NEW SYLLABUS

STRUCTURE OF THE CURRICULUM

for

BACHELOR OF TECHNOLOGY

in

DYESTUFF TECHNOLOGY

Department of Dyestuff Technology
Institute of Chemical Technology
Mumbai – 400019
JULY 2021

Preamble:

The undergraduate programmes at the Institute of Chemical Technology are reputed worldwide. Alumni from these programmes have found a place of pride in the Indian chemical industry including some top names and many as entrepreneurs, in Universities/ Institutes and Research Organisations throughout India and the world. The B.Tech. programmes in the then Department of Chemical Technology, University of Mumbai started in 1934 as post B.Sc., second graduation as B.Sc.(Tech.). Keeping national, societal needs in focus, post-independence, the programme grew into multiple branches keeping connection with chemical engineering content. Once the Institute became a university in 2009, these became independent B. Tech. Programmes retaining their dual core nature. The Institute of Chemical Technology is committed to keeping its syllabi updated and globally relevant for the industry. We have revamped the syllabi of all the B. Tech. programmes now in 2021. The 205 credit programmes each have around 6% humanities, 23% basic sciences, 8% engineering sciences, 12% chemical engineering plus 51% special subjects.

All the courses are credit based and the evaluation are grade based. The credit system is a systematic way of describing an educational programme by attaching credits to its components. The definition of credits is based on student workload, learning outcomes and contact hours. This system is described in detail in Regulation No.9 of the Institute. Each theory course consists of Lectures and tutorials. During tutorial session, it is expected that the problem solving / case studies / relevant real-life applications / student presentations / home assignments/individual or group projects are discussed in the presence of the teacher. Teacher can have the freedom to interchange lectures / tutorials depending upon the topic. Institute gives emphasis on continuous evaluation with considerable freedom to the teacher in deciding the mode of evaluation.

B. Tech. (Dyestuff Technology)

PROGRAMME EDUCATIONAL OBJECTIVES for B. Tech. (Dyestuff Technology)

Sr. No.	Program Education Outcomes
PEO-1	Our graduates are expected to think critically, creatively and apply the fundamentals of chemistry, applied technology and engineering to chemical and allied industries, especially the dyestuff industry, for the benefit of country in

	general, economy, society, and environment.
PEO-2	Our graduates are expected to adopt to evolving technologies and stay in tune with current needs of the country and society
PEO-3	Our graduates are expected to work for implementation of new technologies for the benefit of mankind in general, economy, society & environment in particular
PEO-4	Our graduates are expected to be innovative and have good entrepreneurship, communication, interpersonal and managerial skills

Programme Outcomes (POs) for B. Tech. (Dyestuff Technology.)

PO1	Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
PO6	The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
PO10	Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	Life-long learning: Recognize the need for and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO1	Specialization in the synthesis, analysis and application and knowledge of dyeing techniques: Our graduates will be totally in tune with the current needs of the dyestuff industry and have considerable problem-solving acumen.
PSO2	Core organic chemistry, technology development and implementation: Our graduates have strong foundation in chemistry, and thus combined with their engineering skills and independent ability to develop new dyestuff and allied chemical industry related technologies and successfully implement them at an industrial scale.

Syllabus Structure B. Tech. First Year									
Semester I									
Course Code	**Subjects**	**Credits**	**Hrs/Week**			**Marks for various Exams**			
			L	**T**	**P**	**C.A.**	**M.S.**	**E. S.**	**Total**
CHT1137	Organic Chemistry I	3	2	1	0	10	15	25	50
CHT1341	Physical Chemistry-I	3	2	1	0	10	15	25	50
CHT1139	Industrial Inorganic Chemistry	3	2	1	0	10	15	25	50
MAT1101	Applied Mathematics-I	4	3	1	0	20	30	50	100
PYT1101	Applied Physics-I	4	3	1	0	20	30	25	100
GEP1113	Engineering Graphics and Elementary AutoCAD	4	2	0	4	50	-	50	100
CHP1343	Physical and Analytical Chemistry Laboratory	2	0	0	4	25	-	25	50
	TOTAL:	**23**	**14**	**5**	**8**				**500**
Semester II									
Subject Code	**Subjects**	**Credits**	**Hrs/week**			**Marks for various Exams**			
			L	**T**	**P**	**C.A.**	**M.S.**	**E. S.**	**Total**
CHT1401	Analytical Chemistry	3	2	1	0	10	15	25	50
CHT1342	Physical Chemistry-II	3	2	1	0	10	15	25	50
CHT1138	Organic Chemistry II	3	2	1	0	10	15	25	50
PYT1103	Applied Physics-II	3	2	1	0	10	15	25	50
MAT1102	Applied Mathematics-II	4	3	1	0	20	30	50	100
CET1507	Process Calculations	4	3	1	0	20	30	50	100
PYP1101	Physics Laboratory	2	0	0	4	25	0	25	50
CHP1132	Organic Chemistry Laboratory	2	0	0	4	25	-	25	50
HUP1101	Communication Skills	2	0	0	4	50			50
	TOTAL:	**26**	**14**	**6**	**12**				**550**
Syllabus Structure B. Tech. Second Year									
Semester III									
Subject Code	**Subjects**	**Credits**	**Hrs /week**			**Marks for various Exams**			
			L	**T**	**P**	**C.A.**	**M.S.**	**E.S.**	**Total**
BST1110	Basics of Biology and Applications to Technology	3	2	1	0	10	15	25	50
GET1110	Basics of Mechanical Engineering	3	2	1	0	10	15	25	50
DYT 1101	SPL1: Technology of intermediates I	4	3	1	0	10	15	50	100
CET 1704	Material Technology	3	2	1	0	10	15	25	50

OLT 1102	Chemistry of Oleochemicals and Surfactants	4	3	1	0	20	30	50	100
PYT 1202	Colour Physics and Colour Harmony	3	2	1	0	10	15	25	50
DYP 1001	Pr 1: Analysis of Inorganic Raw Materials used in Dyestuff industries	2	0	0	4	25	0	25	50
PYP 1203	Pr 2: Color physics	2	0	0	4	25	0	25	50
	TOTAL:	24	14	6	8				500

Semester IV

Subject Code	Subjects	Credits	Hrs/week			Marks for various Exams			
			L	T	P	C. A.	M.S.	E. S.	Total
GET1117	Engineering Mechanics and Strength of Materials	3	2	1	0	10	15	25	50
CET1105	Transport Phenomena	4	3	1	0	20	30	50	100
GET1105	Electrical Engineering and Electronics	3	2	1	0	10	15	25	50
DYT 1102	SPL2: Technology of intermediates-II	4	3	1	0	20	30	50	100
DYT 1202	SPL3: Chemical and Physical Constituents of Colorants	3	2	1	0	10	15	25	50
DYT 1107	SPL4: Technology of quinonoid intermediates	3	2	1	0	10	15	25	50
GEP1106	Electrical Engineering and Electronics Laboratory	2	0	0	4	-	-	25	50
MAP1201	Computer Applications Laboratory	2	0	0	4	-	-	25	50
	TOTAL:	24	14	6	8				500

