Department of Dyestuff Technology

Syllabus structure B.Tech First Year

Semester I								
Subjects	**Credits**	**Hrs/Week**			**Marks for various Exams**			
		L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
Physical Chemistry-I	3	2	1	0	10	15	25	50
Analytical Chemistry	3	2	1	0	10	15	25	50
Applied Mathematics-I	4	3	1	0	20	30	50	100
Applied Physics-I	4	3	1	0	20	30	50	100
Physical and Analytical Chemistry Lab	2	0	0	4	25	-	25	50
Engineering Graphics	4	2	0	6	50	-	50	100
Communication Skills	2	0	0	4	50	-	-	50
Introduction to Dyestuff Technology	3	-	-	-	-	-	-	-
TOTAL:	22	12	4	14	-	-	-	500

Semester II								
Subjects	**Credits**	**Hrs/week**			**Marks for various Exams**			
		L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
Physical Chemistry-II	3	2	1	0	10	15	25	50
Organic Chemistry	4	3	1	0	20	30	50	100
Process Calculations	4	3	1	0	20	30	50	100
Applied Mathematics-II	4	3	1	0	20	30	50	100
Applied Physics-II	3	2	1	0	10	15	25	50
Physics Laboratory	2	0	0	4	25	-	25	50
Organic Chemistry Laboratory	2	0	0	4	25	-	25	50
Total	22	13	5	8	-	-	-	500

Semester I

Introduction to Dyestuff Technology (Audit Course)

Credits: 3

Sr. No	Topic	L	T
1	Industrial revolution, Coal tar distillation, Evolution of Industrial chemistry in general and industrial organic chemistry in particular, University of Giesen as a centre for learning early industrial organic chemistry and contributions of Justus von Liebig. Hofmann's contributions in Imperial College and William Henry Perkin's experiments under the tutelage of Hofmann and evolution of dyestuff industry.	**9**	**3**
2	Conceptual understanding of aromatic chemistry post-Kekule's regime. Structural diversities in dyes and evolution of synthetic aromatic chemistry in tandem with colour chemistry. Evolution oy synthetic vat dyes. Bayer's efforts in synthesis of indigo. Rene Bohn's efforts in Indanthrone synthesis and other similar work leading to polycyclic aromatic compounds.	**9**	**3**
3	Evolution of valence bond theory, molecular orbital theory in understanding the bonding, hybridization and structures of complex aromatic compounds. Interpretation of colour in relation chemical constitution in the light of interaction of electromagnetic radiation with organic materials. (This is the area where one can emphasize the importance of physics to the color chemists)	**9**	**3**
4	Evolution of fibre forming polymers particularly polyester as a challenge to the evolution of new range of dyes – the disperse dyes. The concept of spray drying as against the usual drying techniques. Evolution of reactive dyes.	**9**	**3**
5	Nature of chemical engineering operations and unit processes in dyestuff industry. Importance of green chemistry. Innovative applications of colorants. Fundamental science and interplay between electronics, biology, photochemistry and photophysics in the evolution of modern functional colorants and their applications	**9**	**3**
	Total	**45**	**15**

Syllabus Structure B. Tech. Second Year

Semester III								
Subjects	**Credits**	**Hrs /week**			**Marks for various Exams**			
		L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
DYT 1101: Technology of Intermediates-I	4	3	1	0	20	30	50	100
OLT 1102: Chemistry of Oleochemicals and Surfactants	4	3	1	0	20	30	50	100
DYT 1202: Chemical and Physical Constitution of Colorants	3	2	1	0	10	15	25	50
CHT1133: Chemistry and applications of Colorants	4	3	1	0	20	30	50	100
CHT-1124: Inorganic Chemical Technology	4	3	1	0	20	30	50	100
DYP 1001: Analysis of Inorganic Raw Materials used in Dyestuff Industries	2	0	0	4	25	-	25	50
MAP 1201: Computer Applications Lab	2	0	0	4	25	-	25	50
Total	23	14	5	8	-	-	-	550

Semester IV								
Subjects	**Credits**	**Hrs/week**			**Marks for various Exams**			
		L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
GET 1116: Engg. Mechanics & Strength of Materials	4	3	1	0	20	30	50	100
PYT 1202: Colour Physics & Colour Harmony (By Physics)	3	2	1	0	10	15	25	50
CET 1105: Transport Phenomena	4	3	1	0	20	30	50	100
GET 1105: Basic Electrical Engg and Electronics	3	2	1	0	10	15	25	50
DYT 1102: Technology of Intermediates II	4	3	1	0	20	30	50	100
GEP 1106:Electrical Engg and Electronics Lab	2	0	0	4	25	-	25	50
PYP 1203: Colour Physics Lab (By Physics)	2	0	0	4	25	-	25	50
Total	22	13	5	8	-	-	-	500

Semester III

	Course Code: DYP 1101	**Course Title: Technology of Intermediates I (100 marks)**	**Credits = 4**		
			L	**T**	**P**
	Semester: III	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
HSC (Science),					
List of Courses where this course will be prerequisite					
All Dyestuff and Intermediates Special Courses					
Description of relevance of this course in the B. Tech (Dyes) Programme					
• To make the students understand chemistry various intermediates used for chemical industry in general and Dyestuff industry in perticular • To make them understand the unit processes and their relevance in chemical industries . • To enable them to analyse and identify the proper synthetic and industrial method and choose accordingly the further processes to make intermediates. • To develop in them capacity understand proper selection of the chemical processes based on economy and ecological aspects					

Sr. No.	Topic	CO Statement	Knowledge Level	Delivery Method	Teaching Hours
1	Chemical feedstock for Dyestuff industry- Basic Raw materials **a.** Fossil feedstock **b.** Petroleum and coal based raw materials **c.** Importance of BTX	C1, C5	K1, K2	Marker and Board	04
2	Chemistry of Benzenoid intermediates- **a.** Electrophilic aromatic substitution reaction **b.** Orientation in aromatic substitutions	C2, C3, C5	K3	Marker and Board	08
3	Introduction of Functional groups into benzene and technology involved **A.** Basic Unit processes a. Sulphonation	C3, C4	K4, K5	Marker and Board, Projector	16

	b. Nitration c. Reduction d. Halogenation **B. Sulphonation:** (i) Reaction phenomenon and conditions (ii) Sulphonating agents and solvents (iii) Work up and Material of construction (iv) **Substitution in benzene and substituted benzene** (v) Plant and process flow (vi) Safety and process control parameters **C. Nitration:** (i) Reaction phenomenon and conditions (ii) Nitrating agents and solvents (iii) Work up and Material of construction (iv) Substitution in benzene and substituted benzene (v) Plant and process flow (vi) Safety and process control parameters, Run away reactions **D. Reduction:** (i) Reducing agents (ii) Reduction methods (iii) Selection of best method for Benzene and substituent (iv) Process and workup				

	(v) Safety aspect **E. Halogenation** (i) Basic nucleophilic and Electrophilic substitution (ii) Reaction and MOC				
4	Naphthalene Introduction a. Nomenclature, Reactions, Reactivity rules	C2, C5	K2, K3	Marker and Board, Ball and stick model	04
5	**Chemistry: Naphthalene intermediates** **a.** Synthesis of naphthalene **b.** Substitution pattern **c.** Reactions possible and criterion for the same	C2,C3	K2	Marker and Board	18
6	Technology and Reactions of naphthalene **a.** Nitration **b.** Sulphonation **c.** Halogenation **d.** Reduction (Key points are similar to benzene)	C4	K5	Marker and Board, Projector	10

Course Outcomes (students will be able…..)	
	1. To understand the basics of dyestuff industry in terms of raw materials utilized
	2. To understand basic benzene and naphthalene chemistry.
	3. To analyze the various methods for synthesis of different intermediates used in dyes
	4. To know the various technology and safety aspects for reactions.

	5. To identify the substrates and chemistry to synthesize desired product
	6. To understand the basics of dyestuff industry in terms of raw materials utilized

Text / Reference Books:

1. Industrial organic chemistry, Weissermal K., ArpeH.J.VCH, Weinheim, 1993

2. Organic synthesis, Smith M B, Tata McGrow Hill, NY, 2nd Ed, 2004

3. Chemistry of Synthetic Dyes, Lubs H. A., NY 1995

4. Chemistry of synthetic dyes vol I, Venkatraman K., NY 1952

5. Organic Chemistry , Clayden, Oxford Univ. Press, 2001

Assessment method:

1. Unit Test
2. Assignment
3. Seminar
4. Literature survey including patents and research paper

	Course Code: OLT 1102	**Course Title: Chemistry of Oleochemicals and Surfactants (Marks 100)**	**Credits = 4**		
			L	**T**	**P**
	Semester: III	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
	HSC (Science)				
List of Courses where this course will be prerequisite					
	All the Oils, Oleochemicals & Surfactants Special Courses				
Description of relevance of this course in the B. Tech. (Oils, Oleochemicals & Surfactants Technology) Programme					

Students will be able to understand the industrial chemistry of Surfactants and Oleochemicals. They will be trained with respect to techniques of synthesis of oleochemicals and surfactants, colloidal behavior, interfacial phenomenon, and related analytical tools.

Sr. No.	Course Contents (Topics and subtopics)	CO Mapping	Delivery method	Teaching Hours
1.	Oleochemical and Surfactant raw materials and their derivatives as feedstock for Chemical Industries, Worldwide Statistics of Oleochemical and Surfactant Industries	CO1	Chalk and board/ LCD, Tutorial	04
2.	Different techniques of synthesis of Fatty Acid Methyl Esters (FAME), Glycerol and Fatty Alcohols, Fatty Amines, Amides, and Nitriles and their physical and chemical characteristics	CO1, CO2	Chalk and board/ LCD	08
3.	Introduction to the nature of colloidal solutions, Surface Tension and Energy, Definition and classification of surfactants, Hydrophilic and hydrophobic groups and HLB balance, Theory of Surface Actions.	CO3, CO4	Chalk and board/ LCD	06
4.	Self-assembly and packing features of surfactants (bi and multilayers, direct & reverse micelles, vesicles, Microemulsions). Thermodynamics of Adsorption and Micellization, structure of micelles	CO3, CO4	Chalk and board/ LCD	06
5.	Different surface activity phenomenon: Emulsification & de-emulsification, foaming & defoaming, Solubilisation, Dispersion, Wetting, Detergency Prediction of emulsion type from packing geometry, general phase behaviour and Solubility–Temperature Relationship for Surfactants, phase inversion, Kraft and Cloud point	CO3, CO4	Chalk and board/ LCD	08
6.	Synthesis, analysis and applications of Anionic surfactants: Sulphonates (FAMES , AOS, LABS , Paraffin S., Ester & Amide S.), Sulphates (Alcohol & Alcohol ether sulphates, TRO , Sulphated MG, Sulphated Alkanolamides), N-acylated amino acids, Alkyl Phosphates, Sulphosuccinates etc.	CO5, CO6	Chalk and board/ LCD	12
7.	Synthesis, analysis and applications of Nonionic Surfactants: Fatty Alcohol ethers, Alcohol Polyglycol Ethers, Alkyl phenol ethers, Mono and diglycerides, Lecithin, Polyol esters (TWIN, SPAN, Sucrose polyester), Alkanolamides etc.	CO5, CO6	Chalk and board/ LCD, Tutorial	08

	Polymeric and Gemini Surfactants			
8.	Synthesis, analysis and applications of Cationic and Amphoteric Surfactants: Alkoxylated amines, Amine oxide, 2-Alkyl imidazoline, N-alkyl-β-Alanine, Quaternary Ammonium Compounds, Betains, Sulphobetains etc. Speciality Fluorocarbon and Silicone Surfactants	CO5, CO6	Chalk and board/ LCD, Tutorial	08

	Course Code: DYT 1202	**Course Title: Chemical and Physical constitution of Colorants (Marks 50)**	**Credits = 3**		
			L	**T**	**P**
	Semester: III	**Total contact hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
	HSC (Science)				
List of Courses where this course will be prerequisite					
	All the Dyes Special Courses				
Description of relevance of this course in the B. Tech. (Dyes) Programme					
Students will be able to understand the relation between the chemical structure and the colour.					

Sr. No.	Topic	CO Statement	Knowledge level	Delivery method	Teaching Hours
1	Origin of colour in organic molecules. Chromatic and achromatic colors. Red shift, blue shift, hyperchromic effect, solvatochromism, halochromism. Beer-Lambert's law, absorptivity, oscillator strength, , and half band width.	CO1	K2, A2	Chalk and board, Tutorial	03
2.	Early theories of color and constitution - empirical correlations between the chemical structures and their color. Chromophores, auxochromes, distribution rules, chromogens. n→π*, donor-	CO3	K2, K3 & A2	Chalk and board, Tutorial	03

	acceptor, acyclic and cyclic polyene, and cyanine type chromogens				
3.	Resonance theory of color, failures of resonance theory. Steric effects in electronic absorption spectra – some general considerations.	CO2	K2, K3 & A2	Chalk and board, Tutorial	03
4.	Perturbational molecular orbital theory: Alternation of the electronegativity of an atom in an even alternant system. Alteration of the electronegativity of an atom in an odd alternate system, Dewar rules. Other empirical approaches to substituent effects, Mesomeric and field effects, Correlation between the frequency shift of a substitution and the Hammett substituent constant	CO2	K2, K3 & A2	Chalk and board, Tutorial	03
5.	Simple donor-acceptor chromogens: general characteristics – donor group, unsaturated bridge, acceptor group. The carbonyl acceptor – merocyanine types of compounds.	CO4, C04	K2, K3 & A2	Chalk and board, Tutorial	03
6.	Complex donor-acceptor chromogens: classes of complex acceptor residues, donor substituted quinones. Donor substituted azo compounds. Color and constitution of simple azo dyes. Steric effects, and azo-hydrazone tautomerism in azo dyes	CO4, CO5	K4 & A3	Chalk and board, Tutorial	03
7.	Color and chemical constitution of indigoid dyes. Introduction to cross-conjugated chromophores. Chromogens based on acycyclic and cyclic polyene systems: general characteristics with examples. Cyanine type chromogens.	CO4, CO5	K2 & A3	Chalk and board, Tutorial	03
8.	Di- and triaryl methane colorants, heterocyclic analogues of di- and triaryl methane colorants. Simple color and constitution relationships.	CO3, CO4	K2 & A3	Chalk and board, Tutorial	03
9.	Essentials of computational colour chemistry – brief introduction to one particle system. Schrodinger equation. Particle in a box.	CO4	K2	Chalk and board, Tutorial	03
10	Two particle system, Many particle systems – Hartree Fock theory. Basis sets.	C04	K2 & A3	Chalk and board, Tutorial	03
11	Electronic Structure theory. Molecular orbitals and light absorption. Semiempirical methods,	CO2	K2 & A2	Chalk and board, Tutorial	03

12.	Limitations of Hartree Fock method, Computational complexities in post Hartree Fock (wavefunction based methods).	CO4	K2	Chalk and board, Tutorial	03
13.	Introduction to Density Functional Theory and its application in colour chemistry	CO2, CO5	K2	Chalk and board, Seminar	03
14	Excited State calculations, Configuration Interaction Singles.	CO2, CO5	K2	Chalk and board, Seminar	03
15	Time Dependent Density Functional Theory.	CO2, CO5	K2	Chalk and board, Seminar	03

COURSE OUTCOMES

CO1: Ability to understand the constitution of different colorants.

