GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Diploma Engineering

Level: Diploma

Branch: Textile Processing Technology

Subject Code: DI04028041

Subject Name: Chemistry of Intermediates & Dyestuffs

w. e. f. Academic Year:	2025 – 26
Semester:	4th
Category of the Course:	PCC

Prerequisite:	A foundational understanding of the chemistry of intermediates and dyes necessitates prior knowledge of colour theory, as well as the principles of basic and organic chemistry and their practical applications. Students are expected to be acquainted with the diverse chemical processes involved in the preparation of dye intermediates and final dye compounds. Moreover, a strong grasp of fundamental chemical concepts will facilitate comprehension of the synthesis and transformation of intermediates utilized in the production of various textile dyes. Familiarity with essential raw materials, technical terminology, and synthesis methodologies is also crucial, as it enables students to integrate theoretical knowledge with practical applications. This foundational preparation will allow learners to contextualize their studies within the broader framework of textile dye manufacturing, thereby fostering a deeper understanding of the chemical and industrial aspects of colouration science.
Rationale:	Diploma graduates are required to work with a wide range of colours and materials, including intermediates and dyes, which are extensively used in various textile processing operations. To effectively engage in these processes, they must possess a comprehensive understanding of colour theory, along with the structure, properties, and chemistry of dyes and related intermediates. This course is designed to impart fundamental principles and chemical concepts related to basic chemicals, dye intermediates, and the synthesis of various classes of dyes. It emphasizes the relationship between colour and the chemical constitution of dyes, enabling students to develop a scientific understanding of colour and its applications in textiles. Furthermore, the knowledge and competencies developed through this course will be beneficial not only in the textile industry but also in various non-textile sectors where colour and chemical applications are significant.

Course Outcome:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level
01	Explain chemistry of natural and synthetic dyestuffs.	R + U

02	Apply colour theories for colour preparation and identification.	R + U
03	Describe the synthesis of important dye intermediates.	R + U + A
04	Describe dyestuff synthesis based on chemical constitution and application.	R + U + A
05	Explain environmental and industrial aspects for dye synthesis and application.	R + U + A

**Revised Bloom's Taxonomy (RBT)*

Teaching and Examination Scheme:

Teaching Scheme (in Hours)			Total Credits L+T+ (PR/2)	Assessment Pattern and Marks				Total Marks
				Theory		Tutorial / Practical		
L	T	PR	C	ESE(E)	PA(M)	PA(I)	ESE(V)	
3	0	0	3	70	30	0	0	100

Course Content:

Unit No.	Content	No. of Hours	% of Weightage
1.	**Introduction to Dyestuff Chemistry** 1.1 Era of natural dyes 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 Era of synthetic dyes 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 Nomenclature of dyes 1.3.1 Commercial naming of dyes 1.3.2 Colour index naming of dyes	06	14

2.	**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 2.3.3 Baeyer's theory 2.3.4 Nietzki's theory 2.3.5 Watson's theory	06	14
3.	**Chemistry and Synthesis of Dyestuff Intermediates** 3.1 Primaries 3.1.1 Fractional distillation of coal tar 3.2 Reduction 3.2.1 Bechamp reduction 3.2.2 Sulphide reduction 3.2.3 Zinc reduction 3.2.4 Catalytic reduction 3.3 Hydroxylation 3.3.1 Dow process 3.3.2 Cumene process 3.3.3 Alkali fusion 3.4 Carboxylation 3.5 Oxidation 3.6 Synthesis of intermediates 3.6.1 Koch acid 3.6.2 J – acid 3.6.3 H – acid 3.6.4 Gamma acid 3.6.5 S – acid 3.6.6 Schaffer acid 3.6.7 Crocein acid 3.6.8 NW - acid	12	26
4.	**Synthesis of Dyes** 4.1 Synthesis of dyes based on constitution 4.1.1 Nitro dyes (Picric acid, Naphthol yellow – S)	16	35

	4.1.2 Nitroso dyes (Gambine Y) 4.1.3 Azo dyes (Monoazo: Metanil yellow, Diazo : Naphthol blue black 6B, Triazo: Direct deep) 4.1.4 Diphenylmethane dyes (Auramin G) 4.1.5 Triphenylmethane dyes (Malachite green, Crystal violet) 4.1.6 Xanthene dyes (Rhodamine B) 4.1.7 Thiazine dyes (Methylene blue) 4.2 Synthesis of dyes based on application 4.2.1 Acid dyes (Orange II) 4.2.2 Basic dyes (Methyl violet) 4.2.3 Direct cotton dyes (Congo red) 4.2.4 Azoic dyes (Fast blue B-base and coupling component Naphthol AS) 4.2.5 Mordant dyes (Eriochrome Black A) 4.2.6 Vat dyes (Indanthrene brown RRD) 4.2.7 Reactive dyes (Procion red, Procion blue HB)		
5.	**Environmental and Industrial Aspects** 5.1 Overview of dye intermediates and dyestuff industries in India 5.2 Eco-friendly dye synthesis and green chemistry approaches 5.3 By-products and waste management in dye manufacturing 5.4 Non-textile uses of dyes	05	11
	Total	**45**	**100**

Suggested Specification Table with Marks (Theory):

Distribution of Theory Marks (in %)					
R Level	**U Level**	**A Level**	**N Level**	**E Level**	**C Level**
25	**30**	**45**	**0**	**0**	**0**

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
1	Synthetic Dyes	G. R. Chatwal	Himalaya Publishing House, Mumbai – 400004 ISBN: 9788184882209

Sr. No.	Title of Book	Author	Publication with place, year and ISBN
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

(b) Open-source software and website:

1. https://nptel.ac.in
2. www.youtube.com
3. www.dyes-pigments.com
4. https://textilechemrose.blogspot.com
5. www.textilelearner.net
6. www.textiletutorials.com
7. www.textilefashionstudy.com

Suggested Project List:

1) **Safety data sheet:** Visit intermediate manufacturing units' and collect material safety data sheet (MSDS) of various intermediates.
2) **Sample collection:** Visit market shops and collect the samples in which textile dyes are used as their non-textile application.
3) **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.
4) **Colour theories:** Prepare a short video for explaining various colour theories and their relation with chemical constitution.

5) **Intermediate:** Prepare a short video film for explaining the synthesis of intermediate used for dye manufacturing.
6) **Dyes:** Prepare a short video film and presentation for explaining the synthesis of dyestuffs on the bases of their constitutions and applications.
7) **Eco-friendly synthesis project:** Preparation of a natural or bio-based dye (e.g., from beetroot, spinach, onion peel, turmeric).
8) **Survey project:** Overview of Indian dye and dye-intermediate industries (major companies, products, export data).
9) **Green chemistry model:** Design a sustainable dye manufacturing flowchart applying green chemistry principles.

Suggested Activities for Students:

1) Conduct a detailed literature review on natural and synthetic colouring matters to understand their sources, chemistry, and applications.
2) Collect and study various dye samples derived from natural colouring materials and compare their characteristics with synthetic dyes.
3) Visit a dyestuff manufacturing or processing industry to observe production technologies, environmental practices, and quality control systems, followed by preparation of a detailed visit report.
4) Participate in group discussions on recent innovations and technological advancements in dyestuff manufacturing and application.
5) Prepare and present seminars, quizzes, or technical presentations on current developments, trends, and research in the field of dyes and intermediates.

* * * * * * *