To study the effect of different alkalies on rate of dyeing of hot brand reactive dyes on cotton fabric.	I	4
3	To study the effect of electrolyte on rate of dyeing of hot brand reactive dyes on cotton fabric.	I	4
4	To study the effect of organic acid (Formic acid) and inorganic acid (Sulphuric acid) on rate of dyeing of acid dyes on nylon fabric.	I	2
5	To study the effect of count on rate of dyeing of direct dyes on cotton yarn.	I	2
6	To study the effect of temperature on rate of dyeing of direct dyes on cotton fabric.	I	2
7	To study the effect of heat setting temperature on rate of dyeing of disperse dyes on polyester fabric.	I	4
8	To study the effect of carrier on rate of dyeing of disperse dyes on polyester fabric.	I	2
9	To study the effect of types of carrier on rate of dyeing of disperse dyes on polyester fabric.	I	2
10	To study the effect of denier on rate of dyeing of disperse dyes on polyester yarn.	I	2
11	To determine % exhaustion and % fixation of hot brand reactive dyes on cotton fabric.	IV	2
12	Purify the given direct dye sample.	IV	2
	Total Hours		30

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	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	All
6	Electric Iron: 230V, 1000W	All
7	Laboratory Drying, Curing and Setting Chamber: Temperature upto 220°C, working width - 450mm, length 1.7 meter, heater capacity - 8/16/24 kilo-watt	All
8	Digital weighing balance: 0.02 gm accuracy (100 gm)	All
9	CCMS System: Spectrophometer with colour software	7 & 11

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	Major Learning Outcomes	Topics and Sub-topics
Unit – I **Fundamentals of dyeing**	**1a.** Describe important properties of fibres and dyes. **1b.** Evaluate effects of various factors on dyeing rates. **1c.** Explain role of surface charge & water in dyeing.	1.1 Important properties of fibres for dyeing 1.2 Important properties of dyes for dyeing 1.3 Effect of denier, count, heat setting, twist, electrolyte, temperature, pH & M:L R on dyeing rate 1.4 Surface charge (Zeta Potential) 1.5 Role of Water in dyeing
Unit – II **Dyeing Kinetics And Equilibrium**	**2a.** Explain Thermodynamic Aspects of dyeing. **2b.** Describe various Isotherms **2c.** Describe dyeing equilibrium, exhaustion, diffusion & rate of dyeing.	2.1 1st & 2nd law of thermodynamics 2.2 Entropy & Heat of Dyeing 2.3 Adsorption Isotherms like Langmuir, Partition, & Frundlich. 2.4 Le Chateliers' Principle 2.5 Dyeing Equilibrium 2.6 Dye Exhaustion 2.7 Rate of dyeing 2.8 Fick's Law of diffusion
Unit– III **Dye-fibre Interactions**	**3a.** Explain affinity, Substantivity and compatibility of dyes. **3b.** Discuss dyebath Interactions. **3b.** Describe forces responsible for dye fixation.	3.1 Affinity & Substantivity of dyes 3.2 Concept of Compatibility of dyes 3.3 Various dyebath interactions 3.4 Importance of dyeing conditions 3.5 Forces responsible for dye fixation on fibres such as Hydrogen bond, Ionic bond, Covalent bond and Van Der wall's forces.

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit– IV **Behavior of dyes in dyeing**	**4a.** Describe diffusion And diffusion Co-efficient of dyes. **4b.** Explain aggregation and purification of dyes. **4c.** Estimate dyeing of textiles.	4.1 Solubility of dyes 4.2 Importance of diffusion in dyeing 4.3 Diffusion co – efficient of dyes 4.4 Aggregation of dyes in solution 4.5 Estimation of dyeing 4.6 Purification of dyes
Unit – V **Dyeing Mechanism**	**5a.** Describe different dyeing systems **5b.** Explain general mechanism of dyeing **5c.** Describe different dyeing mechanisms	5.1 Classification of dyeing systems 5.2 General mechanism of Dyeing 5.3 Process mechanism of exhaust dyeing 5.4 Process mechanism of Continuous dyeing 5.5 Process mechanism of HTHP dyeing

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	Fundamentals of dyeing	10	04	06	06	16
II	Kinetics of dyeing	10	04	06	06	16
III	Dye-fibre Interactions	08	05	06	04	15
IV	Behavior of dyes in dyeing	07	04	05	04	13
V	Dyeing mechanism	07	03	04	03	10
Total		**42**	**20**	**27**	**23**	**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:

- Literature survey of different dye fibre bonds.
- Collection and Study of various dyed samples of textiles (in terms of physical quality).
- Group discussion on recent trends & awareness about theory of dyeing.
- Collection of data of dyed sample of various fibres (in terms of chemical quality) & makes Power point Presentation.
- Seminar/Quiz/Presentation on recent developments in the field of theory of dyeing.

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) **Data sheet:** Prepare a data sheet for various combinations of chemicals and their quantities required for dyeing of various textiles.

b) **Rate of Dyeing:** Collect the data of various parameters affected the rate of dyeing through industrial survey and internet search.

c) **Dyed sample collection:** Visit Textile Industries / Market shops and collect dyed sample of different types of textiles.

d) **Compatibility report:** Prepare a report on industrial practice for compatibility of dyes.

e) **Dye-Fibre Interaction:** List out different chemical groups present in to dyes and fibres for dye-fibre interactions. Also prepare details about various bond formation occurs between dyes & fibres.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	The physical chemistry of dyeing, Textile Chemistry Vol. III	R. H. Peters	Elsevier scientific publishing company, New York, 1975
2	Theory of colouration of textiles	C. L. Bird & W. S. Boston	Society of Dyers and Colorists, 1975
3	Physical Chemistry of Dyeing	T. Vickerstaff	Oliver and Boyd, London, 1954
4	Instrumental Colour Measurement & Computer Aided Colour Matching for Textile	Dr. R. S. Gandhi & Dr. H. S. Shah	Mahajan Book Distributors, Ahmedabad, 1990
5	Handbook of Textile & Industrial dyeing (Volume-1)	M. Clerk	Woodhead Publishing, 2011 ISBN- 978-1-84569-695-5 (print) ISBN-978-0-85709-397-4 (online)
6	Physico-chemical aspects of textile colouration	Stephen M. Burkinshaw	Willey in association with SDC, 2016 ISBN-978-1-118-72569-6

14. SOFTWARE/LEARNING WEBSITES

a) https://nptel.ac.in

b) www.youtube.com

c) www.fibre2fashinon.com

d) www.textilelearner.net

e) www.textiletutorials.com
f) www.textilefashionstudy.com

15. PO-COMPETENCY-CO MAPPING

Semester VI	Theory of Dyeing – 4362803						
	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 knowledge and skills to conduct dyeing of different textiles as per physical & chemical properties of fibres and dyes.						
Course Outcomes CO a) Evaluate fundamentals of dyeing.	3	2	2	3	--	2	2
CO b) Elaborate Physical chemistry in dyeing.	3	--	--	2	--	--	2
CO c) Explain different dye-fibre interactions.	3	3	2	1	--	--	2
CO d) Analyze behavior of dyes in dyeing.	3	3	1	3	--	2	2
CO e) Analyze dyeing mechanism of textiles.	3	2	2	2	--	2	2

*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

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