GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

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

Course Title: Chemistry of Intermediates and Dyestuffs
(Course Code: 4352802)

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

1. RATIONALE

Diploma graduates are required to use different kinds of colours with materials called intermediates and dyes in variety of Textile processing. They should be aware of of color theory, and structure, properties of dyes and other intermediates, which pertains to Chemistry of these products. This course has been designed to provide basic principle and chemistry of basic chemicals, synthesis of dye intermediates and various dyes with their properties. Students shall understand the fundamentals aspects of colour, relation between colour and chemical constitution of dyes. It provides technical knowhow for colouration and printing of different textiles. Student will able to solve problems during dyestuffs, application as well as its marketing. Students will find this course useful in non-textile fields too.

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,

- **Apply knowledge of color theory, chemical composition, structure, properties of dyes and other intermediates and their synthesis for textile processing.**

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) Explain chemistry of natural and synthetic dyestuffs.
b) Explain different colour theories for preparing and identifying colour.
c) Explain synthesis of different intermediates.
d) Describe synthesis of different dyestuffs based on their constitution.
e) Describe synthesis of different dyestuffs based on their application.

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	0	3	30*	70	--	--	100

(*): 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

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Require
	--- Not Applicable ---		

6. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

S. No.	Equipment Name with Broad Specifications	PrO. No.
	--- Not Applicable ---	

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the above mentioned Cos. 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 records of each synthesis.
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 **Introduction to Dyestuff Chemistry**	1a. Explain natural colouring matters. 1b. Explain synthetic colouring matters. 1c. Describe applications of dyes other than textiles. 1d. Differentiate natural and synthetic coluring matters.	1.1 Natural colouring matters 1.1.1 Heena 1.1.2 Turmeric 1.1.3 Kesar 1.1.4 Alizarine from roots of madder 1.1.5 Logwood 1.1.6 Tyrian purple 1.2 Synthetic Dyes: Milestones 1.2.1 Diazotisation 1.2.2 Direct dye: Congo red 1.2.3 Synthesis of Indigo 1.2.4 Disperse dye 1.2.5 Fluorescent brighteners 1.2.6 Pigment 1.3 Non textile uses of dyes
Unit – II **Colour and Chemical Constitution**	2a. Explain various effects for colour constitution. 2b. Differentiate between auxochrome, chromospheres and chromogen. 2c. Distinguish between colour and chemical constitution. 2d. Explain Different theories to explain relation between colour and chemical constitution.	2.1 Bathochromic, Hypsochromic, Hyperochromic and Hypochromic effects 2.2 Auxochrome, chromogen, chromophore of colour chemistry, colour and chemical constitutions. 2.3 Theories to explain relation between colour and chemical constitutions: 2.3.1 Witt's theory 2.3.2 Armstrong theory
Unit – III **Intermediates**	3a. Discuss primaries, intermediates and unit process 3b. Explain Distillation of coal tar 3c. Describe synthesis of various intermediates	3.1 Primary, Intermediate, and Unit process 3.2 Distillation of coal tar 3.3 Preparation of the following Intermediates: 3.3.1 J – acid 3.3.2 H – acid 3.3.3 Koch acid 3.3.4 Gamma acid 3.3.5 Bon acid
Unit – IV **Synthesis of**	4a. Distinguish the classes of dyestuffs according to their constitution	4.1 Nitro dyes 4.1.1 Picric acid 4.1.2 Naphthol yellow – S