Syllabus Structure B. Tech. Third Year

Semester V

Subject Code	Subjects	Credits	Hrs /week			Marks for various Exams			
			L	T	P	C. A.	M.S.	E. S.	Total
CET1401	Chemical Engineering Operations	3	2	1	0	10	15	25	50
CET1212	Chemical Reaction Engineering	3	2	1	0	10	15	25	50
DYT 1103	SPL5: Technology of azo colorants	4	3	1	0	20	30	50	100
DYT 1207	SPL6: Chemistry and Technology of quinonoid colorants	3	2	1	0	10	15	25	50
DYT 1206	SPL7: Structural Elucidation of organic compounds	3	2	1	0	10	15	25	50
MAT1106	Design and Analysis of Experiments	4	2	2	0	20	30	50	100
DYP 1002	Pr 3: Analysis of Intermediates, Dyes and Fibers	4	0	0	8	50	0	50	100
DYP 1013	Pr 4: Chromatographic techniques	2	0	0	4	50	0	25	50
	TOTAL:	26	13	7	12				550

Semester VI

	Subjects	Credits	Hrs/week			Marks for various Exams			

Subject Code			L	T	P	C.A.	M.S.	E. S.	Total
DYT 1105	SPL8: Technology of cationic and sulfur colorants	4	3	1	0	20	30	50	100
DYT 1203	SPL9: Fluorescent colorants	4	3	1	0	20	30	50	100
TXT 1215	SPL10: Technology of dyeing and printing	3	2	1	0	10	15	25	50
HUT1103	Industrial Psychology & Human Resource Management	3	2	1	0	10	15	25	50
HUT1106	Environment Science and Technology	3	2	1	0	10	15	25	50
	Institute Elective – I (Annexure A)	3	2	1	0	10	15	25	50
DYP 1006	Seminar	3	0	0	6	0	0	0	50
DYP 1014	Pr 5: Preparation of intermediates	2	0	0	4	25	0	25	50
DYP 1003	Pr 6: Experimental dyeing	2	0	0	4	25	0	25	50
	TOTAL:	27	14	6	14				550
	In-plant Training of 8 to 10 weeks after end of semester								

Internship

• After the end of the sixth semester examination and before the start of the seventh semester, every student will have to undergo an internship. The Internship would be of 6 credits.

• The internship (preferably Industrial Internship) would be assigned to the student by the Departmental Internship Coordinator, with the approval of the Head of the Department.

• The total duration of the internship would be for a period equivalent to 12 Calendar weeks. This period typically start from 1st May and end before 30th July every year. This means the end
semester examination of T. Y. Tech (Semester VI) should be completed by 25th April every year. The Semester VII (4th Year B.Tech.) should commence w.e.f. 1st Aug every year. The internship may be completed in one or more organizations as described below.

• The internship could be of the following forms:

(i) Industrial internship in a company (within India or Abroad) involved in R & D/design/manufacturing (QA/QC/Plant Engineering/Stores and Purchase)/marketing/finance/consultancy/Technical services/Engineering / Projects, etc.

(ii) Research internship in reputed Institutes (within India or Abroad) like, ICT, IITs, NITs, IISC, NCL, IICT etc.

• At the end of the internship, each student will submit a written report based on the work carried Out during the Internship. The report will be countersigned by the Supervisor from Industry/ Institute as the case may be.

• Performance of the student will be assessed based on the written report and a presentation to a committee consisting of two faculty members from the Department.

• Students will be assigned a grade based on the written report and a presentation; evaluated by a committee of faculty members.

Syllabus Structure B. Tech. Final Year

Semester VII

Subject Code	Subjects	Credits	Hrs/week			Marks for various Exams			
			L	T	P	C. A.	M.S.	E.S.	Tot al
CET1703	Chemical Process Control	3	2	1	0	10	15	25	50
DYT 1204	SPL11: Heterocyclic intermediates and colorants	3	3	1	0	10	15	25	50
DYT 1205	SPL12: Functional application of colorants	3	2	1	0	10	15	25	50
	Institute Elective- II: (Annexure B)	3	2	1	0	10	15	25	50
DYP 1012	In-plant Training	6	0	0	0	10	15	25	50
HUT1203	Industrial Management	4	3	1	0	20	30	50	100

CEP1714	Chemical Engineering Laboratory	2	0	0	4	25	-	25	50
DYP 1511	Pr 7: Preparation of dyes	2	0	0	4	25	0	25	50
DYP 1007	Project I	2	0	0	4	0	0	0	50
	TOTAL:	28	12	6	12				500

Semester VIII

Subject Code	Subjects	Credits	Hrs /week			Marks for various Exams			
			L	T	P	C.A.	M.S.	E. S.	Total
CET1504	Chemical Project Engineering and Economics	3	2	1	0	10	15	25	50
DYT 1106	SPL13: Case studies in dyestuff industry	4	3	1	0	20	30	50	100
DYT 1108	SPL14 : Technology of inorganic pigments	3	2	1	0	10	15	25	50
DYT 1109	SPL15: Technology of organic pigments	3	2	1	0	10	15	25	50
	Program Elective: (Annexure C)	3	2	1	0	10	15	25	50
	Pre-approved Open Electives from MOOOCs/NPTEL	3	2	1	0	10	15	25	50
DYP 1008	Project II	4	0	0	8	0	0	0	100
DYP 1009	Pr 8: Preparation, analysis and application of dyes, optical brighteners and functional colorants	4	0	0	8	50	0	50	100
	Total	27	13	6	16				550

Semester I

	Course Code: CHT1137	Course Title: Organic Chemistry - I	Credits = 3		
			L	T	P
	Semester: I	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

This is a Basic Organic Chemistry Course. The Organic Chemistry studied at HSC is the basis for building up Advanced Organic Chemistry knowledge.