CO2: Ability to analysis the correlation of proposed absorption and observed absorption.

CO3: Ability to identify the colour changes with different classes of molecules.

CO4: Ability to understand the detail properties of colour changes with respective structural changes.

CO5: Ability to assess the technical importance of colour chemistry.

Recommended books:

1. *Chemistry of Synthetic Dyes and Pigments*, Lubs H. A., Robert E Krieger Publishing Company, New York, 1977
2. *Chemistry of Synthetic Dyes – Vol I*, Venkataraman, K., Academic Press, 1952
3. *Chemistry of Synthetic Dyes – Vol III*, Venkataraman, K., Academic Press, 1972
4. *Colour and Chemical Constitution of Organic Dyes*, Griffiths J., Academic Press, 1976
5. *Quantum Chemistry,* Chandra A. K., Tata McGraw Hill, 1979
6. *Color Chemistry –Synthesis, Properties and Applications of Dyes and Pigments*, Zollinger H., 2nd ed., Weinheim – VCH, 1991

Assessment method:

1. Unit Test
2. Assignment
3. Seminar
4. Literature survey including patents and research papers.

	Course Code: CHT1133	**Course Title:Chemistry and application of Colorants (Marks 100)**	**Credits = 4**		
			L	**T**	**P**
	Semester: III	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
	HSC (Science)				
List of Courses where this course will be prerequisite					
	Additives for polymers, Additives for Coatings Compounding and polymer Processing Analysis of Paints Pigment synthesis Paint formulations				

Description of relevance of this course in the B. Tech. Programme		
Students will understand the pigmentary property, chemistry behind the colorants. They will be able to explain the its applications in various field according to the chemistry involved. Student will be made aware to testing of pigments synthesis processing and applications of dyes pigments latkes		
	Course Contents (Topics and subtopics)	**HrRe**
1	Introduction of Pigments, Colour Index Generic Names of Pigments, Colour Constitution Number, Polymorphism, Properties required in a pigment and extender, Pigment dispersion basics Definitions of pigment, extenders, dyes, pigment dyestuffs, toner and lakes	4
2	Theory of color formation in organic compounds, effect of auxiliary groups on the shade and hue of the pigment (Bathochromic and hyper chromic shift) Practices and requirement of Pigments	3
3	Classification of dyes Various unit operations in the manufacture of intermediates & dyes, Electrophilic nucleophilic substitution reaction,Introduction of various functiona groups Synthesis of dyes, Basics of Azo dyes Vat dyes Reactive dyes, Diazotisation and coupling reactions, azoic colours, acid dyes, mono azo dye; diasazo, nitro, diphenylamine and anthraquinone dyes; acid mordant dyes, azo metal complex dyes,	11
4	Organic pigments - Antraquinone, Benzimidazolonedioxazines, Diazo lakes	6
5	Litholrubones, Monoazo lakes, Napthol AS lakes, Napthol AS, Perylenes, Phthalocyanines, Quinacridones effect pigments	6
6	General methods of processing and synthesis of inorganic pigments: Crushing and grinding, vaporization, co precipitation, filtration, drying, flushing, calcinations/roasting, vapour phase oxidation etc. Raw materials for organic pigments: A brief study of coal tar distillation and the role of distillation products in the manufacture of synthetic dyes: bases and precipitants used in the colour striking,	10
7	Extenders or filler pigments: Sources, manufacture, properties and uses of carbonates, sulphates and other extender pigments like Calcium carbonate, hydrated aluminium oxide, aluminum silicates/ china clays, Magnesium silicate/ talc. White prime pigments: Methods of manufacturing, comparison of properties and composition of TiO2, ZnO, Zinc sulphide and lithopone, Surface treatment of TiO2 and othe pigments, crystal structure and hiding power of TiO2. Manufacture, properties	10
8	Blue and Green Pigments: Properties, composition and manufacturing of following; Chrome green, pigment green B, Ultramarine blue, Prussian blue, Phthalocyanines: Copper phthalocyanines, phthalocyanine green. Application of colourants in plastics and surface coating applications. Ceramic pigments Metallic Pigments effect pigments CICPs Color formulation	10
List of Text Books/ Reference Books		
1	Color Chemistry, 3rd Edition, Heinrich Zollinger, Wiley – VCH 2003	
2	Colorants and Auxiliaries: Colorants v. 1: Organic Chemistry and Application Properties, John Shore, Society of Dyers &Colourists; 2nd edition edition (Jan. 2002)	
3	The Chemistry of Synthetic dyes, K. Venkataraman, Academic Press (1 January 1971)	

4	Industrial Inorganic Pigments, Gunter Buxbaum, Wiley-VCH; 1 edition (March 11, 2005)
5	Industrial Organic Pigments: Production, Properties, Applications, 3rd, Completely Revised Edition by Herbst, Klaus HungerWilly March 2006
6	Application Properties of Pigments By A.Karnik, First Edition Thane1999
Course Outcomes (students will be …..)	
1	Able to understand fundamental knowledge on basics of chemistry involved in the colorants. (K2, A2)
2	Able to describe the types of pigments and their applications (K2, A2)
3	Able to understand and explain the physical properties of Pigments and dyes (K2, A2, S1)
4	Able to explain the synthetic methods used for azo dyes and their properties. (K2, A2, S1)
5	Able to explain the types of dyes on the basis of application, properties. . (K2, A3, S1)

	Course Code: CHT-1124	Course Title: Inorganic Chemical Technology (Marks 100)	Credits = 4		
			L	T	P
	Semester: III	Total contact hours: 60	3	1	0
List of Prerequisite Courses					
	HSC (Science)				
List of Courses where this course will be prerequisite					
	Material Technology,, Nanomaterials and its applications				
Description of relevance of this course in the B. Tech. (Dyes) Programme					
The students will understand the properties of elements based on their position in the periodic table. Students will get to know the different inorganic components involved in nature and their applications in technology.					
	Course Contents (Topics and subtopics)		Reqd. hours		
1	Modern periodic law, Long form of the periodic table, Sketch, Cause of periodicity		4		
2	Division of elements in to s, p, d, and f blocks. General characteristics of s, p, d and f block elements.		4		
3	Definition and explanation of atomic radius, ionic radius, Covalent radius, Vander waals radius. Variation of atomic size along a period and in a group.		4		
4	Definition and Explanation of ionization energy, Successive ionization energy, Factors affecting ionization energy. Variation of ionization energy along a period and in a group. Applications of ionization energy to chemical behavior of an element.		6		
5	Definition and Explanation of electron affinity, Successive electron affinity, Factors affecting electron affinity. Variation of electron affinity along a period and in a group. Applications of electron affinity to chemical behavior of an element.		6		
6	Definition and Explanation of electronegativity, Factors affecting electronegativity. Variation of electronegativity along a period and in a group. Pauling's approach of electronegativity. Calculations of electronegativity by Pauling's method (Numerical), Mulliken,s approach. Applications of electronegativity to bond properties such		6		
7	Definition of oxidation, Reduction, Oxidizing agent and reducing agents according to classical concept , electronic concept, oxidation number concept. Rules for assigning oxidation number, Balancing of redox reactions by ion electron method and Oxidation number		6		

8	Introduction to Acid & Bases, Arrhenius concept, Bronsted-Lowry concept, Lewis acids and bases concept Discuss briefly with suitable example	4
9	Definition of Chemical bonding, Cause for chemical bonding, Types of chemical bonding, defination& explanation of Inonic Bonding, Covalent Bonding, Metallic Bonding, Vander Waal's Bonding, Hydrogen Bonding	4
10	Coordination Chemistry: Nomenclature, Werner theory, VSEPR, crystal field theory, electronic and magnetic properties of the complexes, Organometallics: Metal Ligand concept, , types of ligands,Application of organometallic complexes in hydrogenation,	6
11	Non aqueous solvents: Classification and properties of solvents, study of – liquid ammonia, liquid sulphur dioxide with respect to (i) acid-base reaction (ii) redox reaction (iii) complex formation (iv)	4
12	Inorganic materials : Inorganic polymers, alloys, clays, zeolites, nanomaterials, magnetic materials, Bioinorganic Chemistry : Study of involvement of metals such as Fe, Co, Cu, Zn and their compounds in biological processes, biomineralization, inorganic complexes of	6

List of Text Books/ Reference Books	
1	Principles of Inorganic chemistry by Puri, Sharma and Kalia.
2	Advanced inorganic chemistry by Gurudeep Raj and ChatwalAnand.
3	A New Concise Inorganic Chemistry by J. D. LeeEds., van Nostrand Reinhold, ELBS edition, London.
4	Basic Inorganic Chemistry by F. A. Cotton, G. Wilkinson and P. L. Gaus, John Wiley and Sons, New York, 1976
5	Modern aspects of inorganic chemistry, H.J. Emaleus and A.G. Sharp Eds., Routledge and Kegan Paul
6	Inorganic Chemistry by G. L. Miessler and D. A. Tarr.
7	Chemistry for Degree Students ,B.Sc F.Y by Dr. R.L. Madan(S. Chand)
8	Inorganic Chemistry , P.W. Atkins and D.F. Shriver, Oxford University press, 1999.

Course Outcomes (students will be …..)	
1	Able to **comprehend** the classification of elements according to their position in the Periodic Table (K2, A2)
2	Ab Able to **explain** ionization energy, electron affinity and electronegativity of elements and their trends in the periodic table (K3, A2)
3	Able to **understand** concept of acid, base, oxidation, reduction through various ory and it's importance in Inorganic Chemistry. (K2, A1)
4	Able to **understand and analyze** different types bondings. (K2, A2)

5	Able to **understand** co-ordination chemistry of different types of metal and ligands. (K2, A2)
6	Able to **understand and analyze** the role of inorganic material and it's importance in nature. (K4, A3, S1)

	Course Code: DYP 1001	**Course Title:** Analysis of Inorganic Raw Materials used in Dyestuff Industries **(50 Marks)**	**Credits = 2**		
			L	**T**	**P**
	Semester: III	**Total contact hours: 60**	**0**	**0**	**4**
List of Prerequisite					
	HSC (Science)				
List of Courses where this course will be prerequisite					
	Analysis of various inorganic reagents compounds used in chemical industry				
Description of relevance of this course in the B. Tech. (Textile) Programme					
Students will understand the significance of uses of these inorganic raw materials in the chemical industry					

	Course Contents (Topics and subtopics)	**Reqd. hours**

Sr.	**Topic**	**Hrs.**
1	Estimation by volumetric titrations of inorganic raw materials used in the dyestuff industry – sodium sulphite, sodium bisulphite, sodium metabisulphite, sodium sulphide, sodium hydrosulphite, Rongalite C, bleaching powder, sodium hypochloride, iron powder, zinc dust, hydrogen peroxide, manganese dioxide, sodium nitrite	60

Course Outcome-

1. To estimate the amount of inorganic compounds present
2. To check the purity of compound
3. Ability to understand the controlling and quantitative analysis of reducing agents
4. To analyse and identify the classes of metal containing reducing and oxidizing agents
5. To identify the reducing and oxidizing agents used for synthesis
6. To understand the practical utility of inorganic compounds in synthesis

Sr. No.	Topic	CO Statement	Knowledge Level	Delivery Method	Teaching Hours

1	Estimation of Sodium sulfite	C1	K1	Experiment and theory: Chalk and board	04
2	Estimation of Sodium Sulfide	C2	K2	Experiment and theory: Chalk and board	08
3	Estimation of Sodium Bisulfite	C3,C4	K4	Experiment and theory: Chalk and board	04
4	Estimation of Sodium Metabisulfite	C5	K3	Experiment and theory: Chalk and board	04
5	Estimation of Stannous chloride	C4	K2	Experiment and theory: Chalk and board	08
6	Estimation of sodium nitrite	C4, C5	K3	Experiment and theory: Chalk and board	04
7	Estimation of hydrogen peroxide	C3, C4	K3	Experiment and theory: Chalk and board	04
8	Estimation of ferric alum	C3, C4	K2	Experiment and theory: Chalk and board	04
9	Estimation of zinc	C5	K4,K5	Experiment and theory: Chalk and board	08

10	Estimation of iron	C5, C6	K3	Experiment and theory: Chalk and board	04
11	Estimation of Manganese dioxide	C6	K4	Experiment and theory: Chalk and board	08

Syllabus for Computer Applications,

B. Tech. Semester III

Part I: Spreadsheet Programme (Microsoft Excel or LibreOffice Calc) (3 Lab Sessions)

1. Basic Introduction to Spreadsheet Programmes, Plotting Graphs of Functions and Data Plotting.
2. Exploring Basic Statistics, Hypothesis Testing with Spreadsheet.
3. Numerical Solution of Linear and Non-Linear Equations.

Part II: Statistics with R-Programming (4 Lab Sessions)

1. Basic Introduction to R and Rstudio.
2. Data Management in R.
3. Exploring Distribution Function in R.
4. Hypothesis Testing in R.
5. Basic Regression Analysis in R

Part III: C-Programming

Unit I: (2 Lab Sessions)

What is C-programming? Data Types, Variables, Constants, Arithmetic Operations, Input-Output Statements, Expressions and Expression Evaluations, Type Conversions.

Unit II: (2 Lab Sessions)

Making Decisions-if and switch statement, Repetition Statements-For Loop, While and Do-While Loops, Nested Loops, Use of Break, Continue and Goto in Loops, File Input-Output statements and its use.

