

Department of Chemistry
Revised Syllabus of Advanced Diploma Programme (PG)
Synthesis and processing of dye

Preamble:

This course will provide knowledge to dye chemistry. Emphasis will be given on the most important natural as well as synthetic dye, chemical constitution of dyes and unit process and dye intermediates. Chemical synthesis, properties and characteristics dyes will be discussed in details. This course vividly elaborates its nature and promises the outcomes that are to be accomplished by studying the course.

Programme Objectives:

1. To provide students with broad theoretical and applied background in dye Chemistry with emphasis on qualitative and quantitative technique.
2. To provide broad common frame work of syllabus to expose young graduates to the recent and applied knowledge of interdisciplinary branches of chemistry.
3. To encourage students to participate in various academic activities like midterm tests, online tests, open book tests, tutorial, surprise test, oral, seminar and assignments.
4. To educate and prepare post graduate students from rural and urban area for getting employment in academic institutes, R & D and Quality control laboratories of Indian chemical/pharmaceutical industries as well as multinational and forensic Laboratories.

Program Outcomes:

1. A graduate with a Master's degree in Chemistry has in-depth and detailed functional knowledge of the fundamental, theoretical concepts and is skilled in experimental methods of chemistry.
2. The knowledge in dye chemistry will enhance the merit of students in employment in dye, paint and pigments industry as well as pharmaceutical industry.

I Year Advanced Diploma Programme

1. Title: **Synthesis and processing of dye**
2. Year of Implementation: 2020
3. Duration: Two Years
4. Pattern: Semester
5. Medium of Instruction: English
6. Contact hours: 7 hours/week
7. Structure of Course:

Syllabus Structure

Year	Semester	Course No.	Course Code	Contact Hours	Credits (1Credit=15 H)	Total Marks	
1	I	CT I	ADCDT 101	30	2	75	
		CL I	ADCDL101	60	2	150	
	II	CT II	ADCDT 202	30	2	75	
		CL II	ADCDL202	60	2	150	
	Annual	CP I	ADCDP101	60	2	150	
	Total				240	10	600
2	III	CT III	ADCDT 303	30	2	75	
		CL III	ADCDL303	60	2	150	
	IV	CT IV	ADCDT 404	30	2	75	
		CL IV	ADCDL404	60	2	150	
	Annual	CP II	ADCDP202	60	2	150	
	Industrial and or Incubation and or Research and or Field Training				60	2	-
	Total				270	12	600
	Total				510	22	1200

AD: Advanced Diploma, *: Departmental Code

C: Course, T: Theory, L: Lab (Practical), P: Project

Total No. of Papers: 10 (Theory: 04, Practical: 04, Project: 02) Theory and Practical: Semester, Project: Annual

Semester I

ADCDT 101: Introduction to dye chemistry
(Contact Hrs: 30 Credits: 2)

Learning Objectives:

To introduce students to,

- The fundamentals of dye.
- Learn different dyeing methods.

Unit I: (A) Introduction to the dye Industry**[15]**

Dyes

Definition of dyes, requirements of a good dye i.e. Colour, Chromophore and Auxochrome, Solubility, Linearity, Coplanarity, Fastness, Substantivity, Economic viability.

Definition of fastness and its properties and Mordants with examples

Explanation of nomenclature or abbreviations of commercial dyes with at least one example suffixes – G, O, R, B, K, L, C, S H, 6B, GK, 6GK,

Naming of dyes by colour index (two examples) used in dye industries.

Natural and Synthetic Dyes

Natural Dyes: Definition and limitations of natural dyes.

Examples and uses of natural dyes w.r.t Heena, Turmeric, Saffron, Indigo, Madder, Chlorophyll – **names** of the chief dyeing material/s in each natural dye,

Synthetic dyes: Definition of synthetic dyes, primaries and intermediates. Important milestones in

the development of synthetic dyes

– Emphasis on Name of the Scientist, dyes and the year of the discovery is required.

(B) Substrates for Dyes: Types of fibres

Natural: cellulosic and proteinaceous fibres, examples – wool, silk and cotton structures and names of dyes applied on each of them.