Dyes Based on Constitution	4b. Describe synthesis of Nitro, Nitroso dyes 4c. Explain steps for synthesizing Azo dyes, diphenylmethane and triphenylmethane dyes 4d. Describe synthesis of Xanthene and Thiazine dyes	4.2 Nitroso dyes 4.2.1 Gambine Y 4.3 Azo dyes 4.3.1 Monoazo: Metanil yellow 4.3.2 Diazo : Naphthol blue black 6B 4.3.3 Triazo: Direct deep 4.4 Diphenylmethane dyes 4.4.1 Auramin G 4.5 Triphenylmethane dyes 4.5.1 Malachite green 4.5.2 Crystal violet 4.5.3 Aurin 4.5.4 Rosaniline 4.6 Xanthene dyes 4.6.1 Rhodamine B 4.7 Thiazine dyes 4.7.1 Methylene blue
Unit– V **Synthesis of Dyes Based on Application**	5a. Distinguish the classes of dyestuffs according to their application 5b. Describe synthesis of Acid and Basic dyes 5c. Explain steps for synthesizing Direct and Azoic dyes 5d. Describe synthesis of Mordant, Vat and Reactive dyes	5.1 Acid dyes: Orange II 5.2 Basic dyes : Methyl violet 5.3 Direct cotton dyes: Congo red 5.4 Azoic dyes: Fast blue B-base and coupling component Naphthol AS 5.5 Mordant dyes: Eriochrome Black A 5.6 Vat dyes : Indanthrene brown RRD 5.7 Reactive dyes: Procion red, Procion blue HB

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	Introduction to Dyestuff Chemistry	04	04	04	02	10
II	Colour and Chemical Constitution	06	04	04	02	10
III	Intermediates	08	02	04	08	14
IV	Synthesis of Dyes Based on Constitution	12	04	04	10	18
V	Synthesis of Dyes Based on Application	12	04	04	10	18
Total		**42**	**18**	**20**	**32**	**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 natural and synthetic colouring matters.
- Collection and Study of various samples dyes with natural colouring matters.
- Visit to dyestuff manufacturing industries to study their processing technologies and prepare reports.
- Group discussion on recent innovation in dyestuff manufacturing technology.
- Seminar/Quiz/Presentation on recent developments in dyestuffs manufacturing.

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) **Safety data sheet:** Visit intermediate manufacturing units' and collect material safety data sheet (MSDS) of various intermediates.
b) **Sample collection:** Visit market shops and collect the samples in which textile dyes are used as their non-textile application.
c) **Natural dyed sample collection:** Visit textile dyeing industries/market shops who are using natural colouring matters as dyestuffs, and collect at least 20 to 30 various dyed samples.
d) **Colour theories:** Prepare a short video for explaining various colour theories and their relation with chemical constitution.
e) **Intermediate:** Prepare a short video film for explaining the synthesis of intermediate used for dye manufacturing.
f) **Dyes:** Prepare a short video film and presentation for explaining the synthesis of dyestuffs on the bases of their constitutions and applications.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Synthetic Dyes	G. R. Chatwal	Himalaya Publishing House, Mumbai – 400004 ISBN: 9788184882209
2	A Textbook of Synthetic Dyes	M. S. Yadav O. D. Tyagi	Anmol Publications Pvt Ltd, New Delhi ISBN: 9788170413493
3	Chemistry of Dyes and Principles of Dyeing Vol - II	Dr V. A. Shenai	Sevak Pulications, Mumbai – 400031
4	Synthetic Organic Chemistry	O. P Agarwal	Krishan Prakashan, Meerut, Uttar Pradesh – 250001 ISBN: 9788182831773
5	Unit processes in Organic Synthesis	P. H. Groggins	Mc Graw-Hill Ltd., New Delhi. ISBN: 9780074621431
6	Chemistry of Synthetic dyes Vol – I to VII	K. VenkatRaman,	Academic Press, New York, USA ISBN: 978-0124145405

14. SOFTWARE/LEARNING WEBSITES

a) https://nptel.ac.in
b) www.youtube.com
c) www.dyes-pigments.com
d) https://textilechemrose.blogspot.com
e) www.textilelearner.net
f) www.textiletutorials.com
g) www.textilefashionstudy.com

15. PO-COMPETENCY-CO MAPPING

Semester III	Chemistry of Intermediates and Dyes – 4352803						
	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 processing of denims & garments and improving quality & sustainability.						
Course Outcomes CO a) Explain chemistry of natural and synthetic dyestuffs	3	3	--	--	3	2	2
CO b) Explain different colour theories for preparing and identifying colour	3	3	--	--	3	2	3
CO c) Explain synthesis of different intermediates	3	3	2	--	3	2	2
CO d) Describe synthesis of different dyestuffs based on their constitution	3	3	2	--	3	2	2
CO e)Describe synthesis of different dyestuffs based on their application	3	3	2	--	3	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

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