Unit III: (3 Lab Sessions)

Functions- User Defined functions, Calling Function and passing arguments, Arrays- Definition, Accessing and Storing elements, Concept of Multi-dimensional Arrays, Array and Functions.

Unit IV: (2 Lab Sessions)

String Manipulation. Basic of Structures and unions. Dynamic Memory allocation.

References:

1. Programming In Ansi C, E Balagurusamy, Tata McGraw-Hill Publishing Company Limited, 2002
2. Let Us C, Yashavant P. Kanetkar, 2008, Infinity Science Press
3. Introductory Statistics with R, Peter Dalgaard, Springer, 2008
4. Basic Statistics: An Introduction with R, Tenko Raykov, George A. Marcoulides, 2013
5. Excel for Chemists: A Comprehensive guide, E. Joseph Billo, WILEY, 2011
6. Mathematical Modeling with Excel, Brian Albright, Jones & Bartlett India Private Limited, 2010
7. Statistics and Probability for Engineering Applications With Microsoft® Excel by W.J. DeCoursey, 2003

Semester IV

	Course Code: GET 1116	Course Title: Engineering Mechanics and Strength of Materials	Credits = 4		
			L	T	P
	Semester: IV	Total contact hours: 60, Marks : 100	3	1	0

	List of Prerequisite Courses	
	XIIth Standard Physics and Mathematics, Applied Mathemaics-I and II, Applied Physics-I	

Description of relevance of this course in the B. Tech. (All Branches)

This subject will help students to understand use of basics of Applied Mechanics and Strength of Materials. As a practicing engineer and technologist, what are different types of forces to be considered and how to quantify them during design of equipments? To know the conditions of equilibrium and how to apply them to analyse the problems. Importance of centre of gravity and moment of Inertia in Engineering Design. Study of different types of stresses and strains occurring in various components of the structure. Advantages and disadvantages of various geometric sections available for engineering design. What are different advance fibre polymer composite materials used in Industry for various applications. Different performance enhancing construction chemicals. This is the foundation course for a good Design Engineer and Technologist.

	Course Contents (Topics and subtopics)	Reqd. hours
1	Concepts of forces, their types, Resolution of forces, Composition of forces, Steps in Engineering Design, Different types supports and free body diagram.	4
2	Equilibrium of rigid bodies - Conditions of equilibrium. Determinant and indeterminate structures. Equilibrium of beams, trusses and frames problems on analysis of beams and truss.	5
3	Concept of moment of Inertia (Second moment of area) its use. Parallel axis theorem. Problems of finding centroid and moment of Inertia of single figures, composite figures. Perpendicular axis theorem, Polar M.I., Radius of gyration.	5
4	Shear Force and Bending Moment - Basic concept, S.F. and B.M. diagram for cantilever, simply supported beams (with or without overhang). Problems with concentrated and U.D. loads.	5
5	Stresses and Strains - Tensile and compressive stresses, strains, modulus of elasticity, modulus of rigidity, bulk modulus. Thermal stresses and strains. Problems based on stresses and strains. Basics of Engineering Design - Steps in the engineering design, Importance of analysis, 1-D, 2-D and 3-D analysis and interpretation of results. Design	5

	philosophies.	
6	Theory of Bending - Assumptions in derivation of basic equation, Basic equation, section modulus, bending stress distribution.	4
7	Problems on shear stress - Concept, Derivation of basic formula. Shear stress distribution for standard shapes. Problems of Shear stress distribution	4
8	Slope and Deflection of beams - Basic concept, Slope and Deflection of cantilever and simply supported beams under standard loading. Macaulay's method.	4
9	Short and Long Columns (Struts) – Basic Concept, Crippling load, End conditions, Euler's and Rankine's Approach (Without Derivations)	4
10	Torsion of a circular shaft – Concept, basic derivation, shear stress distribution, power transmitted by shafts, Simple problems	4
11	Thin and Thick Cylinders – Concept of circumferential, longitudinal stresses, Behaviour of thin cylinders, problems on thin cylindrical and spherical shells, Behaviour of thick cylinders (Theory only)	4
12	Natural Materials, Manmade materials, Materials used for coatings, anticorrosive coatings, special purpose floorings, water proofing compounds, Various polymers and epoxies used for industrial applications. Composite Materials – various types of fibres, fabrics used in polymer composites, Glass and Carbon fibre polymer composites, methods of manufacturing, Uses in various industrial applications.	6
13	Concrete – Basics, Ingredients of concrete, properties of concrete, testing of fresh and hardened concrete, uses of concrete. Different types of performance enhancing and special purpose construction chemicals. Plasticizers and super-plasticizers, air entraining agents, accelerators and retarders, viscosity modifying agents, corrosion inhibitors, Cement, Basic process of hardening, types of cements, blended cements, Recycling of waste – value addition.	6
List of Text Books/ Reference Books		
	Engineering Mechanics Vol I Statics by B. N. Thadani, Publisher Wenall Book Corporation	
	Introduction to Mechanics of Solids by Egor Popov, Prentice Hall of India Pvt. Ltd	
	Mechanics of Materials by Ferdinand Beer and E. Russel Johnston, Tata McGraw Hill	
	Fundamentals of applied Mechanics by Dadhe, Jamdar and Walavalkar, Sarita Prakashan Pune	
	Engineering Mechanics by S. Timoshenko and D. H. Young, McGraw Hill Publications	
	Strength of Materials by Ferdinand Singer and Andrew Pytel, Harper Colins Publishers	

	Mechanics of composite Materials by Autar K. Kaw, Publisher CRC Press	
	Fundamental of Fibre reinforced composite materials by A. R. Busell and J. Renard, Taylor & Francis	
	Concrete Technology by A. M. Neville, Pearson Education ltd	
	Concrete Technology – Theory and Practice by M. S. Shetty, S. Chand & Co.	
	Corrosion and Corrosion Protection Handbook by Philip A. Schweitzer, CRC press	

Course Objectives

1) To know the various types of forces acting on the various structures in engineering. To know the conditions of equilibrium and how to apply them to analyse the structures.
2) To understand the concept and importance of centroid and moment of Inertia for different sections used in engineering and plane areas.
3) To analyse the different types of structures to know axial force, shear force and bending moment in the different parts of the body/structure.
4) To know the basics of different stresses and strains, types of materials and their properties.
5) To able to determine the axial stress, bending stress and shear stress in the structure and draw its variation across the section.
6) To understand the deformations in axial, lateral and rotational direction. Calculation of slope and deflections in different beams under simple and complex loading.
7) To understand torsional loads, Use in power transmission. Behavious of short and long columns with various end conditions.
8) To know the Thin and Thick cylinders, stresses and strains in thin cylinders.
9) To know various polymers, epoxies, fibre polymer composite materials used for various applications in engineering.
10) To make awareness about the cement and its composites, performance enhancing construction chemicals used to alter properties.

Course Outcome:

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

CO 1	Quantify the actions and able to find reactions by applying conditions of equilibrium
CO 2	Find out the Centroid and Moment of Inertia for various cross sections used in engineering structures and for plane areas.
CO 3	Able to draw the Shear Force and Bending Moment diagram for different types of beams under simple and complex loading.
CO 4	Calculate the forces, reactions, stresses, strains in components of the bodies of a complex engineering structure.
CO 5	To find out the Bending Stresses at different positions and Shear Stress distribution across the cross section at various points.
CO 6	To calculate the Slope and Deflection at different points under simple and complex loading.
CO 7	To know effect of Torsion in shafts, power transmission, Euler's and Rankine's approach for columns.
CO 8	To know Thin and Thick cylinders, stresses and strains in thin cylinders.
CO 9	To know various polymers and epoxies, fibre polymer composites used in various applications in engineering. Corrosion of steel and its mitigation.
CO 10	To know most widely used cement composite – Concrete, Chemicals used to alter the properties of concrete.

Course Outcomes	PO1	PO2	PO3	PO 4	PO 5	PO 6	PO 7	PO 8	PO9	PO1 0	PO1 1	PO1 2	PSO 1,2,3 ,4
CO1	2	2	1	-	-	-	-	-	-	-	-	-	
CO2	2	2	1	-	-	-	-	-	-	-	-	-	
CO3	2	2	1	-	-	-	-	-	-	-	-	-	
CO4	2	2	1	-	-	-	-	-	-	-	-	-	

CO5	2	2	1	-	-	-	-	-	-	-	-	-	
CO6	2	2	1	-	-	-	-	-	-	-	-	-	
CO7	2	2	1										
CO8	2	2	1										
CO9	2	2	1										
CO10	2	2	1										

	Course Code: PYT 1202	**Course Title: Colour Physics &Colour Harmony (Marks 50) (By Physics)**	**Credits = 3**		
			L	**T**	**P**
	Semester: IV	Total contact hours: 45	**2**	**1**	**0**

List of Prerequisite Courses		
	Applied Physics –I & II	
List of Courses where this course will be prerequisite		
	Colour Physics Lab, Additives for Polymers, Additives for Coatings, Pigment Synthesis Lab, Technology of Textile Dyeing, Technology of Textile Printing, Technology of Garment Manufacturing. & Processing.	
Description of relevance of this course in the B. Tech./B. Pharm. Program		
Students will be trained to understand the mechanism behind visibility of different colours. The students will be made aware of different technics and terms of colour physics that can be applied into various fields.		
	Course contents(topics/subtopics)	**Required hrs**
1	**Introduction:** Colour as a concept, its definition, geometric and chromatic attributes	**3**
2	**Radiation and illumination:** SPD, CT andCCT; Sources and illuminants; Need for artificial sources – various ways of producing light and different artificial sources; efficacy and colour rendering properties of sources.	**6**
3	**Interaction of radiation with matter** : gloss and diffused reflectance, travel, flip and flop colour,polar diagrams; absorption of light in sample-various transitions in dye molecule, Beer – Lambert law and its verification, deviation from Beer – Lambert law, Additivity of absorbances, mixture analysis, various instruments used for the purpose; absorbance and scattering in the sample – Kubelka Munk theory.	**8**
4	**Perception of colour** in **eye \ brain**: various colour coding processes at retina and beyond it, colour constancy, colour theories, anomalous colour visions, metamerism	**6**
5	**Colour specification**: Additive-substractive mixing, Grassmann's law,1931 and1964CIE system-XYZ and L*a*b*colour spaces, colour difference formulae, Munsell colour order system	**8**
6	**Recipe match prediction**: Single constant Kubelka – Munk theory of colourant formulation and recepie prediction; Modern computerised methods of colour matching	**6**

7	**Colour Harmony**: Definition, colour associations, colour harmony theories; colour contrasts-successive and simultaneous contrast, contrast of proportion, intensity, value, hue etc.(Itten's contrasts);colour wheel and various colour schemes, dominant, subdominant and accent colours; visual weight and balance in colour schemes	**8**

List of Text Books/ Reference Books	
1	Colour Physics for Industry, R. McDonald, West Yorkshire, 1997.
2	Color: A Multidisciplinary Approach; Zollinger Heinrich Zurich, Verlag Helvetica Chemica Acta, 1999
3	The Colour Science of Dyes and Pigments, R. McLaren Bristol, Adam Hilger Ltd., 1983
4	Industrial Colour Technology, Johnson R. M., Sartzman M, American Chemical Society, Washington D.C., 1971.
5	Coloring of Plastics: Fundamentals by Robert A. Charvat John Wiley & Sons, 11-Mar-2005
6	Coloring of plastics: theory and practice by M.Ahmad Van Nostrand Reinhold, 1979

Course Outcomes (students will be able to.....)	
1	Understand the colour perception and the effect of various parameters on it. (K1,K2)
2	Understand various visual and colour processes in human beings. (K1,K2)
3	Understand various systems to specify uniquely a colour stimulus and use them to do so.(K1,K2,K3)
4	Use knowledge of such colour systems to predict recipe (K2, K3)
5	Understand colour harmony to study various colour contrasts. (K1, K2)
6	Understand various colour harmony theories and the use of colour wheel. (K1, K2, K3)

	Course Code: CET1105	**Course Title: Transport Phenomena (Marks 100)**	**Credits = 4**		
			L	**T**	**P**
	Semester: IV	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite					
	Applied Physics –I & II				
List of Courses where this course will be prerequisite					

	Technology of Thermoplastics,Technology of Thermosets ,Fabrication and design of moulds, Project, Processing of Polymers	
Description of relevance of this course in the B. Tech. Programme		
Students will be trained to understand fundamentals of mass transfer,lamilar turbulent flow Bernoullies equation and its application.The students will be made aware of design aspect of heat exchangers, condensers evaporators and heat transfer basics		
	Course contents	**Required hrs**
1	Fluid Statics and applications to engineering importance.	2
2	Equations of Continuity and motion for Laminar and Turbulent Flows with applications to simple problems	8
3	Bernoulli's Equation and engineering applications, Pressure drop in pipes and Fittings, Piping design and fluid moving machinery such as pumps, blowers, compressors, vacuum systems, etc.	10
4	Gas – liquid Two phase flow: types of flow regimes, Regime maps, estimation of pressure drop and hold-up	2
5	Fundamentals of mass transfer: Molecular diffusion in fluids, mass transfer coefficients, and interface mass transfer, steady state theories of mass transfer, Whitman's two-film theory, and its variations.	10
6	Heat conduction in Cartesian, cylindrical and spherical coordinate systems. Convective heat transfer in laminar and turbulent boundary layers. Theories of heat transfer and analogy between momentum and heat	8
7	Design aspects of exchangers like: Double pipe heat exchangers: Concurrent, counter-current and cross flows, mean temperature difference. Shell and tube heat exchangers: Basic construction and features. Design	10
8	Introduction to Compact Exchangers.	2
9	Heat transfer aspects in condensers, reboilers and evaporators.	4
10	Heat transfer in agitated vessels: coils, jackets, limpet coils, calculation of heat transfer coefficients, heating and cooling times, applications to batch reactors and batch processes	4
List of Text Books/ Reference Books		
1	Transport Processes and Separation Process Principles: Geankoplis, C.J.	
2	Unit Operations of Chemical Engineering, McCabe W.L., Smith J.C., Harriot P.	
3	Coulson and Richardson's CHEMICAL ENGINEERING, Volume 1	
4	Heat Transfer: Principles and Applications: Dutta, B.K	
5	Principles of Mass Transfer and Separation Processes	

6	Transport Phenomena: Brodkey, R.S.
7	Fluid Mechanics: Kundu, P.K.
8	Fluid Mechanics: Subramanya, K
9	Fluid Dynamics and Heat Transfer: Knudsen and Katz
10	Process Heat Transfer: Kern, D.Q.
11	Heat Exchangers: Kakac, S., Bergles, A.E., Mayinger, F.
12	Process Heat Transfer: Hewitt, G.
Course Outcomes (students will be able to.....)	
1	Understand the colour perception and the effect of various parameters on it. (K1,K2)
2	Understand various visual and colour processes in human beings. (K1,K2)
3	Understand various systems to specify uniquely a colour stimulus and use them to do so.(K1,K2,K3)
4	Use knowledge of such colour systems to predict recipe (K2, K3)
5	Understand colour harmony to study various colour contrasts. (K1, K2)
6	Understand various colour harmony theories and the use of colour wheel. (K1, K2, K3)

Course Code: GET 1105	Course Title: Basic Electrical Engineering and Electronics (Marks 50)	Credits =3		
		L	T	P
Semester: IV	Total contact hours: 40	2	1	0

List of Prerequisite Courses

XIIth Standard Physics and Mathematics courses,

List of Courses where this course will be prerequisite

Course objectives

1. Students will get an insight to the importance of Electrical Energy in Chemical Plants.
2. The students will understand the basics of electricity,
3. They will get basic knowledge about Transformer and selection of different types of drives for a given application process.
4. They will get basic knowledge as regards to electronic devices and their application in Power supplies, amplifiers and other circuits.