List of Courses where this course will be Prerequisite

Organic Chemistry – II, Biochemistry and several Special Subjects of individual departments

Description of relevance of this course in the B. Tech. (Pharm. Chem. Tech.) Programme

To acquaint the students with IUPAC and other types of Nomenclature of organic compounds, fundamentals of Organic Chemistry including reaction mechanisms, organic transformations, types of reactions, selectivity of chemical transformations, etc., stereochemical implications of organic reactions, functional group identification and reactions

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**a. IUPAC Nomenclature of Organic Compounds**	3
	b. Reactive intermediates Carbocations, Carbanions, Carbon radicals and Carbenes – Generation, Structure, Stability and Reactions	5
2	**Stereochemistry of Organic Compounds** containing one and two asymmetric carbon atoms, Stereo descriptors – R/S, E/Z, erythro and thero, Conformation – Ethane and butane Enantiomers and Diastereomers, meso compounds, different representations of stereoisomers – Saw-horse, Newmann, Wedge and dash and Fischer and their interconversions	8
3	**Haloalkanes** Aliphatic Nucleophilic Substitution Reactions: S_N1, S_N2 Elimination Reactions: E1, E2	7
4	**Chemistry of Carbonyl Compounds** Concept of acidity and tautomerism of carbonyl compounds, General methods of preparation and Nucleophilic Addition reactions Enolate chemistry, Aldol and related condensation reactions, Michael reaction, Robinson annulation, Claisen condensation, Dieckmann condensation, Mannich reaction	9
5	**Chemistry of Aromatic Compounds** Hückel rules, Aromatic, Non-aromatic and Anti-aromatic compounds, Benzenoid and non-benzenoid aromatic compounds	3
6	**Electrophilic Aromatic Substitution Reactions** Nitration, Halogenation, Alkylation, Acylation and Sulfonation Activating, deactivating and orienting effects of functional groups in mono- and poly-substituted benzenes Friedel-Crafts alkylation, Acylation, Gattermann, Gattermann-Koch, Riemer-Tiemann reactions	10
	Total	**45**

List of Text Books/Reference Books

1	Clayden, J., Greeves, N., Warren, S.; Organic Chemsitry; 2nd ed.; Oxford University Press (2012)
2	Graham Solomons, T. W.; Fryhle, Craig B.; Snyder, Scott A. Organic Chemistry; 12th Ed.; John Wiley & Sons. Inc. (2016)
3	Smith, M. B.; March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure; 7th ed.; Wiley, India (2015)
4	Carey F. A., Sundberg, R. J. Advanced Organic Chemistry: Part A: Structure and Mechanisms; 5th ed.; Springer (2005)

5	Carey F. A., Sundberg, R. J.; Advanced Organic Chemistry: Part B: Reaction and Synthesis; 5th ed.; Springer (2007)
6	Wade, L. G.; Simek, J. W.; Singh, M. S. Organic Chemistry; 9th Ed.; Pearson Education (2019)
7	Eliel, E. L. Stereochemistry of Carbon Compounds; Mcgraw-Hill (2001)
8	Bruice, Paula, Y. Organic Chemistry; 8th Ed.; Pearson Education (2020)

Course Outcomes (Students will be able to…..)	
CO1	draw structures of organic compounds and write their IUPAC names correctly (K2)
CO2	appreciate the stereochemical implications of organic compounds and visualize and appreciate chirality concept (K2)
CO3	understand organic chemistry reactions related to aliphatic as well as aromatic compounds as well as decipher the outcome of a given organic transformation (K3)
CO4	interpret and analyze reactions having different functionalities, deduce and solve problems related to the reactions as well as apply them, if need be (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO3	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO4	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: CHT1341	**Course Title: Physical Chemistry - I**	**Credits = 3**		
			L	**T**	**P**
	Semester: I	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

Standard XII Chemistry

List of Courses where this course will be Prerequisite

Physical and Analytical Chemistry Laboratory (CHP1343), Physical Chemistry - II (CHT1342)

Description of relevance of this course in the B. Tech. Programme

The course will enable the students to understand and apply the principles of thermodynamics to real-world systems. The students would be able to apply the insights to understand the stability of solutions, spontaneity of physical/chemical processes, effect of thermodynamics parameters on phase and chemical equilibria, etc.

Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
1	**Introduction -** Thermodynamic systems, Work, Heat and Energy, State and Path functions, Intensive and Extensive variables	3
2	**First Law of Thermodynamics -** Enthalpy and heat capacities, Application of First Law to gases, Standard states, Enthalpy changes of chemical and physical conversions, Thermochemistry – Hess's Law	6
3	**Second and Third Laws of Thermodynamics -** Statements and applications of Second Law of thermodynamics, Clausius inequality, Entropy as a state function, Entropy changes for reversible and irreversible processes, Entropy and probability Third Law of Thermodynamics, Absolute entropies, Verification of Third Law	6

4	**Spontaneous Process and Equilibrium -** Combined statement of First and Second Laws of thermodynamics, Helmholtz and Gibbs free energy, Spontaneity and Free energy, Maxwell's relations, Effect of T and P on free energy, Van't Hoff equation, Free energy and equilibrium constant, Ellingham diagrams	7
5	**Multicomponent Systems -** Free energy and entropy of mixing, Partial molar quantities and chemical potential, Gibbs Duhem equation	5
6	**Phase Equilibria -** Gibbs Phase rule, Clausius- Clapeyron equation, Stability of phases, First and second order phase transitions, Phase diagrams of one and two two-component systems, l-L systems - TC, PC phase diagrams, distillation and azeotropes, L/S systems, S/S – eutectics and deep eutectics, Phase diagram of three-component systems	3
7	**Equilibrium in Solutions –** Ideal and non-ideal solutions, Henry's law and Raoult's law, Colligative properties Solubility Equilibria – Solubility constant, Common ion effect, Effect of added salts on solubility, pH, Weak and strong acids and bases, Buffer solutions, Ionic solutions, Activity and activity coefficients, Thermodynamic properties of electrolytes in solutions	6
8	Chemical Equilibria - Equilibrium constants, Le Chaterlier's principle, Effect of temperature, pressure and composition on equilibrium	6
9	Electrochemistry – Thermodynamics of electrochemical systems - Types of electrochemical cells, Determination of electrode potentials, Activity and activity coefficients, Dissociation of electrolytes, Ionic equilibria	3
Total		**45**
List of Text Books/Reference Books		
1	Atkins, Peter W.; Paula, Julio de; Keeler, James. Atkin's Physical Chemistry; 11th Ed.; Oxford University Press (2018)	
2	Atkins, Peter W.; Paula, Julio de. Elements of Physical Chemistry; 7th Ed.; Oxford University Press (2017)	
3	Levine, Ira. Physical Chemistry; 6th Ed.; McGraw-Hill Education (2009)	
Course Outcomes (Students will be able to…..)		
CO1	comprehend the laws of thermodynamics and related concepts and to explain the molecular basis for the same (K2)	
CO2	apply the concepts of partial molar quantities to explain the behaviour of pure substances and solutions (K3)	
CO3	apply principles of phase equilibria in two- and three-component systems (K3)	
CO4	elucidate the effect of thermodynamic quantities on chemical equilibria and relate it to properties of chemical systems (K2)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K3	3	3	2	2	2	3	1	3	0	3	2	2	2	3
CO3	K3	3	3	1	2	2	0	3	3	2	3	3	2	3	3
CO4	K2	2	2	0	2	0	3	3	3	3	3	3	1	2	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: CHT1139	Course Title: Industrial Inorganic Chemistry	Credits = 3		
			L	T	P
	Semester: I	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Inorganic Chemistry

List of Courses where this course will be Prerequisite

Material Technology (CET 1704), Engineering Mechanics and Strength of Materials (GET117), Environment Science and Technology (HUT1106)