Semi – synthetic: definition and examples

Synthetic: Nylon, Polyesters and Polyamides structures and names of dyes applied on each of them

Blended fabrics: definition and examples

Binding forces of dyes on substrate: ionic forces, covalent linkages, hydrogen bonding, vander-walls forces

Unit II: Classification of dyes based on applications and dyeing methods [15]

Dyeing methods

Basic Operations involved in dyeing process:

- i. Preparation of fibres
- ii. Preparation of dyebath
- iii. Application of dyes
- iv. Finishing

Dyeing Method of Cotton Fibres:

- (i) Direct dyeing
- (ii) Vat dyeing
- (iii) Mordant dyeing
- (iv) Disperse dyeing

Classification of dyes based on applicability on substrates (examples with structures)

- (a) Acid Dyes- Orange II,
- (b) Basic Dyes-methyl violet,
- (c) Direct cotton Dyes- Benzofast Yellow 5GL
- (d) Azoic Dyes – Diazo components; Fast yellow G, Fast orange R.

Coupling components. Naphthol AS, Naphthol ASG

- (e) Mordant Dyes-Eriochrome Black A, Alizarin.
- (f) Vat Dyes- Indanthrene brown RRD,
- (g) Sulphur Dyes- Sulphur Black T (no structure)
- (h) Disperse Dyes-Celliton Fast brown 3R,

Reactive Dyes- Cibacron Brilliant Red B,

Optical Brighteners: General idea, important characteristics of optical brighteners and their classes [Stilbene, Coumarin, Heterocyclic vinylene derivatives, Diaryl pyrazolines, Naphthylamide derivatives] general structure of each class.

Learning Outcomes:

At the end of course, student will,

- Understand different dyes, their chemical structure.
- Explain different dyeing methods.

Reference Books:

1. Chemistry of Synthetic Dyes, Vol I – IV, Venkatraman K., Academic Press 1972
2. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY ,1995

3. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973
4. Environmental Studies, Joseph Benny, Tata McGraw Hill Education, 2005
5. Fundamental Concepts of Environmental Chemistry, Sodhi. G. S., Alpha Science International, 2009; Planning Commission, Niti Aayog, FSSAI and FDA websites
6. Green Chemistry for Dyes Removal from Waste Water- Research Trends and Applications, Ed. Sharma S.K., Wiley, 2015
7. Environmental Pollution- Monitoring and Control, Khopkar S.M., New Age International (P) Ltd, New Delhi, 1982

ADCDL101: (Practical):
(Contact Hrs: 60 Credits: 02)

Learning Objectives:

To make students familiar with,

- synthesis methods of dyes
- analysis of dyes

List of Practicals

1. Thin layer chromatography (TLC) of a mixture of dyes.
2. Dyeing of wool silk with commonly used dye classes such as Acid, Metal complex, and Basic dyes etc. including chrome dyes of wool.
3. Dyeing of cotton with acid
4. Dyeing of cotton with metal complex
5. Dyeing of cotton with reactive dyes
6. Dyeing of acrylic and Art Silk (viscose rayon).
7. Extraction of natural dyes from natural resource (*Haldi*)
8. Extraction of natural dyes from natural resource (*Toor dal*)
Any suitable experiment may be added

Learning Outcomes:

After completion of the practical, student will develop

1. the synthetic skill in dye chemistry.
2. analytical identification skill in dye chemistry.

Reference Books:

1. Fundamental Processes Of Dye Chemistry by Hans Eduard Fierz-David And Louis Blangey
2. Industrial Inorganic Pigments Edited by G. Buxbaum and G. Pfaff, Wiley VCH
3. Chemistry of Synthetic Dyes – Vol II, Venkataraman K., Academic Press, New York, 1952
4. Color Chemistry –Synthesis, Properties and Applications of Dyes and Pigments, Zollinger H., 2nd ed., Weinheim – VCH, 1991

Semester II

ADCDT 202: Chemical Constitution of Dyes

(Contact Hrs: 30 Credits: 2)

Learning Objectives:

To introduce students with,

1. Composition of dyes and dye intermediates.
2. Different unit processes for preparation of dyes.

Unit I (A) Colour and Chemical Constitution of Dyes**[15]**

Absorption of visible light, Colour of wavelength absorbed, Complementary colour.

Relation between colour and chemical constitution.