S.No.	Topic	Hrs.
1	Basic Laws: Kirchoff's current and voltage law, Simple series and parallel connections, star and delta transformation. Mesh and nodal analysis, Basic elements R, L and C. Concept of self and mutual inductance.	6
2	Network theorems: super position, Thevenin's theorems	2
3	A.C. Fundamentals: Equations of alternating voltages and currents, cycle, frequency. Time period, amplitude, peak value average value, R.M.S. value, A.C. through resistance, inductance and capacitance, simple RL, RC and RLC circuits.	5

	Resonance in series RLC circuits, Power, power factor, series and parallel circuits.	
4	Three Phase systems: Star and delta connections, relationship between line and phase voltages and currents, Power in three phase circuits	**3**
5	Transformer: Introduction, principle of operation, e.m.f. equation, phasor diagrams. Ideal transformer, transformer on no load, Transformer under load, Transformer losses, efficiency, regulation.	**5**
6	Introduction to dc and ac drives	**3**
7	Diodes and rectifiers: P-N junction diode characteristics, Zener diode, Half wave and full wave rectifiers, their waveforms, brief introduction to filters.	**4**
7	Bi-polar junction transistor: Current components. Modes of operation, Input and output characteristics, Regions of operation, Transistor as an amplifier, classification of amplifiers	**6**
8	Introduction to Uni junction transistor, Characteristics, UJT relaxation oscillator,	**3**
9	Silicon controlled rectifier, controlled rectification, characteristics, methods of turning-on. Applications.	**3**

List of Text Books/ Reference Books

Electrical Engineering Fundamentals by Vincent Deltoro

Electronic devices and circuits by Boylstead, Nashelsky

Electrical Machines by Nagrath, Kothari

Electrical Machines by P.S. Bhimbra

Electrical Technology by B.L.Theraja, A.K.Theraja vol I,II,IV

Thyristors and their applications by M.Ramamurthy

Power Electronics by P.S. Bhimbra

Course Outcomes (students will be able to…..)

1. Understand the basic concepts of D.C circuits. Solve basic electrical circuit problems
2. Understand the basic concepts of single phase and three phase AC supply and

circuits.
3. Understand the basic concepts of transformers and motors used as various industrial drives.
4. Understand the basic concepts of electronic devices and their applications

	Course Code: DYT 1102	Course Title: Technology of Intermediates-II (Marks 100)	Credits = 4		
			L	T	P
	Semester: IV	Total contact hours: 60	3	1	0
List of Prerequisite Courses					
	HSC (Science)				
List of Courses where this course will be prerequisite					
	Organic chemistry, Technology of Intermediates I				
Description of relevance of this course in the B. Tech. (Dyes) Programme					

- To make the students understand chemistry various intermediates used for chemical industry in general and Dyestuff industry in perticular
- To make them understand the unit processes and their relevance in chemical industries .
- To enable them to analyse and identify the proper synthetic and industrial method and choose accordingly the further processes to make intermediates.
- To develop in them capacity understand proper selection of the chemical processes based on economy and ecological aspects

Sr. No.	Topic	Hrs.
1	Chemistry of Naphthalene	02
2	Unit Processes: a. Friedel Craft's Reaction b. Oxidation c. Ammonolysis d. Hydrolysis e. Diazotization and coupling d. Bucherer Reaction, Reverse	30
3	Synthesis of naphthol, naphthylamine sulphonic acids, Bon acid and its derivatives	08
4	Case studies	08
5	Active Methylene compounds	04

6	Technology and safety aspects	04
7	Separation techniques and agitation system	04

Course Outcome-

1. To understand the basics of Naphthalene chemistry.
2. To understand basic unit processes for naphthalene and benzene.
3. To analyze the various methods for synthesis of different intermediates used in dyes
4. To know the various technology and safety aspects for reactions.
5. To know various separation techniques used commercially and agitation systems for processes

Sr. No.	Topic	CO Statement	Knowledge Level	Delivery Method	Teaching Hours
1	Chemistry of Naphthalene **a.** Synthesis of naphthalene **b** Raw materials **c**. Mechanism	C1, C2	K1, K2	Marker and Board	02
2	Unit Processes: **a.** Friedel Craft's Reaction (i) Types alkylation and acylation (ii) Reagents used (iii) Products and isolation (iv) MOC **b**. Oxidation (i) Types (ii) Radical Reaction (iii) Reactor design and safety aspect **c.** Ammonolysis (i) Reaction conditions (ii) Substrate requirement and	C3, C4	K3	Marker and Board	30

	substitution pattern **d.** Hydrolysis (i) Types (ii) Reaction conditions and work up (iii) Technology **e.** Diazotization and coupling (i) Definition (ii) Types (iii) Reagents required (iv) Reaction conditions and work up (v) Process control test and MOC (vi) Reactor designing (vii) Substitution pattern and reaction conditions **f.** Bucherer Reaction, Reverse Specially designed for naphthalene chemistry				
3	Synthesis of naphthol, naphthylamine sulphonic acids, Bon acid and its derivatives	C2, C4	K4, K5	Marker and Board, Projector	08
4	Case studies Commercially important bulk and specialty intermediates synthesis	C1, C4	K2, K3	Marker and Board, Ball and stick model	08
5	Active Methylene compounds And utility in dyes and intermediates	C3	K2	Marker and Board	04

6	Technology and safety aspects Environmental conditions and factors affecting the reaction	C4	K5	Marker and Board, Projector	04
7	Separation techniques and agitation system Various agitation systems, power functions, reactor designing aspects, separation techniques: (a) Physical method (b) Chemical method	C4, C5	K4	Marker and Board, Projector	04

Text / Reference Books:

1. Industrial organic chemistry, Weissermal K., ArpeH.J.VCH, Weinheim, 1993

2. Organic synthesis, Smith M B, Tata McGrow Hill, NY, 2nd Ed, 2004

3. Chemistry of Synthetic Dyes, Lubs H. A., NY 1995

4. Chemistry of synthetic dyes vol I, Venkatraman K., NY 1952

5. Organic Chemistry , Clayden, Oxford Univ. Press, 2001

Assessment method:

1. Unit Test
2. Assignment
3. Seminar
4. Literature survey including patents and research paper

Course Code: GEP 1106	Course Title: Electrical Engineering and Electronics laboratory (Marks 50)	Credits = 2		
		L	T	P
Semester: IV	Total contact hours: 60	0	0	4

List of Prerequisite Courses

XII Standard Physics and Mathematics courses,

List of Courses where this course will be prerequisite

Course objectives

1. Students will get an insight to the importance of Electrical Energy in Chemical Plants.
2. The students will understand the basics of electricity.
3. They will understand the working and utility of transformers and electrical drives.
4. They will get basic knowledge as regards to electronic devices and their application in Power supplies, amplifiers and other circuits.

Suitable no of experiments out of the following will be conducted.

1. Superposition Theorem

2. Thevenin's Theorem

3. Series RL circuit

4. Reconance in Series RLC circuit

5. H.W. and F.W. Rectifiers

6. Cathode Ray Oscilloscope

7. Input and output characteristic of npn transistor in CE mode.

8. Load Test on Transformer

9. Three phase star connection

10. Three phase delta connection

11. Study of UJT relaxatation oscillator

12. Design of UJT relaxation oscillator

12. Load Test on 3 phase induction motor

13. Study of Thermo couple

Course Outcomes (students will be able to…..)
1. Understand concepts of basic working of D.C circuits.
2. Understand the basic applications of single phase and three phase AC supply and circuits.
3. Understand the working and utility of transformers and motors used as various industrial drives.
4. Understand the basic working and applications of electronic devices and circuits

	Course Code: PYP 1203	**Course Title: Colour Physics Lab (Marks50) (By Physics)**	**Credits = 2**		
			L	**T**	**P**
	Semester: IV	**Total contact hours: 40**	**0**	**0**	**4**
List of Prerequisite					
	HSC (Science)				
List of Courses where this course will be prerequisite					
	Technology of Textile Dyeing Technology of Textile Printing Experimental dyeing Experiments in Printing Technology of Garment Manufacturing. & Processing				
Description of relevance of this course in the B. Tech. (Textile) Programme					
Students will be trained to determine various parameters related to colour physics which are applicable in different fields.					
	Course contents(topics/subtopics)		**Required hrs**		
1	Determination of unknown concentration of a dye in solution by Dubosque colorimeter.		4		
2	Verification of B-L law (dependence of absorbance on concentration) by spectrophotometer.		4		
3	Mixture analysis using spectrophotometer.		4		
4	Determination of gloss of various samples using gloss meter		4		

5	Determination of color of various textile samples in terms of Lovibond primaries and chromaticity co-ordinates using Lovibond tintometer	4
6	Specification of color of a textile sample in terms of 'Lab' at using color computer.	4
7	Finding color differences (ΔE) between set of samples vis a vis dye solution concentration	4
8	Finding color differences (ΔE) between set of samples vis a vis time of exposure.	4
9	Determination of colors of samples in terms of Munsell color system using Munsell Color Tree	4
10	Recipe prediction and matching of colored samples using CCM.	4
Course Outcomes (students will be able.....)		
1	To understand colour specifying systems and schemes of quantification of colour.	
2	To measure the intensity of the transmitted light and correlate it with concept of chromophore and colour	
3	To use instruments to uniquely specify a colour in terms of nos.	
4	To explain various concepts of colour mixing, sources etc.	

Syllabus Structure B. Tech. Third Year

Semester V								
Subjects	**Credits**	**Hrs /week**			**Marks for various Exams**			
		L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
Chemical Engineering Operations	3	2	1	0	10	15	25	50
Chemical Reaction Engineering	3	2	1	0	10	15	25	50
DYT 1103: Technology of Azo colorants	4	3	1	0	20	30	50	100
DYT 1104: Technology of Quinonoid colorants	4	3	1	0	20	30	50	100
TXT 1215: Technology of dyeing and printing	4	3	1	0	20	30	50	100

DYP 1002: Analysis of intermediates, dyes and fibers	4	0	0	8	50	-	50	100
DYP 1003: Experimental Dyeing	2	0	0	4	25	-	25	50
Total	24	13	5	12	-	-	-	550

Semester VI								
Subjects	**Credits**	**Hrs/week**			**Marks for various Exams**			
		L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
DYT 1203: Fluorescent Colorants	4	3	1	0	20	30	50	100
DYT 1204: Heterocyclic intermediates and colorants	3	2	1	0	10	15	25	50
Humanities / Management Subject II	3	2	1	0	10	15	25	50
Humanities / Manageme0.nt Subject III	3	2	1	0	10	15	25	50
Elective – I Chemistry and Technology of Specialty Organic Intermediates and Fine chemicals **OR** Career options and literature survey	3	2	1	0	10	15	25	50
DYP 1004: Chromatography techniques and Preparation of intermediates and dyes	4	0	0	8	50	-	50	100
TXP 1013: Wet processing of textiles	2	0	0	4	25	-	25	50
DYP 1003: Process and Plant design	2	0	0	4	25	-	25	50
Total	24	11	5	16	-	-	-	500

Semester V

	Course Code: DYP 1103	**Course Title: Technology of Azo Colorants (100 marks)**	**Credits = 4**		
			L	**T**	**P**
	Semester: V	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
HSC (Science),					
List of Courses where this course will be prerequisite					
All Dyestuff and Intermediates Special Courses					

Sr. No.	Topic	CO Statement	Knowledge Level	Delivery Method	Teaching Hours
1	Classification of dyes Application of dyes Textile fibres Dyes classified according to dyeing properties Acid, acid-mordant, basic, direct, vat, sulphur, reactive, disperse	CO1		Chalk and Board	04
2	Direct dyes Dyeing of cotton Chemical constitution and substantivity Examples of bis azo dyes for cotton Manufacture of direct dyes Chemical constitution and fastness properties Drawbacks of direct dyes	CO2,CO3			8
3	Reactive dyes Concept of reactive dyeing as a way of improving wash fastness History of reactive dyes	CO3			18

	Proof of fibre-dye reaction Reactive dyes based on cyanuric chloride Reactive dyes based on vinyl sulphone Other reactive systems Bi-functional reactive dyes Manufacture of reactive dyes				
4	Acid dyes Dyeing of wool Monoazo acid dyes Dyes from diazotized o-aminophenols Soluble chromium complexes of mordant azo dyes Neutral dyeing metal complexes Metal complexes for leather dyeing Constitution of metal-dye complexes	CO2			10
5	Trisazo and polykisazo dyes	CO2			4
6	Disperse dyes Dyeing of hydrophobic fibres Ionamines Development of disperse dyes General structure of disperse azo dyes Preparation and manufacture of diazo components Diazotization of weakly basic aromatic amines Preparation of and manufacture of coupling components Hydroxyethylation and handling of ethylene oxide Manufacture of disperse azo dyes	CO2,CO3, CO4			16