Description of relevance of this course in the B. Tech. Programme

To acquaint the students with synthesis, properties and applications of various industrial inorganic chemicals

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Primary Inorganic Materials:** Water, Hydrogen, Hydrogen Peroxide and Inorganic Peroxo Compounds, Nitrogen, Ammonia, Nitric acid, and Nitrogen Compounds, Phosphorus, Phosphoric acid and its Compounds, Sulfur, Sulfuric acid and Sulfur Compounds, Halogens, Chloralkali and Halogen Compounds	12
2	**Metals and Their Compounds:** Alkali and Alkaline Earth Metals and their Compounds, Aluminum and its Compounds, Chromium Compounds and Chromium, Silicon and its Inorganic Compounds, Manganese Compounds and Manganese, Metallurgy of Iron	10
3	**Organo-Silicon Compounds:** Industrially Important Organo-silicon Compounds, Industrially Important Silanes, Silicones, Industrial Silicone Products	7
4	**Inorganic Solids:** Silicate Products, Inorganic Fibers, Construction Materials, Enamel, Ceramics, Metallic Hard Materials, Carbon Modifications, Fillers, Inorganic Pigments, Cement, Glass	8
5	**Nuclear Cycle:** Economic Importance of Nuclear Energy, General Information about the Nuclear Fuel Cycle, Availability of Uranium, Nuclear Reactor Types, Nuclear Fuel Production Disposal of Waste from Nuclear Power Stations	8
Total		**45**

List of Text Books/ Reference Books

1	Büchel, Karl Heinz; Moretto, Hans-Heinrich; Woditsch, Peter. Industrial Inorganic Chemistry, Second, Completely Revised Edition; Wiley-VCH (2008)
2	Benvenuto, Mark Anthony. Industrial Inorganic Chemistry; de Gruyter (2015)
3	Swaddle, T. W. Inorganic Chemistry – An Industrial and Environmental Perspective; 1st Ed.; Academic Press (1997)
4	House, James, E. Inorganic Chemistry; 3rd Ed.; Academic Press, Inc. (2019)

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

CO1	Explain various industrial chemicals of nitrogen, sulfur, hydrogen, phosphorus and halogens (K2)
CO2	Explain and apply the concept the alkali and alkaline-earth metal based industrial chemicals, iron metallurgy (K3)
CO3	Explain inorganic solid materials like glass, silicone, cement, ceramics, etc. (K2)
CO4	Explain the concept of nuclear fuel and power industry (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	0	3	2	3	3	3	3	1	3	2

CO2	K3	3	3	2	2	2	3	3	1	3	3	2	2	3	3
CO3	K2	3	2	0	2	1	3	3	3	3	0	3	1	2	1
CO4	K2	3	2	1	2	1	2	3	3	3	3	1	1	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: MAT1101	**Course Title: Applied Mathematics – I**	**Credits = 4**		
			L	**T**	**P**
	Semester: I	**Total Contact Hours: 60**	**3**	**1**	**0**

List of Prerequisite Courses

HSC Standard Mathematics

List of Courses where this course will be prerequisite

This is a basic Mathematics course. This knowledge will be required in almost all subjects later.

Description of relevance of this course in the B. Tech. Program

Applied Mathematics is beyond crunching numbers. It is useful for solving real-life problems and make an impact in the world, technology being one of those fields. The knowledge gained is required for solving various mathematical equations in several Chemical Engineering courses such as MEBC, Momentum Transfer, Reaction Engineering, Separation Processes, Thermodynamics, and several others.

Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
1	**Linear Algebra:** Vectors in IR^n, Notion of linear independence and dependence. Vector subspaces of IR^n, Basis of a vector subspace, Row space, Null space, and Column space, Rank of a matrix, Determinants and rank of matrices Abstract vector spaces, Linear transformations in IR^n, Matrix of a linear transformation, Change of basis and similarity, Rank-nullity theorem, and its applications Inner product spaces, Orthonormal bases, Gram-Schmidt orthogonalization process, Eigenvalues and eigenvectors, Characteristic polynomials, Eigenvalues of special orthogonal projection and its application to least methods Diagonalization of matrices and its applications stochastic matrices, Solving initial value system of linear ordinary differential equations	15
2	**Differential Calculus:** Higher order differentiation and Leibnitz Rule for the derivative, Taylor's and Maclaurin's theorems, Maxima/Minima, Convexity of functions, Radius of Curvature. Functions of two or more variables, Limit and continuity, Partial differentiation, Total derivatives, Taylor's theorem for multivariable functions and its application to error calculations, Maxima/Minima	15
3	**Integral Calculus:** Beta and Gamma functions, Differentiation under the integral sign, Multiple integrals, Line and surface integrals, Applications of Green's, Gauss-Divergence and Stokes theorems	15
4	**Probability & Statistics:** Random variables and cumulative distribution function, Probability mass function and probability density function, Some common univariate distributions: Binomial, Poisson, Uniform, exponential, Normal, Expectation and Moments, Moment generating function, Multiple random variables and Joint distribution, Marginal distributions, Covariance and Correlation Concept of parameter estimation: Maximum likelihood estimation, Method of least squares and Simple linear regression, Nonlinear regression	15
	Total	**60**

List of Textbooks/Reference Books

1	Stang, G. Linear Algebra and its Applications; 4th Ed.; Thomson (2006)
2	Anton, Howard; Kaul, Anton. Elementary Linear Algebra; 12th Ed.; Wiley (2019)
3	Friedberg, Stephen H.; Insel, Arnold J.; Spence, Lawrence E. Linear Algebra; 5th Ed.; Pearson Education (2019).
4	Hughes-Hallett, Deborah; Gleason, Andrew M.; McCallum, William G. Calculus: Single and Multivariable; 6th Ed.; John Wiley & Sons, Inc. (2012)
5	Kreyszig, E.; Advanced Engineering Mathematics; 10th Ed.; Wiley Global Education (2010) (Officially Prescribed)
6	Iyengar, S. R. K.; Jain, R. K. Advanced Engineering Mathematics; 4th Ed.; Alpha Science (2014)
7	Ross, Sheldon M. A First Course in Probability; 10th Ed.; Pearson Education (2018)
8	Hines, William W.; Montgomery, Douglas C.; Goldsman, David M.; Borror, Connie M. Probability and Statistics in Engineering; 4th Ed.; John Wiley & Sons, Inc. (2003)
9	Boes, Duane C.; Graybill, Franklin A.; Mood, Alexander McFarlane. Introduction To the Theory of Statistics; 3rd Ed.; McGraw Hill Education (India) (2013)

Course Outcomes (Students will be able to…..)	
CO1	understand the notion of differentiability and be able to find maxima and minima of functions of one and several variables (K3)
CO2	compute surface and volume integrals (K3)
CO3	Understand and explain the notion of vectors and vector spaces (K2)
CO4	solve systems of linear equations and eigenvalue problems analytically and numerically (K3)
CO5	fit relationship between two data sets using linear, non-linear regression (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	0	2	3	3	2	3	3	3	2	3	3
CO2	K3	3	3	2	2	2	3	1	1	3	3	2	1	3	3
CO3	K2	3	2	1	2	1	2	3	3	3	3	3	0	3	2
CO4	K3	3	3	2	1	2	3	2	0	0	0	3	2	3	3
CO5	K3	3	3	1	2	2	3	3	2	3	3	1	2	3	3
Course	K3	3	3	2	2	2	3	3	2	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PYT1101	**Course Title: Applied Physics – I**	**Credits = 4**		
			L	**T**	**P**
	Semester: I	**Total Contact Hours: 60**	**3**	**1**	**0**

List of Prerequisite Courses

Standard XII Physics

List of Courses where this course will be prerequisite

Applied Physics – II, Physics Laboratory, Chemical Engineering Thermodynamics, Momentum and Mass Transfer, Heat Transfer, Material Science and Engineering, Structural Mechanics, etc.