- (i) Armstrong theory (quinonoid theory) and its limitations.
- (ii) Witt's Theory: Chromophore, Auxochrome, Bathochromic & Hypsochromic Shift, Hypochromic & Hyperchromic effect
- (iii) Valence Bond theory, comparative study and relation of colour in the following classes of compounds/dyes: Benzene, Nitrobenzene, Nitroanilines, Nitrophenols, Benzoquinones, Azo, Triphenyl methane, Anthraquinones.
- (iv) Molecular Orbital Theory.

(B) Unit process and Dye Intermediates**A brief idea of Unit Processes**

Introduction to primaries and intermediates

Unit processes: definition and brief ideas of below unit processes:

- (a) Nitration
- (b) Sulphonation
- (c) Halogenation
- (d) Diazotization: (3 different methods & its importance)
- (e) Ammonolysis
- (f) Oxidation

NB: Definition, Reagents, Examples of each unit processes mentioned above with reaction conditions (mechanism is not expected)

Unit II: Preparation of the Following Intermediates**[15]**

Benzene derivatives: Benzenesulphonic acid; 1,3-Benzenedisulphonic acid; sulphanilic acid; o-, m-, p-chloronitrobenzenes;

o-, m-, p-nitroanilines; o-, m-, p-phenylene diamines; Naphthol ASG

Naphthalene Derivative: Schaeffer acid; Tobias acid; Naphthionic acid;

N.W. acid; cleve-6-acid; H-acid; Naphthol AS

Anthracene Derivative: 1-Nitroanthraquinone; 1-Aminoanthraquinone

Anthraquinone-2-sulphonic acid; Benzanthrone.

Learning Outcomes:

At the end of the course, student will able to,

- Understand chemical composition of dyes.
- Describe different unit processes used for dye making.

Reference Books:

1. Chemistry of Synthetic Dyes, Vol I – VIII, Venkatraman K., Academic Press 1972
2. The Chemistry of Synthetic Dyes and Pigments, Lubs H.A., Robert E Krieger Publishing Company, NY ,1995

3. Chemistry of Dyes and Principles of Dyeing, Shenai V.A., Sevak Publications, 1973
4. LUBS Chemistry of synthetic dyes and pigments, R.E. Krieger Publishing Company. Chemistry of dyes and intermediates, Cain, Thorpe and Linstend. 1969.
5. Dyeing and Chemical technology of textile fibres, E.R. Trotman.
6. Development in the Chemistry and Technology of Organic Dyes, J. Driffths, Society of Chemicals Industry, Blackwell Scientific Publications
7. The chemistry of Synthetic Dyes, K. Venkataraman, Academic Press, Vol. I-III.
8. The analytical Chemistry of Synthetic Dyes, K. Venkateraman, John Wiley, New York.
9. A Laboratory Course in Dyeing, C.H. Gites, The society of Dyes and Colourists.
10. The Dyeing of Synthetic polymers and acetate fibres, D.M. Nunn, Dyers Company Publishing Trust.
11. Dyes and Their Intermediates, H.A. Abraham, Pergamon Press.

ADCDL 202: Practical

(Contact Hrs: 60 Credits: 02)

Learning Objectives: To expert students in

1. Synthesis of various dyes.
2. Separation and Purification

List of Practicals

1. Synthesis, separation and purification of Methyl orange
 2. Synthesis of Azo Dyes
 3. Synthesis of Congo Red
 4. Synthesis of Indigo dye
 5. Photo reactivity of dyes
 6. Extraction of natural dyes from natural resource (*Beet*)
 7. Extraction of natural dyes from natural resource (*Jaswand*)
 8. Synthesis of Fluoresceins from phthalic anhydride
- Any suitable experiment may be added

Learning Outcomes:

After completion of the practical, student will

1. Develop the synthetic and analytical identification skill in dye chemistry.
2. Synthesize different dyes and improvements in its properties

Reference Books:

1. Fundamental Processes Of Dye Chemistry by Hans Eduard Fierz-David And Louis Blangey
2. Industrial Inorganic Pigments Edited by G. Buxbaum and G. Pfaff, Wiley VCH
3. Chemistry of Synthetic Dyes – Vol II, Venkataraman K., Academic Press, New York, 1952
4. Color Chemistry – Synthesis, Properties and Applications of Dyes and Pigments, Zollinger H., 2nd ed., Weinheim – VCH, 1991

ADCDP 101: Project

(Contact Hrs. 60, Credits: 2)