	Heterocyclic diazo and coupling components				

Course Outcomes (students will be able…..)	
	5. To explain the and define the classes of dyes, substrates
	6. To understand the variety and chemistry of dyes and their application
	7. Overview of recent trends in the field of dyes containing azo groups
	7. Techniques of diazotization and variations available

Text / Reference Books:

Chemistry of Synthetic Dyes, Lubs H. A., NY 1995

Chemistry of synthetic dyes vol I, Venkatraman K., NY 1952

Chemistry of azo colorants Vol I and Vol II- P. Zollinger

Assessment method:

1. Unit Test
2. Assignment
3. Seminar
4. Literature survey including patents and research paper

	Course Code: DYT 1104	**Course Title: Technology of Quinonoid colorants (Marks 100)**	**Credits = 4**		
			L	**T**	**P**
	Semester: V	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
	HSC (Science)				
List of Courses where this course will be prerequisite					
	Dyes students				

Sr. No.	Course Contents (Topics and subtopics)	CO Mapping	Delivery method	Teaching Hours
1.	Introduction to Anthraquinone chemistry, Synthesis, mechanism, sources of Anthraquinones	Co1, CO2	Chalk and board/ LCD, Tutorial	15
2.	Reactions of Anthraquinone: Sulphonation, Nitration, Halogenation, Bucherer Reaction	CO3	Chalk and board/ LCD	10
3.	Chemistry of Anthraquinonoid, Indigoid, polycyclic Quinonoids vat dyes	CO2,CO3	Chalk and board/ LCD	10
4.	Disperse dyes, Reactive dyes, Acid dyes based on Quinonoid systems	CO4	Chalk and board/ LCD	15
5.	Vat dyes and pigments	CO2	Chalk and board/ LCD	5
6.	Synthesis and technology for unit processes, material of construction, Work up	CO4	Chalk and board/ LCD	5

Course Outcome:

- ***CO1:*** *Define* and *state* different terminologies related to AQ
- **CO2:** *Describe* and *explain* the Chemistry and technology of AQ based compounds
- **CO3:** Application of AQ in pigments and dyes
- **CO4:** *Outline* the synthesis of various commercially important products

Reference Books:

1. Industrial Organic Chemistry, Weissermal K., Arpe H. J., VCH, Weinheim, 1993

2. Organic Chemistry, Clayden, Greeves, Warren, Oxford University Press, 2001

3. FIAT 1313

4. Material of Construction, Lee

5. Unit Operations, McCabe, Smith

6. Chemistry of Synthetic Dyes – Vol I, Venkataraman, K., Academic Press, 1952

7. Synthesis and Application of Dyes, Rys and Zollinger

8. The Chemistry of Synthetic Dyes – Vol II, Venkataraman K., Academic Press

9. The Chemistry of Synthetic Dyes – Vol IV, Venkataraman K., Academic Press

10. The Chemistry of Synthetic Dyes – Vol VI, Venkataraman K., Academic Press

11. The Chemistry of Synthetic Dyes and Pigments, Lubs H. A., Robert E. Krieger Publishing Co

12. Industrial Dyes – Chemistry, Properties, Applications, Hunger K. (Ed), Wiley-VCH, Weinheim, 2003 ICT

List of assignments and Open Ended Projects:

1. Literature survey including patents and research papers of fundamental process

- Design based small project **or**

- Study report based on latest scientific development **or**

- Technology study report/modeling/ simulation/collection report

- Presentations based on topics given

These can be done in a group containing maximum **three** students in each.

2. Generation of problem based project to enhance the basic mental and technical level of students.

3. Evaluation should be done on **approach of the student on his/her efforts** (not on completion) to study the design module of given task

	Course Code: TXT 1215	Course Title: Technology of Dyeing and Printing (Marks 100)	Credits = 4		
			L	T	P
	Semester: V	Total contact hours: 60	3	1	0
List of Prerequisite Courses					
	HSC (Science)				
List of Courses where this course will be prerequisite					
	Chemistry and Application of Colorants				
Description of relevance of this course in the B. Tech. (Dyes) Programme					

- To make the students understand chemistry various substrates and their coloration processes.
- To make them understand the dyeing processes and the machineries involved
- To enable them to understand the properties of substrates in relation to the properties of dyes used for their coloration..
- To develop in them capacity understand proper selection of the colorants based on their structural diversities

Sr. No.	Topic	CO Statement	Knowledge level	Delivery method	Teaching Hours
1	General considerations of the application of different classes of synthetic dyes to important textile fibres	CO1	K2, A2	Chalk and board, Tutorial	8
2.	Introduction to physico-chemical principles involved in dyeing.	CO3	K2, K3 & A2	Chalk and board, Tutorial	2
3.	Dye Class specific dyeing methods and dyeing machinery	CO2	K2, K3 & A2	Chalk and board, Tutorial	15
4.	Preparation of fabrics for Dyeing and printing, Ingredients of Print Paste, Selection of Ingredients of Print paste	CO2	K2, K3 & A2	Chalk and board, Tutorial	10
5.	Basic Styles of Printing	CO4, C06	K2, K3 & A2	Chalk and board, Tutorial	10

6.	Methods of Printing	CO4, CO5	K4 & A3	Chalk and board, Tutorial	10
7.	Fastness requirements of coloured fabrics	CO4, CO5	K2 & A3	Chalk and board, Tutorial	5

COURSE OUTCOMES

1. Able to identify and define the applications of different classes of synthetic dyes with the physio-chemical principles involved in dyeing, preparation of fabric for dyeing and printing(K2, A2, S1)

2. Able to understand dyeing machinery. (K2, A2)

3. Able to list and understand the function of the ingredients used in printing paste. (K2, A2, S1)

4. Able to understand and explain basic styles of printing. (K2, A2)

5. Able to understand and describe methods of printing. (K2, A2, S2)

6. Able to understand fastness requirements and principles / techniques involved in the measurement of colored fabrics. (K2, A2)

Text / Reference Books:

1. Experimental Dyeing by Giles, SDC

2. Textile Dyeing, V A Shenai

3. Textile Printing, V A Shenoi

5. Textile Fibres V A Shenoi

Assessment method:

1. Unit Test

2. Assignment

3. Seminar

4. Literature survey including patents and research paper

	Course Code: DYP 1002	Course Title: Analysis of intermediates, dyes and fibres (100 Marks)	Credits = 4		
			L	T	P
	Semester: V	Total contact hours: 60	0	0	8
List of Prerequisite Courses					
	HSC (Science)				
List of Courses where this course will be prerequisite					
Description of relevance of this course in the B. Tech. Programme					

	Course Contents (Topics and subtopics)	Hr
1	To analyze the purity of amine by the method of Diazotization– aniline, sulphanilic acid, chloroanilines, toluidines, anisidines, etc	
2	Coupling experiments- Estimation of phenols and naphthols by bromination – phenol, 2-naphthol, R-acid, etc	
3	Estimation of naphtholsulphonic acids and aminonaphtholsulphonic acids by diazo-coupling – Schaffer acid, R salt, gamma acid, J acid, etc	
4	Estimation of dyes by reduction – Sunset Yellow, Ponceau 4R, Orange II, Tartrazine, etc	
5	Identification of dyes – acid, basic, direct, acid mordant, vat, sulphur	
6	Identification of fibres – cotton, wool, silk, nylon, polyester	
7	To analyze the purity of amine by the method of Diazotization– aniline, sulphanilic acid, chloroanilines, toluidines, anisidines, etc	

8	Coupling experiments- Estimation of phenols and naphthols by bromination – phenol, 2-naphthol, R-acid, etc	
Course Outcomes (students will be …..)		

1. To analyse the purity of the amines used for dye synthesis.
2. To check the presence of coupling components purity required for final dye synthesis.
3. To understand the presence of diazo groups and reducible groups in the given dye structure.
4. To analyse and identify the classes of dyes from the application oriented perspective.
5. To identify the substrates and chemistry of the fibers for dye affinity.
6. To understand the practical utility of concepts learnt in dyes and intermediates synthesis.

	Course Code: DYP 1003	Course Title: Experimental Dyeing	Credits = 2		
			L	T	P
	Semester: V	Total contact hours: 60	0	0	4
List of Prerequisite Courses					
	HSC (Science)				
List of Courses where this course will be prerequisite					
	All practical courses in subsequent semesters				
Description of relevance of this course in the B. Tech. (Dyes) Programme					
Students will understand the significance of uses all the kinds of dyes used in the coloration or various textile substrates					
	Course Contents (Topics and subtopics)		Reqd. hours		
1	Application anionic, cationic and nonionic colorants to synthetic and natural textile substrates		60		
Course Outcomes (students will be …..)					
2	7. To apply water soluble dyes to hydrophilic substrates				
3	8. To apply water-insoluble dyes to hydrophilic substrates				
4	9. Ability to categorize the dyes according to the substrates.				
5	10. To analyse and identify the dyes on textiles				
6	11. To identify the requirements of the dyes as against the suitability of substrated for dyeing				

Semester VI

	Course Code: DYT 1203	**Course Title: Fluorescent Colorants (100 marks)**	**Credits = 4**		
			L	**T**	**P**
	Semester: VI	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
HSC (Science),					
List of Courses where this course will be prerequisite					
All Dyestuff and Intermediates Special Courses					
Description of relevance of this course in the B. Tech (Dyes) Programme					
• To make the students understand physics and chemistry of fluorescent colorants used in colorants industry. • To make them understand the structure and synthesis of fluorescent colorants. • To enable them to analyze and identify the proper synthetic and industrial method and choose accordingly the further processes to make fluorescent dyes.					

Sr. No.	Topic	CO Statement	Knowledge Level	Delivery Method	Teaching Hours
1	Introduction to luminescence phenomena. Various terms like intersystem crossing, internal conversion, Stokes shift, and fluorescence quantum yield. Energy Level diagrams. Singlet and triplet states.Franck-Condon principle, Kasha's rule. Quantum mechanically allowed transitions. Charge transfer mediated effects	C1, C5	K1, K2	Marker and Board	12
2	Stilbene based optical whiteners and fluorescent dyes	C2, C3, C5	K3	Marker and Board	16
3	Coumarin and carbostyryl based optical whiteners and fluorescent dyes	C3, C4	K4, K5	Marker and Board, Projector	12
4	Pyrazoline, naphthaliminde, benzanthrone,	C2, C5	K2, K3	Marker and Board, Ball	08

	and azabenzanthrone based fluorophores			and stick model	
5	Water soluble fluorescent dyes, Cyanine dyes, xanthenes, oxazines, and similar dyes. BODIPY and their Aza analogues	C2,C3	K2	Marker and Board	12

	Course Outcomes (students will be able…..)
	9. To understand the basics of fluorescence
	10. To understand basic fluorophores.
	11. To analyze the various fluorophores for optical whitening, and functional applications
	8. To know the various aspects of water soluble fluorescent dyes in biology.
	9. To identify the syntetic route for a desired fluorescent dye
	6. To understand the basics of commercial fluorescent dyes.

Text / Reference Books:

1. Molecular Fluorescence: Principles and Applications by B Valeur, Wiley VCH

2. Principles of Fluorescence Spectroscopy J R Lackowiz, Springer

Assessment method:

1. Unit Test
2. Assignment
3. Seminar
4. Literature survey including patents and research paper

	Course Code: DYT 1204	**Course Title: Heterocyclic colorants**	**Credits = 4**		
			L	**T**	**P**
	Semester: VI	Total contact hours: 60	**3**	**1**	**0**
List of Prerequisite Courses					
	Applied Physics –I & II				
List of Courses where this course will be prerequisite					
Description of relevance of this course in the B. Tech./B. Pharm. Program					
Course Outcomes (students will be able to.....)					
	CO1: Ability to identify the classes of heterocycles. **CO2**: Ability to design synthetic route of different heterocycles. **CO3**: Ability to propose the retrosynthetic pathway of different heterocycles. **CO4**: Ability to understand the reactivity of different heterocycles. **CO5**: Ability to assess the technical importance of heterocycles.				

Sr. No.	Topic	CO Statement	Knowledge level	Delivery method	Teaching Hours
1.	Chemistry of three membered rings with one hetero atom – epoxides, aziridines and episulphides, preparation and reactions	CO1, CO2, CO4	K2, A2	Chalk and board	01
2.	Chemistry of furan, pyrrole and thiophene – Paal-Knorr synthesis, Hantzsch synthesis, Hinsberg synthesis. Electrophilic reactions, nucleophilic and radical substitutions, reaction with bases, reactions of C-metallated , reaction with reducing agents,electrocyclic reactions,photochemical reactions,oxy and amino derivatives etc.	CO1, CO2, CO3, CO4	K2, K3 & A2	Chalk and board, Tutorial	08
3.	Chemistry of condensed five-membered heterocycles – various syntheses of indoles, benzofuran and benzo[b]thiophenes. Electrophilic reactions, nucleophilic and radical substitutions	CO1, CO2, CO3, CO4	K2, K3 & A2	Chalk and board, Tutorial	07
4.	Chemistry of 1,2 and 1,3 azoles. 2-Methylbenzoxazole, 2-methylbenzothiazole, 2-methylbenzimidazole. Electrophilic reactions, nucleophilic and radical substitutions, quarternary azolium salts, side chain reactivity	CO1, CO2, CO3, CO4	K2, K3 & A2	Chalk and board, Tutorial	04

5.	Chemistry of pyridine, pyrimidine and pyridine oxide – Preparation. Electrophilic reactions, nucleophilic and radical substitutions, side chain reactivity, reactions with oxidizing agents,reactions of c-metallated ,electrocyclic reactions, photochemical reactions, oxy and aminopyridines, alkylpyridines, pyridine aldehyde, ketones, carboxylic acids and esters ,quaternary pyridinium salts, pyridine N-oxides etc.	CO2, CO3, CO4	K2, K3 & A2	Chalk and board, Tutorial	06
6.	Chemistry of quinoline and isoquinoline – Skraup synthesis – quinoline and quinaldine, N-methyaltion of quinaldine. Friedlander synthesis, Bischler-Napieralski synthesis – methyl isoquinoline, Pictet-Spengler synthesis. Electrophilic reactions, nucleophilic and radical substitutions on quinoline and isoquinoline. Side chain reactivity of both of them.	CO2, CO4	K2, K3 & A2	Chalk and board, Tutorial	02
7.	Technically important heterocycles derivatives	CO5	K4 & A3	Seminar, Tutorial	01
8.	Basic important intermediates and dyes: Fischer-indole synthesis, Skraup synthesis, oxazines and thiazine dyes(cationic dyes), indigo and thioindigo dyes, phthalocyanine, carbazole chemistry, vat dyes based on anthranthrone type system	CO4,CO5		Chalk and board	01
9.	Refer some research papers on heterocycles used in dyes. (Assignment)				