Description of relevance of this course in the B. Tech. Program

This is a basic physics course. This knowledge will be required in almost all subjects later on.This knowledge is also required for understanding various chemical engineering concepts that will be introduced in courses such as momentum transfer, reaction engineering, separation processes, thermodynamics, heat transfer, etc.

Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**

1	**Solid State Physics** Crystal Structure of Solids: unit cell, space lattices and Bravais lattice, Miller indices, directions and crystallographic planes, Cubic crystals: SSC, BCC, FCC, Hexagonal crystals: HCP, atomic radius, packing fraction, Bragg's law of x-ray diffraction, determination of crystal structure using Bragg spectrometer Semiconductor Physics: Formation of energy bands in solids, concept of Fermi level, classification of solids: conductor, semiconductor and insulator, intrinsic and extrinsic semiconductors, effect of doping, mobility of charge carriers, conductivity, Hall effect	15
2	**Fluid Mechanics** Basic concepts of density and pressure in a fluid, ideal and real fluids, Pascal's law, absolute pressure and pressure gauges, basic concepts of surface tension and buoyancy, fluid flow, equation of continuity, Bernoulli's equation, streamlined and turbulent flow, concept of viscosity, Newton's law of viscosity, brief introduction to non-Newtonian behaviour	15
3	**Optics and Fibre Optics** Diffraction: Introduction to interference and example; concept of diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits; diffraction grating, characteristics of diffraction grating and its applications Polarisation: Introduction, polarisation by reflection, polarisation by double refraction, scattering of light, circular and elliptical polarisation, optical activity Fibre Optics: Introduction, optical fibre as a dielectric wave guide: total internal reflection, numerical aperture and various fibre parameters, losses associated with optical fibres, step and graded index fibres, application of optical fibres	10
4	**Lasers** Introduction to interaction of radiation with matter, principles and working of laser: population inversion, pumping, various modes, threshold population inversion, types of laser: solid state, semiconductor, gas; application of lasers least squares and Simple linear regression, Nonlinear regression	10
5	**Ultrasound** Generation of ultrasound: mechanical, electromechanical transducers; propagation of ultrasound, attenuation, velocity of ultrasound and parameters affecting it, measurement of velocity, cavitation, applications of ultrasound	10
	Total	**60**
List of Textbooks/Reference Books		
1	Physics:Vols. I and II – D. Halliday and R. Resnick, Wiley Eastern	
2	Lectures on Physics: Vols. I, II and III – R. P. Feynman, R. B. Leighton and M. Sands, Narosa.	
3	Concepts of Modern Physics – A. Beiser, McGraw-Hill.	
4	Introduction to Modern Optics – G. R. Fowles ,Dover Publications	
5	A Course of Experiments with LASERs – R. S. Sirohi, Wiley Eastern.	
6	Optical Fibre Communication – G. Keiser, McGraw-Hill	
7	Optoelectronics – J. Wilson and J. F. B. Hawkes, 2nd ed, Prentice-Hall India	
8	Ultrasonics: Methods and Applications – J. Blitz, Butterworth	
9	Applied Sonochemistry – T. J. Mason and J. P. Lorimer, Wiley VCH.	
Course Outcomes (Students will be able to…..)		
CO1	apply acoustic cavitation of Chemical Engineering Processes (K3)	
CO2	apply Bernoulli equation in simple pipe flows (K3)	
CO3	explain the principles of lasers, types of lasers and applications (K2)	
CO4	calculate resolving power of instruments (K3)	
CO5	describe principles of optical fibre communication (K2)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	1	1	3	3	3	3	2	3	3
CO2	K3	3	1	2	1	2	3	3	3	3	3	0	2	1	3
CO3	K2	3	2	1	2	0	3	3	3	3	2	3	1	3	2
CO4	K3	2	3	2	1	2	2	0	2	3	3	3	2	0	3
CO5	K2	3	2	1	2	0	0	3	3	1	3	1	1	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: GEP1113	**Course Title:** Engineering Graphics and Elementary AUTOCAD	**Credits = 4**		
			L	**T**	**P**
	Semester: I	**Total Contact Hours: 90**	**2**	**0**	**4**

List of Prerequisite Courses

Basic Geometry

List of Courses where this course will be prerequisite

Basic Mechanical Engineering (GET1110), Engineering Mechanics and Strength of Materials (GET1117), Chemical Engineering Operations (CET1401), Chemical Process Control (CET1703)

Description of relevance of this course in the B. Tech. Program

A Chemical Technology student is required to know various processes and equipment used in the processes. Some of the elementary processes such as filtration, size reduction, evaporation, condensation, crystallization etc., are very common to all the branches of Technology. These and several other processes require machines and equipment. One should be familiar with the design, manufacturing, working, and maintenance of such machines and equipment. The subject of 'Drawing' is a medium through which, one can learn all such matters, because the drawings are used to represent the objects and the processes on paper. With the help of the drawings, a lot of accurate information is conveyed, which otherwise will not be practicable through spoken words or written text. Drawing is a language used by Engineers and Technologists. This course is required in many subjects as well as later on in the professional career.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	**Orthographic Projections:** Conversion of 3D object or pictorial view into front view, top view and side views using first angle method of projection Sectional views draw sectional front view, top view, and side view Problems with section plane cutting object exactly at centre or off centre Orthographic views of at least 15 machine parts using mini drafter and drawing board	20
2	**Isometric Projections and Isometric Views:** Isometric scale, draw pictorial view or 3D view using front and top view or front view and any one side view Machine parts with circle, semicircle in the orthographic views and slots on inclined planes At least 10 isometric drawings using mini drafter and drawing board	12
3	**Missing Views:** Draw top view when front and any one side view is given Draw any one side view or both the side views when front view and top view is given. Problems involving sectional views. At least 6 machine parts using mini drafter and drawing board.	12
4	**Assembly Drawing**: Draw front view and top view or side view of assembly after assembling all the details of machine parts Convert assembly into details Assembly drawing of Nut and bolt, footstep bearings, Plummer block, etc.	20