Recommended books:

1. Heterocyclic Chemistry, 4th ed., Joule J. A. and Mills K., Blackwell Science, 2000

2. The Chemistry of Heterocycles – Structures, Reactions, Syntheses and Applications, Eicher T., Hauptmann S. and Speicher A., Wiley-VCH GmbH & Co, KGaA, 2003

3. Heterocyclic Chemistry – Vols I, II and III, Gupta R. R., Kumar M. and Gupta V., Springer, 2005

4. Fundamental process of Dye Chemistry- Fierz David

Assessment method:

5. Unit Test
6. Assignment
7. Seminar

	Course Code: DYP 1004	**Course Title: Chromatography techniques and Preparation of intermediates and dyes**	**Credits = 4**		
			L	**T**	**P**
	Semester: IV	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite					
List of Courses where this course will be prerequisite					
Course Outcomes (students will be able to.....)					
1	At the end of this course the student will be able to: • **CO1:** *Understand* the principle behind chromatographic techniques – TLC, paper and column – used for the separation of organic compounds • **CO2:** *Learn* to use the appropriate technique for a given separation scenario • **CO3:** *Conduct* these processes in the lab independently for the separation of two or more organic compounds that may or may not be coloured • **CO4:** *Apply* these techniques whenever separation of organic compounds needs to be done				

Detailed Syllabus

Sr.No.	Main topic	Sub topic	Hrs.
1	TLC (Thin layer chromatography)	• Preparation of simple and rugged TLC plates	30

		• Movement of a coloured compound on a TLC plate with solvents of increasing polarity • Separation of two coloured compounds • Detection techniques for colourless compounds (iodine chamber, permanganate/2,4-DNP/etc spray) • Separation of a mixture of coloured and colourless compounds • Separation of a mixture of 2 and 3 colourless compounds	
2	Paper chromatography	• Movement of a coloured compound on paper with solvents of increasing polarity • Separation of two coloured compounds • Detection techniques for colourless compounds (iodine chamber, permanganate/2,4-DNP/etc spray) • Separation of a mixture of coloured and colourless compounds	15
3	Column chromatography	• Preparation of a column • Separation of 2 coloured compounds • Separation of a mixture of a coloured and colourless compound • Separation of 2 colourless compounds	15

Sl. No.	**Course Content**	**CO Statement**	**Knowledge level**	**Delivery method**	**No. Of Hours to be handled**
1	TLC (Thin layer chromatography)	CO1, CO2, CO3, CO4	K1, K2, K3, K4, K5, K6 S3	Laboratory Practical	30
2	Paper chromatography	CO1, CO2, CO3, CO4	K3, K4, K5, K6 S3	Laboratory Practical	15
3	Column chromatography	CO1, CO2, CO3, CO4	K3, K4, K5, K6 S3	Laboratory Practical	15

Assessment method:

1. Inspection of laboratory notebook
2. Viva

Course Code: TXP 1013	Course Title: Wet Processing of Textiles	Credits =3		
		L	T	P
Semester: VI	Total contact hours:	2	1	0
List of Prerequisite Courses				
List of Courses where this course will be prerequisite				
Course objectives				

S.No.	Topic	Hrs.
1	To study dyeing of cotton with reactive dye and azoics on padding mangle	8
2	To study the dyeing of cotton hank by tub liquoring using azoics	8
3	To study dyeing of cotton with reactive dyes on Laboratory Jigger	4
4	To study dyeing of cotton hosiery with reactive dye on Laboratory Winch	4
5	Direct style of printing – Direct, Reactive, solubilised vat and azoic	8
6	Direct style printing on Polyester and Nylon with disperse dyes	4
7	Direct style printing on Nylon and Wool with acid and direct dyes	4
7	Printing of Cotton, Polyester and its blend with Pigments	4
8	Discharge style of printing – white discharge under direct and azoic ground	4
9	Resist style of printing – White and colour resist under reactive	4
10	Special styles of printing like Batik, Tie and Dye	8

List of Text Books/ Reference Books

Course Outcomes (students will be able to…..)

5. Able to explain and use dyeing of cotton with reactive dye and azoics using padding mangle.(K3, A2, S1)
6. Able to explain, carry out and examine printing of Cotton, Polyester and its blend with Pigments. (K3, A2, S2)
7. Able to process and evaluate dyeing of cotton hank by tub liquoring using azoics. (K3, A3, S3)
8. Able to choose and apply different styles of printing on Natural and Synthetic fabrics using different dye classes (K3, A2, S1)
9. Able to comprehend basis of special styles of printing like Batik, Tie and Dye(K3, A2, S1)

10. Able to comprehend and use machinery for dyeing of cotton with reactive dyes on Laboratory Jigger and Winch(K3, A2, S1)
11. Able to explain and carry out discharge and resist style of printing of cotton. (K3, A2, S1)

	Course Code: DYP 1003	**Course Title: Process and Plant Design (Marks 100)**	**Credits = 4**		
			L	**T**	**P**
	Semester: VI	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
	Basic knowledge of unit processes				
List of Courses where this course will be prerequisite					

	Organic chemistry, Technology of Intermediates	

Table 1

Sr. No.	Topic	Course Outcome	Hrs.	Delivery Method
1	Introduction to unit processes *w.r.t* Plant designing layout	CO1	06	OHP, Marker and Board, Power point presentations
2	Processes like sulphonation, Nitration, Oxidation, Reduction, Hydrolysis, Ammonolysis, FC reaction etc their plant diagram and flow sheet, MOC	CO1,CO2	24	OHP, Marker and Board, Power point presentations
3	Specification of raw materials, study of process, addition pattern, Process control tests, Designing of plant and reactor vessels for the described capacity	CO3	10	OHP, Marker and Board, Power point presentations
4	Selection of process and its alterations in terms yield, selectivity etc.	CO2	08	OHP, Marker and Board, Power point presentations
5	Multistep reactions and their process design	CO2,CO3	08	OHP, Marker and Board, Power point presentations
6	Cost and Capacity for the entire plant of designed capacity	CO3,	08	OHP, Marker and Board, Power point presentations

Course Outcome-

CO1: To understand the unit processes and their industrial scale up

CO2: Transfer of technology from pilot scale to plant scale by designing process with study of process parameters

CO3: Calculations based on real industry situation with volume based understanding

Text / Reference Books:

1. Industrial organic chemistry, Weissermal K., ArpeH.J.VCH, Weinheim, 1993

2. Organic synthesis, Smith M B, Tata McGrow Hill, NY, 2nd Ed, 2004

3. Chemistry of Synthetic Dyes, Lubs H. A., NY 1995

4. Chemistry of synthetic dyes vol I, Venkatraman K., NY 1952

5. Handbook of Chemical Process Development, Chandalia S. B., Multi-Tech Publishing Co.

6.BIOS Reports, *FIAT Reports*

7. *Organic Synthesis Collective Volumes I-V*

8. Unit processes in organic syntheses, P.H. Groggins

Assessment method:

1. Unit Test
2. Assignment
3. Seminar
4. Literature survey including patents and research paper

Elective I

Chemistry and Technology of Specialty Organic

Intermediates and Fine chemicals

Type of course: Dyestuff Technology Subject

Prerequisite: Industry visits for unit process study

Rationale: To introduce various existing processes and technology of Dyes and pigment field to students.

Teaching and Examination Scheme:

Marks	**50**
Number of Hours per Week	**2 + 1**
Credits	**3**
Class	**T Y B Tech (Dyes)**
Semester	**1**

Content:

Sr. No.	Topic	Teaching Hours
1.	Chemistry – Chemistry of some advanced dyestuff intermediates, agrochemical and pharmaceutical intermediates, chiral chemistry Retrosynthesis Technology – Brief discussion on manufacture of some agrochemical and pharmaceutical intermediates, handling of solvents, solvent recovery, IPR issues	15
2.	Chemistry – Chemistry of some perfumery and flavor intermediates Technology – Brief discussion on manufacture of some perfumery	10

	and flavor intermediates	
3.	Brief discussion on fine chemical industry with examples of some global fine chemical companies	05

Reference Books:

- Fine Chemicals manufacture – Technology & Engineering, Cybulski A., Moulijn J. A., Sharma M. M., Sheldon R. A., Elsevier.
- Catalysis of Organic Reactions, Ford M. E. (Ed), Marcel Dekker Inc.
- Fine Chemicals – The Industry and the Business, Pollak P., Wiley
- Chirality in Industry II – Developments in the Commercial Manufacture and Applications of Optically Active Compounds, Collins A. N., Sheldrake G. N., Crosby J. (Eds), John Wiley & Sons.
- Organic Synthesis Engineering, Doraiswamy L. K., Oxford University Press.
- Handbook of Chemical Process Development, Chandalia S. B., Multi-Tech Publishing Co.
- Solvent Recovery Handbook, Smallwood I., Blackwell Publishing. Industrial Organic Chemistry, Arpe H.J.VCH, Weinheim, Weissermal K.1993

List of assignments and Open Ended Projects:

1. Assignments and presentations:

- Design based small project **or**

- Study report based on latest scientific development **or**

- Technology study report

These can be done in a group containing maximum **three** students in each.

2. Evaluation based on assignments and short presentations and discussions

Course Outcome

At the end of this course you will be able to:

CO1: *Define* and *state* different terminologies related to fine chemicals

CO2: *Describe* and *explain* the general requirements for specialty chemicals and their techniques and application procedures

CO3: *Classify and differentiate* chemicals based on application and chemical constitution

CO4: Outline the synthesis of various compounds

CO5: *Justify* and *illustrate* the involvement of green chemistry and advancement strategies

Sl. No.	Course Content	CO Statement	knowledge level	Delivery method
1	Chemistry – Chemistry of some advanced dyestuff intermediates, agrochemical and pharmaceutical intermediates, chiral chemistry Retrosynthesis Technology – Brief discussion on manufacture of some agrochemical and pharmaceutical intermediates, handling of solvents, solvent recovery, IPR issues	CO1, CO2, CO4	K2 and A1	Chalk and board
2	Chemistry – Chemistry of some perfumery and flavor intermediates Technology – Brief discussion on manufacture of some perfumery and flavor Intermediates	CO3 and CO5	K2 and A2	Chalk and board
3.	Brief discussion on fine chemical industry with examples of some global fine chemical companies	CO2, CO4, CO5	K1 and A2	Chalk and Board

OR

Elective I

Code & Title of the Course	Career options and literature survey
Marks	50
Number of Hours per Week	4
Credits	2
Class	T Y B Tech (Dyes)
Semester	VI

Sr.No.	Topic	**Course Outcome**	**Hrs.**
1	Discussion with invited industry professionals on career options in various functions – manufacturing, R&D, sales, marketing, QA and QC, procurement, technical service, project, personnel	CO1, CO3	32
2	Introduction to literature survey – Dictionary of Organic Compounds, Beilstein, Chemical Abstracts, Colour Index, BIOS and FIAT reports, on-line sources – with individual exercises and presentations	CO2	28

Course Outcome:

CO1: Discussion with industry personnel to understand the developments and opportunities available for future

CO2: Authentic and systematic literature survey and technical finding methods

CO3: Different area of work available and interaction with industry world

Syllabus Structure B. Tech. Final Year

Semester VII (will be of 10 weeks duration)								
Subjects	**Credits**	**Hrs/week**			**Marks for various Exams**			
		L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
Instrumentation and Process Control	3	2	1	0	10	15	25	50
DYT 1105: Technology of cationic and sulfur colorants	4	3	1	0	20	30	50	100
DYT1206; Structural Elucidation of organic compounds	3	2	1	0	10	15	25	50
Elective – II Reaction Mechanism and reagent chemistry **OR** Computational Colour Chemistry	3	2	1	0	10	15	25	50
Humanities / Management Subject I	3	2	1	0	10	15	25	50
Chem. Eng. Laboratory	2	0	0	4	25	-	25	50
DYP 1006: Seminar	2	0	0	4	-	-	50	50
DYP 1007: Project I	4	0	0	8	-	-	100	100
Total	24	11	5	16	-	-	-	500

Semester VIII								
Subjects	**Credits**	**Hrs /week**			**Marks for various Exams**			
		L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
Project Engineering and Economics	3	2	1	0	10	15	25	50
DYT 1106: Case Studies in dyestuff industries	3	2	1	0	10	15	25	50
DYT 1205 : Functional application of organic colorants	3	2	1	0	10	15	25	50
DYT 1107: Technology of pigments	4	3	1	0	20	30	50	100
Elective III: Introduction to green chemistry OR Chemistry of agrochemicals OR Chemistry and Technology of Inorganic pigments	3	2	1	0	10	15	25	50
DYP 1008:Project II	4	0	0	8	-	-	100	100
DYP 1009: Preparation, analysis and application of Dyes, optical brighteners and functional colorants	4	0	0	8	50	-	50	100
Total	24	11	5	16	-	-	-	500

Semester VII

	Course Code: DYT 1105	**Course Title: Technology of Sulphur and Cationic Colorants (Marks 100)**	**Credits = 4**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
	HSC (Science)				
List of Courses where this course will be prerequisite					
	All the Dyes Special Courses				
Description of relevance of this course in the B. Tech. (Dyes) Programme					
Students will be able to understand the chemistry and Technology of Sulphur and Cationic Colorants.					

Sr. No.	Topic	CO Statement	Knowledge level	Delivery method	Teaching Hours
1	Sulphur Dyes, method of application, method of formation. Intermediates used in the manufacture of Sulphur dyes. Solubilized Sulphur Dyes	CO1	K2, A2	Chalk and board, Tutorial	12
2.	Different kinds of cationic dyes – conventional and pendant. Properties of basic dyes. Conversion of disperse dyes into pendant basic dyes and properties of pendant basic dyes.	CO3	K2, K3 & A2	Chalk and board, Tutorial	09
3.	Conventional basic dyes. Diphenylmethane and ketone-imine class. Synthesis. Disubstittuedtriohenylmethane	CO2	K2, K3 & A2	Chalk and board, Tutorial	12

	dyes and trisubstittuedtriphenylmethane dyes.typical synthesis and manufacturing methods.				
4.	Basic dyes for acrylic fibres, rating dyes. Oxidative coupling methods. Synthesis of heterocyclic intermediates	CO2	K2, K3 & A2	Chalk and board, Tutorial	12

COURSE OUTCOMES

CO1: Ability to understand the constitution of Sulphur dyes.

CO2: Ability to structural diversities in cationic dyes.

CO3: Ability to identify the colour changes with different classes of cationic dyes.

CO4: Ability to understand the process in the manufacture of Sulphur dyes.

CO5: Ability to assess the technical importance of cationic dyes and their manufacture.

Recommended books:

1. *Chemistry of Synthetic Dyes and Pigments*, Lubs H. A., Robert E Krieger Publishing Company, New York, 1977

2. *Chemistry of Synthetic Dyes – Vol II*, Venkataraman, K., Academic Press, 1952

3. *Chemistry of Synthetic Dyes – Vol IV*, Venkataraman, K., Academic Press, 1972

6. Color Chemistry –Synthesis, Properties and Applications of Dyes and Pigments, Zollinger H., 2nd ed., Weinheim – VCH, 1991

Assessment method:

8. Unit Test
9. Assignment
10. Seminar
11. Literature survey including patents and research papers.

	Course Code: DYT 1206	**Course Title: Structural elucidation of organic molecular spectroscopy**	**Credits = 4**		
		(Marks 100)	**L**	**T**	**P**
	Semester:VII	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
List of Courses where this course will be prerequisite					
Description of relevance of this course in the B. Tech. Programme					

Sr. No.	Course Contents (Topics and subtopics)	CO Mapping	Delivery method	Teaching Hours
1.	Introduction to spectral methods of analysis. UV-Visible spectroscopy.	CO1, CO2, CO3, CO4	Chalk and board	02
2.	Nuclear Magnetic Resonance Spectroscopy: Principles, some basic terms. Shielding and	CO1, CO2, CO3, CO4	Chalk and board,	09

	de-shielding , chemical shift in ^{1}H-NMR spectroscopy, Magnetic Anisotropy, Spin-Spin coupling and splitting in ^{1}NMR spectroscopy, Coupling constant, analysis of ^{1}H-NMR spectrum.		Tutorial		
3.	IR-Spectroscopy: Basic theory, fingerprint region, treatment to identify functional groups, structure elucidation.	CO1, CO2, CO3, CO4	Chalk and board, Tutorial	08	
4.	Mass spectroscopy: Basic terms and nitrogen rule. Mass Spectral Data, Representation of fragmentation process, factors governing fragmentation process, examples of common types of fragmentation.	CO1, CO2, CO3, CO4	Chalk and board, Tutorial	06	
5.	Combined use of IR, NMR and Mass spectroscopy for structure elucidation.	CO4	Chalk and board, Tutorial	04	
6.	Utility of all chromatographic techniques like GC , HPLC and HPTLC in organic chemistry. Some other advance techniques like GC-MS and LC-MS for self study. X-RAY diffraction and scanning and similar techniques.	CO1, CO2	Chalk and board, Tutorial	01	

Elective II

Reaction mechanism and reagent chemistry

COURSE OUTCOMES

CO1: Ability to identify the classes of organic molecular structure.

CO2: Ability to design synthetic route of different organic molecules.

CO3: Ability to propose the retrosynthetic pathway of different organic molecules.

CO4: Ability to understand the reactivity of different reagents.

CO5: Ability to assess the technical importance of organic mechanism.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks			Total Marks
L	T	Test	C	Theory Marks		Continuous Assessment	
				Mid Sem	End Sem		
3	1	2	3	15	20	15	50

L-Lectures; T-Tutorial; C-Credit

Content:

Sr. No.	Topic	CO Statement	Knowledge level	Delivery method	Teaching Hours
1.	Study of intermediates: Carbocations, carbanions, carbenes, nitrenes, free radicals their stability, formation and reactions.	CO1,CO2,CO 3, CO4, CO5	K3, A2	Chalk and board	7
2.	Discussion on mechanism of organic reactions and problem solving (class work as well assignment): Molecular rearrangements, cyclisation reactions. Reagents used in oxidation and reductions. C-C bond forming reactions, palladium catalysed coupling reaction.	CO1,CO2,CO 3, CO4, CO5	K3, A2	Chalk and board	10
3.	Discussion and revision of concepts – substitution and elimination reactions, electrophilic and nucleophilic aromatic substitution reactions, free radical reaction.	CO1,CO2,CO 3, CO4, CO5	K3, A2	Chalk and board	8
4.	Neighbouring group participation; 1,2 and 1,4 addition to conjugated systems.	CO1,CO2,CO 3, CO4, CO5	K3, A2	Chalk and board	5

Recommended books:

1. Organic Chemistry, Morrison R. T. and Boyd R. N.
2. Mechanism and Theory in Organic Chemistry, Lowry T. H. and Richardson K. S., Harper and Row
3. Fundamentals of Organic Reaction Mechanisms, Harris J. M. and Wamser C. C., John Wiley and Sons
4. The Art of Writing Reasonable Organic Reaction Mechanisms, Grossman R. B., Springer

Assessment method:

1. Unit Test
2. Assignment

OR

Elective II

	Course Code:	**Course Title: Computational Colour Chemistry (50 Marks)**	**Credits = 3**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
Chemical and Physical Constitution of Colorants (Sem III) and Physics and Mathematics courses (Sem I, II, III, IV)					
List of Courses where this course will be prerequisite Computational Material Science (for MTech course), Advanced Computational Methods in Colour Chemistry (for MTech course)					
All Dyestuff and Intermediates Special Courses					
Description of relevance of this course in the B. Tech (Dyes) Programme					

- To make the students understand computational material science in general and computational color chemistry in particular
- To make them understand the physical basis of color of organic molecules of industrial importance.
- To enable them to analyze the early empirical theories of color and chemical constitution relationships of industrial dyes in the light of quantum chemistry.
- To develop in them capacity to understand proper selection of computational strategy for understanding the properties of commercial important organic colorants.

Sr. No.	Topic	CO Statement	Knowledge Level	Delivery Method	Teaching Hours
1	Evolution of computational material science. Early qualitative theories of color and chemical constitution like theory of unsaturation, quinonoid theory. Manifestation of color as an outcome of interaction between electromagnetic radiation and matter.	C1, C5	K1, K2	Marker and Board	04
2	Brief revision of quantum mechanical concepts with special reference to one electron systems. Particle in one-dimensional box treatment and its application to polyene and cyanine dyes. Particle in a ring, sphere and application in understanding the application in the absorption spectra of aromatic hydrocarbons.	C2, C3, C5	K3	Marker and Board	12
3	Beer-Lambert law. Quantitative treatment of strength of absorption of electromagnetic radiation. Absorption cross section. Transition dipole and transition dipole moment. Solvatochromism in colorants and its application to understand the excited state properties of dyes.	C3, C4	K4, K5	Marker and Board, Projector	08
4	Problems associated with the many electron systems. Hartree-Fock formalism for many electron systems.	C2, C5	K2, K3	Marker and Board, Ball and stick model	08
5	Quantum mechanical concepts relevant to	C2,C3	K2	Marker and	06

	the understanding of bonding in organic colorants. Resonance theory, valence bond descriptions. Bond Length Alternation, Bond Order Alternation, Aromaticity and quantum mechanical descriptors of aromaticity.			Board	
6	Semiempirical methods of calculation of absorption spectra. Configuration Interaction Singles. Hartree-Fockmethod in Time Dependent Domain. Density Functional Theory and its Time Dependent formalism.Post- HartreeFock methods.	C4	K5	Marker and Board, Projector	12

	Course Outcomes (students will be able…..)
	1. To understand the basics of color and chemical constitution
	2. To understand basics of computational material science
	3. To analyze the various quantum mechanical tools to understand color of dyes
	4. To know the various methodologies in computational spectroscopy
	5. To identify and benchmark computational methodologies
	6. To understand the functioning of computational spectroscopy related softwares.

Text / Reference Books:

1. J. Griffiths, Colour and Constitution of Organic Molecules, Academic Press, London (1976)

2. J. Fabian, H. Hartmann, Light Absorption of Organic Colorants, Springer-Verlag, Berlin 1980

3. S.M. Bachrach, Computational Organic Chemistry, Wiley, 2014

4. W.Koch, Chemist's guide to Density Functional Theory, Wiley-VCH, 2008

Assessment method:

1. Unit Test
2. Assignment
3. Seminar
4. Literature survey including patents and research paper

Semester VIII

	Course Code: DYT 1106	**Course Title: Case Studies in Dyestuff Technology (Marks : 100)**	**Credits = 4**		
			L	**T**	**P**
	Semester: VIII	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
Description of relevance of this course in the B. Tech. (All Branches)					
	Course Contents (Topics and subtopics)	**Course Outcome**	**Reqd. hours**		

1	Case studies in intermediates and dyes with emphasis on sources of literature and selection of methods.	CO1,CO2	45

List of Text Books/ Reference Books

1. *BIOS Reports*
2. *FIAT Reports*
3. *CIOS Reports*
4. *Organic Synthesis Collective Volumes I-V*

Course Outcome:

CO1: Industry oriented situations for synthesis or isolation of intermediates

CO2: Students will be able to understand practical aspects of selection of suitable methods and isolation techniques

	Course Code: DYT 1205	**Course Title: Functional Applications of Organic Colorants**		**Credits = 3**		
				L	**T**	**P**

	Semester: VIII	Total contact hours: 45		**2**	**1**	**0**

	List of Prerequisite
	List of Courses where this course will be prerequisite
	.
	Description of relevance of this course in the B. Tech./B. Pharm. Program

	Course contents(topics/subtopics)	**Course Outcome**	**Required hrs**
1	Introduction to functional dyes. Indicator dyes, dyes used in other analytical techniques, laser dyes, liquid crystal dyes	**CO1,CO3**	**06**
2	Dyes in photography and electrophotograpy	**CO3**	**08**
3	Dyes for ink jet printing, thermal printing	**CO2**	**04**
4	Dyes used in light harvesting devices like solar cells and other related uses, holography, Imaging	**CO3**	**04**
5	Non linear optical properties of dyes and infrared absorbing dyes	**CO1**	**03**
6	Quasi aromatic fluorescent compounds	**CO2**	**03**
7	Colorants for Photodynamic theory	**CO1, CO3**	**03**

		List of Text Books/ Reference Books
1		Advances in Color Chemistry – Vol I, Peters A. T.
2		Advances in Color Chemistry – Vol II, Peters A. T.
3		Non-Textile Dyes, Freeman H. S.
4		Coloring of Plastics: Fundamentals by Robert A. Charvat John Wiley & Sons, 11-Mar-2005
5		Coloring of plastics: theory and practice by M.Ahmad Van Nostrand Reinhold, 1979

6		Coloring of plastics: theory and practice by M.Ahmad Van Nostrand Reinhold, 1979
	Course Outcomes (students will be able to.....)	
1		To have a broad idea about functional applications of dyes
2		To understandunderlying properties for their application in commercial product
3		To know various colorants based on specific molecule engineering

Subject Code: 1009			Credit	Subject: **Chemistry and Technology of pigments** **(100 Marks)**		Total Marks
L	T	Test	C	Theory Marks	Continuous Assessment	

				Mid Sem	End Sem		
4	2	0	3	30	20	15	100

Course Syllabus

Sl.No.	Contents	Hrs.
1	Introduction to pigments, colour and physical constitution, optical properties of pigments, crystalline modifications and other basic properties	10
2	Chemistry – Lake pigments, condensation pigments, arylide pigments, copper phthalocyanine, benzimidazolone pigments, vat pigments, quinacridone pigments. Technology – manufacture of some of the above pigments	10
3	High performance pigments, dioxazine pigments, diketopyrrolopyrrole pigments, perylene pigments and other condensed heterocyclic pigments, quinophthalone pigments, azamethine pigments, thiazine pigments	20
4	Heterocyclic analogues of conventional pigments, luminescent pigments	5
5	Pigment finishing and standardisation. Newer Technologies of pigment processing. Latent Pigment Technology. Pigment Flush.	5
6	Pigments in organo electronics and other modern applications. Pigments for printing inks, ink jet printing and other applications.	10

Reference Books:

1. Chemistry of Synthetic Dyes – Vol II, Venkataraman K., Academic Press, New York, 1952

2. Industrial Organic Pigments – Production, Properties, Applications, Herbst W. and Hunger K., VCH Verlag, Weinheim, 1997.

3. High Performance Pigments, Smith H. M.

At the end of this course you will be able to:

- *CO1; Differentiate* between dyes and pigments
- *CO2: Conceptualize* the basic pigmentary properties like hue, tinctorial strength, blooming, bleeding, stability, optical properties, polymorphism, etc.
- *CO3: Classify* the pigments based on chemical constitution and color

- *CO4: Correlate* and predict various application properties of pigments
- *CO5: Describe* and *apply* the standardization and after treatment methods of pigments
- *CO6: Propose* synthetic routes for different pigments

Course Prerequisite: The student should have cleared B.Tech sixth semester from the Dyestuff Technology Department

Course Objectives: The following are the course objectives-

- To have a clear idea about the basic differences between dyes and pigments
- To know about the concepts of various pigmentary properties
- Aware of the various classes of organic pigments and their synthetic routes
- Be familiar with the standardization techniques and finishing treatments of organic pigments

Plan for course delivery

Sl. No.	Course Content	CO Statement	Knowledge level	Delivery method	No. Of Hours to be handled
1	Introduction to pigments, colour and physical constitution, optical properties of pigments, crystalline modifications and other basic properties	CO1, CO2	K1, K2, A1 and A2	Chalk and board	5
2	Chemistry – Lake pigments, condensation pigments, arylide pigments, copper phthalocyanine, benzimidazolone pigments, vat pigments, quinacridone pigments.	CO3, CO4	K1, K2, K3, A1 and A2	Chalk and board	8
3	High performance pigments, dioxazine pigments,	CO3, CO4	K1, K2, K3,	Chalk and	8

	diketopyrrolopyrrole pigments, perylene pigments and other condensed heterocyclic pigments, quinophthalone pigments, azamethine pigments, thiazine pigments		A1 and A2	board	
4	Heterocyclic analogues of conventional pigments, luminescent pigments	CO3, CO4	K1, K2, K3, A1 and A2	Chalk and board	2
5	Pigment finishing and standardisation	CO5	K1, K2, K3, A1 and A2	Chalk and board	3
6	Technology – manufacture of some of the above pigments	CO6	K3 and A3	Chalk and board	4

	Course Code: Elective III	**Course Title: Technology of Pigments**	**Credits = 3**		
		(50 marks)	**L**	**T**	**P**
	Semester:	**Total contact hours: 30**	**2**	**1**	**0**
List of Prerequisite Courses					

List of Courses where this course will be prerequisite
Department of Dyestuff Technology
Description of relevance of this course in the B. Tech (Dyes) Programme
• To give students the information on general properties of inorganic pigments. • To enable students to gain knowledge on white, colored, black, and special effect inorganic pigments that are used in commercial product. • In addition, to make student understand the underlying properties of a pigment behindtheir particular application. • To enable them to knowtheraw materials available for the production of pigments, method for production, analysis and handling, and related toxicology.