5	**Introduction to Computer-Aided Drawing:** Role of CAD in design and development of new products, Advantages of CAD. Creating two-dimensional drawing with dimensions using suitable software (Minimum 2 exercises mandatory) Introduction to Solid Modelling: Creating 3D models of various components using suitable modelling software (Minimum 2 exercises mandatory)	26
	Total	**90**
List of Textbooks/Reference Books		
1	Bright, Steven. AutoCAD Fundamentals: A Comprehensive Guide on Engineering Drawing and Modeling (2020)	
2	Rathnam, K. A First Course in Engineering Drawing; Springer (2017)	
3	Agrawal, Basant. Engineering Drawing; McGraw-Hill Education (2015)	
4	Bhatt, N. D. Engineering Drawing by N. D. Bhatt.; 11th Ed.; C. Publishing House Pvt. Ltd. (2011)	
5	Shah, M. B.; Rana, B. C. Engineering Drawing; 2nd Ed.; Pearson Education (2014)	
6	Giesecke, Frederick E.; Lockhart, Shawna; Goodman, Marla; Johnson, Cindy M. Technical Drawing with Engineering Graphics; 15th Ed.; Pearson Prentice Hall (2016)	
7	Dubey, N. H. Engineering Drawing; 15th Ed.; Nandu (2015)	
Course Outcomes (Students will be able to…..)		
CO1	prepare multi view orthographic projections of objects by visualizing them in different positions. (K3)	
CO2	draw sectional views and develop surfaces of a given object. (K3)	
CO3	prepare pictorial drawings using the principles of isometric projections to visualize objects in three dimensions. (K3)	
CO4	prepare assembly drawing. (K3)	
CO5	obtain Multiview projections and solid models of objects using CAD tools (K3)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	2	2	2	3	3	3	1	2	3	2	3	1
CO3	K3	3	3	2	2	1	1	3	3	3	3	3	2	2	3
CO4	K3	3	3	2	2	2	3	0	2	3	3	3	2	3	1
CO5	K3	3	2	2	0	2	3	3	3	1	3	0	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: CHP1343	**Course Title: Physical and Analytical Chemistry Laboratory**	**Credits = 2**		
			L	**T**	**P**
	Semester: I	**Total Contact Hours: 60**	**0**	**0**	**4**
List of Prerequisite Courses					
Standard XIIth Chemistry Laboratory courses					
List of Courses where this course will be prerequisite					
This is a basic Course. This knowledge will be required in Applied Chemistry subjects later.					
Description of relevance of this course in the B. Tech. Program					
Students will become familiar with laboratory experimental skills, plan and interpretation of experimental tasks, understand the relevance of principles of physical chemistry in chemical processes					
Sr. No.	**Course Contents (Topics and Subtopics)**		**Required Hours**		
1	Experiments based on chemical reaction kinetics, phase equilibria and electrolyte systems, surface and interfacial phenomena such as surface tension and CMC measurements		4 hrs/session X 15 sessions		
	Total		**60**		

List of Text Books/ Reference Books	
1	Practical physical Chemistry – B. Viswanthan and P. S. Raghavan
2	Practical physical Chemistry- Alexander Findlay
Course Outcomes (students will be able to…..)	
CO1	identify and determine physicochemical parameters using simple tools.(K3)
CO2	interpretation of data and drawing scientific conclusions, dryers, etc.(K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	2	3	3	2	3	3
CO2	K4	3	3	1	3	1	2	3	1	3	3	0	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0, No Contribution

K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

Semester II

	Course Code: CHT1401	Course Title: Analytical Chemistry	Credits = 3		
			L	T	P
	Semester: II	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Chemistry

List of Courses where this course will be prerequisite

Physical and Analytical Chemistry Laboratory (CHP1343), other Chemistry Courses

Description of relevance of this course in the B. Tech. Program

The course introduces the students to key concepts of chemical analysis – sampling, selection of analytical method and data analysis. It presents basic techniques like spectroscopy and chromatography. The students should be able to select an appropriate analytical technique and apply it in accordance with its strengths and limitations.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to Chemical Analysis, Terminology (technique/method/procedure /protocol), Broad classification of analytical techniques, Good Laboratory Practices (GLP)	5
2	Sampling: Basics and procedures, preparation of laboratory samples Criteria for selecting analytical methods – accuracy, precision, sensitivity, selectivity, and detection limit Calibration and validation	8
3	Data Analysis: Errors – Systematic and random errors, statistical treatment of experimental results (F, Q and t tests, rejection of data, and confidence intervals), least square method, correlation coefficients	6
4	Spectroscopic Methods: General principle, instrumentation and applications of - UV-visible spectroscopy - Fluorescence spectroscopy	8
5	Electrochemical Methods: General principles, instrumentation and applications of – Conductometry, Potentiometry, Coulometry, Voltammetry	8
6	Chromatographic Methods: General principle, instrumentation and applications of - Gas chromatography (GC), High-performance liquid chromatography (HPLC), Ion-exchange chromatography, Size-exclusion chromatography	10
	Total	**45**

List of Textbooks/Reference Books

1	Modern Analytical Chemistry by David Harvey, McGraw-Hill, 1999.
2	Quantitative Analysis by R. A. Day and A. L. Underwood, Prentice Hall of India, 2001.
3	Instrumental Methods of Analysis by H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle, Wadsworth Publishing, USA
4	Fundamentals of Analytical Chemistry by D. A. Skoog, D. M. West, F. James Holler and S. R. Crouch, Cengage Learning, 2014
5	Principles of Instrumental Analysis by D. A. Skoog, F. James Holler and S. R. Crouch, Cengage Learning, 2007

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

CO1	Apply the knowledge of sampling, data analysis and select proper analytical method (K3)
CO2	Explain the principles of UV Visible and Fluorescence spectroscopic methods (K2)
CO3	Explain the principles of electrochemical methods (K2)
CO4	Explain the principles of chromatographic methods (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	0	3	3	0	2	3	3
CO2	K2	3	1	0	1	1	0	3	3	2	3	3	0	2	2

CO3	K2	3	2	1	2	0	3	3	3	3	2	3	1	3	2
CO4	K2	3	2	1	1	1	3	2	3	3	3	3	1	1	2
Course	K3	3	2	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: CHT1342	Course Title: Physical Chemistry - II	Credits = 3		
			L	T	P
	Semester: II	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Chemistry, Physical Chemistry - I (CHT1341)