Sr. No.	Topic	CO Statement	Knowledge Level	Delivery Method	Teaching Hours
1	Introduction to inorganic pigment;Their classification,Fundamental aspects of their chemical and physical properties;Introduction to general method of determination of inorganic pigment.	C1	K2, K3	Marker and Board	07
2	White Pigments based on Titanium Oxide, Zinc oxide, and Zinc Sulfide; properties, production, raw materials, application in commercial products, and toxicology	C2	K3	Marker and Board	06
3	Various colored pigments on metal oxides and hydroxides; synthesis, properties, uses and economic aspects	C3	K3	Marker and Board, Projector	08
4	Natural source and commercial production of black pigments; Chemical and Physical properties of black pigments;their application in Paints, Plastics, and Printing inks; Detailed Safety issues and,Toxicology	C4	K2	Marker and Board	05
5	Inorganic pigments with special properties for examples Magnetic pigment, Luminescent pigments, Transparent pigments, Electroluminescent pigments, Special effect	C5	K2	Marker and Board	04

	pigments, etc.				

CO statement:**Course Outcomes (students will be able…..)**	
	To have a broad idea onphysical and chemical properties of inorganic pigments
	To understandunderlying properties of white inorganic pigment for their application in commercial product
	To know various colored pigments based on metal oxide and hydroxide
	. To gain knowledge onproperties, production, applicationof various inorganic black pigments
	. To gain knowledge on inorganic pigments that possess special properties

Text / Reference Books:

1. Industrial Inorganic Pigments Edited by G. Buxbaum and G. Pfaff, Wiley VCH

Assessment method:

1. Unit Test
2. Assignment
3. Seminar
4. Literature survey including patents and research paper

Elective III

Subject: Technology of Agrochemicals

Code & Title of the Course	DYT
Marks	50
Number of Hours per Week	3
Credits	2
Class	B Tech (Dyes)
Semester	VIII (Elective)

Course Outcome

At the end of this course you will be able to:

- **CO1:** *Define* and *state* different terminologies related to agrochemicals
- **CO2:** *Describe* and *explain* the general requirements for pesticides design, their formulation techniques, application procedures and residue analysis
- **CO3:** *Classify and differentiate* agrochemicals based on application and chemical constitution
- **CO4:** *Outline* the synthesis of various commercially important pesticides
- **CO5:** *Justify* and *illustrate* the potential environmental risk and involvement of green chemistry and pest management strategies in agro chemistry

Detailed Syllabus:

1. **General Introduction**: Definition, importance & classification of agrochemicals. Classification of pesticides on chemical nature and according to target species, mode of action. Classification of insects and pests-Public health pests/Agricultural pests/Domestic pests/Animal husbandry pests/Plant pests etc. Toxicity (acute and chronic toxicity in mammals, birds, aquatic species etc.). Causes of outbreak of pest growth & development. Insect pest control in agro chemistry-Principle and practices. [3]
2. **Pesticide Formulations, Techniques and Analysis**- General aspects: definition, objectives, process, purpose, product spectrum, classification, formulation codes etc. Equipment used in preparation of formulations. Precautions in the use of pesticides.A brief introduction on methods of analysis of physical properties of formulations- Suspensibility, wettability, Emulsion

stability, wet sieve test, acidity, alkalinity, moisture content, Flash Point, Specific gravity, Persistent foaming, water runoff test, dry sieve test etc. Regulations and Quality- Brief introduction on the packaging of pesticide products. Pesticide application techniques and devices used – Dusters and sprayers, types of nozzles etc. Calculation of amount of formulation required for field application. [5]

3. **Pesticides Synthesis and Manufacturing Technology**- Retrosynthesis of Agrochemicals. Following classes of pesticides are to be studied -Hydrocarbons, Halogenated hydrocarbons, carboxylic acids, phenols, amines, amides, aryloxycarboxylic acids, organophosphorous, heteroaromatic pesticides etc. Important reactions namely Michaelis-Arbuzov reaction, Perkow reaction, Thiono-thiolo rearrangement involved in the preparation, properties of important pesticides. Manufacturing processes of some commercially important pesticides. [10]
4. **Pesticides and Environmental Risk Assessment**: Movement, Degradation and Metabolism of Pesticides-Theory Movement and fate of pesticides in environmental components like soil, air, water, flora and fauna, and other non-target organisms. Fate and adverse effects of pesticides on them. Decontamination of pesticides through physical, chemical, photochemical, microbial, enzymatic and biotechnological techniques. Ground water decontamination; Movement in plant, animal and other living systems: Penetration, translocation, excretion etc. Persistence – factors affecting (physical, chemical, biochemical etc.), primary and secondary metabolites in plants and animals with examples. Different methods of pesticide disposal (physical, chemical, incineration and soil treatment). Disposal of industrial effluents and related xenobiotics. [3]
5. **Pesticidal Residue Analysis and analytical Techniques in Pesticide Chemistry**- Application of analytical techniques for residue analysis such as spectrophotometry, chromatography including GC, HPLC, GC-MS, LCMS and ELISA etc. [5]
6. **Recent advances in pest control:** Green Chemistry in pesticides- insect attractants, chemosterilents and repellents, mode of action and Applications. Tactics and strategies of Integrated Pest Management. Management of insects and diseases in stored agricultural commodities, side effects of applications etc. [2]

Sl. No.	Course Content	CO Statement	Knowledge level	Delivery method	No. Of Hours to be handled
1	General Introduction	CO1, CO2, CO3	K1, K2, K3	Chalk board	5
2	Pesticide Formulations, Techniques and Analysis	CO1, CO2, CO3	K1, K2, K3	Chalk board	5
3	Pesticide Synthesis and	CO4	K1, K2, K3,	Chalk board	10

	Manufacturing Technology		K4		
4	Pesticides and Environmental Risk Assessment	CO5	K1, K2, K3, S3	Presentation, Assignments and Chalk board	3
5	Pesticidal Residue Analysis and analytical Techniques in Pesticide Chemistry	CO3	K1, K2 and K3	Chalk board	5
6	Recent advances in pest control	CO5	K1, K2 , K3 and S3	Presentation, Assignments and Chalk board	2

Reference Books:

1. N. N. Melnikov: *Chemistry of Pesticides (English) Springer.*
2. M. B. Green, G. S. Hartley, T. F. West, *Chemical for Crop Improvement and Pest Management (Pergamon).*
3. R. Clemlyn: *Pesticides.*
4. K. H. Buchel: *Chemistry of Pesticides*.
5. H. B. Scher: *Advances in pesticides formulation Technology. ACS, NO.254*.
6. J. Miyamamoto & P.C. Jearney : *Pesticide Chemistry Vol. IV (Pergamon).*
7. W. Valukenburg : *Pesticide formulations (Dekker).*
8. Shree Ramulu: *Methods of Pesticide Analysis*
9. M. B. Green, G. S. Hartley and T. F. West: *Chemicals for crop Improvement and pest management (Pergamon).*
10. N. B. Scher: *Controlled releases Pesticides ACS Sypm. No. 53*.
11. N. E. Cardarelli: *Controlled Released Pesticides Formulation CRC.*
12. Kydonius: *Controlled release formulation. Technologies, CRC.*
13. H. A. Moye: *Analysis of pesticide residues*
14. G. S. Dhaliwal and R. Arora.: *Principles of insect Pest Management.*
15. R.T.Gahukar: *Neem in plant protection: Agri-Horticultural Pub. Nagpur, 2003.*
16. P.S.Marg, G.K.Kohn, J.J.Menn : *Pesticide Synthesis*

Assessment:

- Class Assignment
- Mid-Sem Exam
- End-Sem Exam

OR

Elective III

Introduction to Green Chemistry

Type of course: Dyestuff Technology Subject

Prerequisite: Industry visits for unit process study

Rationale: To introduce various existing processes and technology of Dyes and pigment field to students.

Teaching and Examination Scheme:

Marks	**50**
Number of Hours per Week	**2 + 1**
Credits	**3**
Class	**Final Year B Tech (Dyes)**
Semester	**2**

Content:

Sr. No.	Topic	Teaching Hours
1.	Philosophy of the environment, sustainable development and Green Chemistry, need of Green Chemistry, 12 principles of Green Chemistry, waste minimization and atom economy, atom economic and atom uneconomic reactions	6
2.	Chemical practice and solvent usage, need for alternative solvents, water and renewable solvents, room temperature ionic liquids, applications of supercritical fluids and fluorous solvents, 'solvent free' chemistry	8
3.	History of chemistry and Green Chemistry, emergence of green	8

	synthesis, dyes industry and Green Chemistry, reduction of energy requirement, reduction of risk and hazard.	
4.	Catalysis and Green Chemistry, heterogeneous catalysis, homogeneous catalysis, phase transfer catalysis, biocatalysis, photocatalysis	8

Reference Books:

- Solvent-free Organic Synthesis, Tanaka K., WILEY-VCH, Verlag, 2003.
- Green Solvents for Chemistry: Perspectives and Practice, Oxford University Press, U.K., 2003.
- Green Chemistry: Theory and Practice, Anastas P. T. and Warner J. C., Oxford University Press, U.K., 1998.
- Introduction to green Chemistry, Matlack A. S., Marcel Dekker, Inc., New York, 2001.
- Green Chemistry: An Introductory Text, Lancaster M., Royal Society of Chemistry, Cambridge, U.K., 2002

List of assignments and Open Ended Projects:

1. Literature survey including patents and research papers of fundamental green based process

- Design based small project **or**

- Study report based on latest scientific development **or**

- Presentations based on topics given

These can be done in a group containing maximum **three** students in each.

2. Evaluation based on presentations and discussions

Course Outcome: After learning the course the students should be able:

CO1. Green aspects of chemistry

CO2. Utility and modification of processes to have green and better environmental protective aspect

CO3. Safer and healthy atmosphere building

Table 2

Sl. No.	Course Content	CO Statement	knowledge level	Delivery method
1	Philosophy of the environment, sustainable development and Green Chemistry, need of Green Chemistry, 12 principles of Green Chemistry, waste minimization and atom economy, atom economic and atom uneconomic reactions	CO1 and CO2	K2 and A1	Chalk and board
2	Chemical practice and solvent usage, need for alternative solvents, water and renewable solvents, room temperature ionic liquids, applications of supercritical fluids and fluorous solvents, 'solvent free' chemistry	CO1 and CO2	K2 and A2	Chalk and board

3	History of chemistry and Green Chemistry, emergence of green synthesis, dyes industry and Green Chemistry, reduction of energy requirement, reduction of risk and hazard.	CO1, CO3	K1, A1	Chalk and board
4	Catalysis and Green Chemistry, heterogeneous catalysis, homogeneous catalysis, phase transfer catalysis, biocatalysis, photocatalysis	CO1, CO2, CO3	K1 and A2	Chalk and board

Preparation, Analysis and Application of Dyes, Intermediates, Optical Brighteners and Functional Colorants

Code & Title of the Course	DYP1009
Marks	100
Number of Hours per Week	8
Credits	4
Class	Final Year B Tech (Dyes)
Semester	VIII

Course Outcome

At the end of this course you will be able to:

- **CO1***: Comprehend* the fundamental knowledge of dyes and intermediates
- **CO2:** *Conduct* experiments in the lab independently for the synthesis of dyes, intermediates and optical brightners and *analyse* the products
- **CO3:** *Execute* the process with utmost efficiency and precession
- **CO4:** *Construct* the experimental setup for the unit process according to the procedure
- **CO5:** *Complete* each experiments within stipulated time

Detailed Syllabus

Sl. No.	Detailed Syllabus	List of Experiments	Hours

1	Preparation, analysis and application of some intermediates	• *Preparation of p-Nitroso N,N-dimethyl aniline Hydrochloride.* • *Synthesis of Benzocoumarin* • *Preparation of p-Amino acetanilide* • *Synthesis of para-dimethyl amino benzaldehyde* • *Synthesis of 1,2,4-Acid* • *Diamino stilbene disolphonic acid*	40
2	Preparation, analysis and application of some dyes	• *Preparation of Indophenol blue* • *Synthesis of Acid Blue 40* • *Metal complex dyes* • *Synthesis of Xanthene dyes* • *Preparation of dis azo dye* • *Synthesis of Azo coumarin dye* • *Synthesis of Malachite Green*	40
3	Preparation, analysis and application of some optical brighteners	• *Preparation of DNSDA* • *Preparation of DASDA* • *Preparation of triazine based optical brightner*	20
4	Preparation, analysis and application of some functional colorants	• *Preparation of coumarin based functional colorants*	20

Sl. No.	**Course Content**	**CO Statement**	**Knowledge level**	**Delivery method**	**No. Of Hours to be handled**
1	Preparation, analysis and application of some dyes	CO1, CO2, CO3, CO4, CO5	K1, K2, K3, K4, K5, K6 S3	Laboratory Practical	40
2	Preparation, analysis and application of some intermediates	CO1, CO2, CO3, CO4, CO5	K3, K4, K5, K6 S3	Laboratory Practical	40
3	Preparation, analysis and application of some optical brighteners	CO1, CO2, CO3, CO4, CO5	K3, K4, K5, K6 S3	Laboratory Practical	20

4	Preparation, analysis and application of some functional colorants	CO1, CO2, CO3, CO4, CO5	K3, K4, K5, K6 S3	Laboratory Practical	20

Assessment methods:

3. Viva
4. Assignment
5. Practical

Recommended books:

Fundamental Processes Of Dye Chemistry by Hans Eduard Fierz-David And Louis Blangey