List of Courses where this course will be prerequisite

Other Chemistry and Applied Chemistry courses

Description of relevance of this course in the B. Tech. Program

Students should learn to appreciate the relevance of kinetic studies and parameters affecting the same. The understanding of kinetic principles should be applied towards understanding complex reaction pathways and their mechanistic studies. The concept of interfaces and surfaces are instrumental in conveying the applications and importance of disperse systems.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction – concept of reaction rates and order, experimental methods in kinetic studies, differential and integral methods to formulate rate equations of zero, first and second order reactions Experimental methods of kinetic studies	3
2	Kinetics and reaction mechanism – rate determining step, steady state approximation Complex reactions- parallel, consecutive and reversible reactions Mechanism of thermal, photochemical chain reactions, polymerization reactions Fast reactions – experimental techniques	6
3	Homogenous catalysis – homogeneous acid / base catalysis (specific and general acid catalysis), enzyme catalysis (Michalis-Menten kinetics)	4
4	Reactions at interface – Adsorption isotherms, kinetics of surface reactions- Hishelwood and Rideal models of surface reactions	4
5	Theories of reaction rates - Theory of unimolecular reactions, collision theory and transition state theory, Effect of temperature, Solvent effects on reaction rates	6
6	Surface and interfacial Chemistry – introduction, surface tension and surface free energy, methods of determining surface and interfacial tensions	10
7	Thermodynamics of surfaces – surface excess, Gibbs adsorption equation, curved surfaces- bubbles, droplets and foams, Kelvin, Young Laplace and Thomson equations, homogeneous nucleation	4
8	Liquid-liquid and solid-liquid interfaces – contact angle, wetting and spreading, adhesion and cohesion, contact angle measurements and hysteresis	4
9	Surfactants: Types, adsorption at surfaces and interfaces, surfactant aggregates, factors affecting aggregation phenomena, applications of surfactants and mixed surfactant systems	4
10	Colloids: preparation, stability, characterization, surface charges and electrical double layer Emulsions: Thermodynamics and stability of emulsions, microemulsions and foams, HLB values	5
	Total	**45**

List of Textbooks/Reference Books

1	Physical Chemistry (11th edition) by P. W. Atkins, J. de Paula and J. Keeler, Oxford University Press, 2017.
2	Chemical Kinetics (3rd edition) by Keith J. Laidler, New York : Harper & Row, 1987.
3	Introduction to Colloid and Surface Chemistry (4th edition) by Duncan Shaw, Butterworth-Heinemann 2013.
4	Surfaces, Interfaces, and Colloids: Principles and Applications (2nd edition) by Drew Myers, John Wiley & Sons, Inc., 1999

5	Surfactants and Interfacial Phenomena (4th edition) by M. J. Rosen, John Wiley & Sons, Inc., 2012
Course Outcomes (Students will be able to…..)	
CO1	comprehend fundamental knowledge in chemical kinetics with basics of order, molecularity and temperature effect (K2)
CO2	examine kinetics for complex, fast as well as surface reactions and comprehend different theories in kinetics (K4)
CO3	comprehend fundamental knowledge and thermodynamics in surface and interfacial chemistry (K3)
CO4	evaluate the behavior of surface-active agents and disperse systems based on the knowledge of interfacial phenomena (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	0	3	3	3	3	3	3	0	3	2
CO2	K4	3	1	2	3	2	3	3	3	3	1	3	2	3	3
CO3	K3	3	3	0	2	2	3	3	2	2	3	3	1	3	2
CO4	K4	3	2	2	3	2	0	3	3	3	3	2	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code:	**Course Title:**	**Credits = 3**		
	CHT1138	**Organic Chemistry - II**	**L**	**T**	**P**
	Semester: II	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

Organic Chemistry - I (CHT1137)

List of Courses where this course will be prerequisite

Other Chemistry and Applied Chemistry courses

Description of relevance of this course in the B. Tech. Program

To acquaint the students with concepts related to aromatic, heteroaromatic and pericyclic reactions so that they are perfectly aligned to apply the same for the future courses and in their professional career

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Nitro and amino arenes Reactions, basicity of aminoarenes, diazotisation reactions	5
2	Aromatic nucleophilic substitution reactions Addition, elimination mechanism; elimination – addition mechanism (benzyne), Sandmeyer reaction	5
3	Pericyclic Reactions Symmetry of molecular orbitals, frontier orbitals of ethylene, 1,3-butadiene, 1,3,5-hexatriene and allyl system, classification of pericyclic reactions; Woodward-Hoffmann correlation diagrams, FMO and PMO approaches; electrocyclic reaction -conrotatory and disrotatory motions of 4n, 4n+2 and allyl systems; cycloaddition -antara facial and suprafacial addition, 4n and 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions; sigmatropic rearrangements - suprafacial and antarafacial shifts of hydrohen, sigmatropic shifts involving carbon moieties, 3,3- and 5,5-sigmatropic rearrangements, Claisen, Cope and Aza-Cope rearrangements, ene reaction.	13
4	Heteroaromatic compounds	10

	IUPAC nomenclature, structures and common names, comparison with benzenoid compounds, reactivity and synthesis – pyrroles, furans, thiophenes and pyridines	
5	Named Organic reactions Perkin reaction (Mauvine synthesis-dyes), Fischer indole synthesis, (dyes), Jacobson Corey epoxide synthesis (Pharmaceutical), Ziegler Natta polymerisation (polymer), Multicomponent reactions, Mailard reaction (foods), Strecker amino acid synthesis (Pharmaceuticals & Food), Wittig reactions, Prilezhaev reaction	12
	Total	**45**
List of Textbooks/Reference Books		
1	Clayden, J., Greeves, N., Warren, S.; Organic Chemsitry; 2nd ed.; Oxford University Press (2012)	
2	Graham Solomons, T. W.; Fryhle, Craig B.; Snyder, Scott A. Organic Chemistry; 12th Ed.; John Wiley & Sons. Inc. (2016)	
3	Smith, M. B.; March's Advanced Organic Chemistry: Reactions, Mechanisms and Structure; 7th ed.; Wiley, India (2015)	
4	Carey F. A., Sundberg, R. J. Advanced Organic Chemistry: Part A: Structure and Mechanisms; 5th ed.; Springer (2005)	
5	Carey F. A., Sundberg, R. J.; Advanced Organic Chemistry: Part B: Reaction and Synthesis; 5th ed.; Springer (2007)	
6	Wade, L. G.; Simek, J. W.; Singh, M. S. Organic Chemistry; 9th Ed.; Pearson Education (2019)	
7	Eliel, E. L. Stereochemistry of Carbon Compounds; Mcgraw-Hill (2001)	
8	Bruice, Paula, Y. Organic Chemistry; 8th Ed.; Pearson Education (2020)	
Course Outcomes (Students will be able to…..)		
CO1	Explain the aromatic chemistry and interpret the outcome of general transformations (K3)	
CO2	Appreciate and visualize the reactions involving radicals such as cyclizations, pericyclic reactions in synthesis (K3)	
CO3	Understand the importance of heterocycles, learn the properties and synthetic routes, interpret IUPAC of compounds and decipher outcomes of various transformations involving heterocycles (K3)	
CO4	Apply the knowledge obtained through the course to predict the outcome of reactions and devise solutions to unknown problems (K3)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	0	3	3	2	3	3
CO2	K3	3	3	2	2	1	3	3	3	3	3	3	2	0	3
CO3	K3	3	3	2	1	2	2	1	3	2	3	3	2	3	3
CO4	K3	3	2	0	2	2	3	3	3	3	3	3	1	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PYT1103	Course Title: Applied Physics - II	Credits = 3		
			L	T	P
	Semester: II	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses
Standard XII Physics, Applied Physics – I, Physics Laboratory
List of Courses where this course will be prerequisite
This is a basic physics course. This knowledge will be required in almost all subjects later on.
Description of relevance of this course in the B. Tech. Program
The knowledge gained from this course is required for understanding various chemical engineering concepts that will be introduced in courses such as momentum transfer, reaction engineering, separation processes, thermodynamics, heat transfer, etc.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Quantum Mechanics** Introduction to quantum physics, black body radiation, explanation using the photon concept, photoelectric effect, Compton effect, de Broglie hypothesis, wave-particle duality, Born's interpretation of the wave function, verification of matter waves, uncertainty principle, Schrodinger wave equation, particle in box, quantum harmonic oscillator, hydrogen atom (no detailed derivation)	25
2	**Dielectric and Magnetic Properties of Materials** Introduction to the 'del' operator and vector calculus, revision of the laws of electrostatics, electric current and the continuity equation, revision of the laws of magnetism. Polarisation, permeability and dielectric constant, polar and non-polar dielectrics, internal fields in a solid, Clausius-Mossotti equation, applications of dielectrics. Magnetisation, permeability and susceptibility, classification of magnetic materials, ferromagnetism, magnetic domains and hysteresis, applications.	20
	Total	**45**

List of Textbooks/Reference Books	
1	Physics : Vols. I and II – D. Halliday and R. Resnick, Wiley Eastern
2	Lectures on Physics: Vols. I, II and III – R. P. Feynman, R. B. Leighton and M. Sands, Narosa.
3	Concepts of Modern Physics – A. Beiser, McGraw-Hill.
4	Solid State Physics – A. J. Dekker, 1957, MacMillan India.
5	Perspectives of Modern Physics – A. Beiser, 1969, McGraw-Hill.
Course Outcomes (Students will be able to…..)	
CO1	do simple quantum mechanics calculations (K3)
CO2	define various terms related to properties of materials such as, permeability, polarization, etc (K2)
CO3	state some of the basic laws related to quantum mechanics as well as magnetic and dielectric properties of materials (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO3	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: MAT1102	Course Title: Applied Mathematics – II	Credits = 4		
			L	T	P
	Semester: II	Total contact hours: 60	3	1	0

List of Prerequisite Courses

HSC Standard Mathematics, Applied Mathematics – I

List of Courses where this course will be prerequisite

This is a basic Mathematics course. This knowledge will be required in almost all subjects later.

Description of relevance of this course in the B. Tech. Program

This is a basic Mathematics course. This knowledge will be required in almost all subjects later on. This knowledge is also required for solving various mathematical equations that need to be solved in several chemical engineering courses such as MEBC, momentum transfer, reaction engineering, separation processes, thermodynamics, etc.

	Course Contents (Topics and subtopics)	Hours
1	**Numerical Methods - I:** Solutions of system of linear equations (Gauss-elimination, LU-decomposition etc.) Numerical methods for solving non-linear algebraic / transcendental etc. Newton's method, Secant, Regula Falsi methods. Numerical solution set of linear algebraic equations: Jacobi, Gauss Siedel, and under / over relaxation methods	15
2	**Numerical Methods - II:** Interpolation and extrapolation for equal and non-equal spaced data (Newtons Forward, Newtons backward and Lagrange) Numerical integration (trapezoidal rule, Simpson's Rule) Numerical methods for solution of initial values problems using RK method, Euler's method and Taylor series method.	15
3	**Differential Equations - I:** Differential Equations: Solution of Higher order ODE with constant and variable coefficients and its applications to boundary and initial value problems, Series solution of differential equations, Bessel functions, Legendre Polynomials, Error function.	15
4	**Differential Equations – II:** Fourier series, Laplace Transforms and their application in differential equation (both ODEs PDEs). Partial Differential Equations, Classification of higher order PDEs, Solution of parabolic equation using separation of variables	15
	Total	**60**

List of Textbooks/ Reference books

1	E. Kreyszig, Advanced Engineering Mathematics (8th Edition), John Wiley (1999). (Officially prescribed)
2	S. R. K. Iyengar, R. K. Jain, Advanced Engineering Mathematics Narosa.
3	M. K. Jain, S R K Iyengar and R K Jain, Numerical Methods: For Scientific and Engineering Computation, New Age International Publication
4	W. E. Boyce and R. DiPrima, Elementary Differential Equations (8th Edition), John Wiley (2005).
5	R. V. Churchill and J. W. Brown, Fourier series and boundary value problems (7th Edition), McGraw-Hill (2006).

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

CO 1	solve system of linear algebraic equations.
CO 2	do numerical integrations of functions.
CO 3	solve higher order ODE by analytical methods.
CO 4	solve initial value problems using numerical methods.

CO 5	apply Fourier series and Laplace transform techniques to solve ODE and PDE.

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	2	3	2	3	3	3	3	3	3	2	3	2
CO3	K4	3	2	1	2	1	3	3	2	3	3	3	1	3	3
CO4	K3	3	3	3	2	2	2	3	3	3	3	3	2	3	2
CO5	K3	3	2	2	3	2	3	3	3	2	3	3	2	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, Knowledge level from cognitive domain; A, Affective domain; P, Psychomotor domain

	Course Code:	**Course Title:**	**Credits = 4**		
	CET1507	**Process Calculations**	**L**	**T**	**P**
	Semester: II	**Total Contact Hours: 60**	**2**	**2**	**0**

List of Prerequisite Courses

Standard XII Mathematics, Chemistry, Physics

List of Courses where this course will be prerequisite

This is a basic Course. This knowledge will be required in ALL subjects later.

Description of relevance of this course in the B. Tech. Program

The course introduces various concepts used in Chemical Engineering to the students. The knowledge of this course is required for in ALL B. Tech. courses in the subsequent semesters including the project work. It can be applied in various situations such as process selection, economics, sustainability, environmental impacts and others.

Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
1	Introduction to chemical process calculations, Overview of single- and multistage operations, Concept of process flow sheets	2
2	Revision of Units and Dimensions, Dimensional analysis of equations, Mathematical techniques	4
3	Mole concept, Composition relationship, Types of flow rates	2
4	Material balance in non-reacting systems: Application to single- and multistage processes	8
5	Stoichiometry	2
6	Material balance in reacting systems: Application to single- and multistage processes	6
7	Behavior of gases and vapors	4
8	Introduction to Psychrometry, Humidity and air-conditioning calculations.	6
9	Calculation of X-Y diagrams based on Raoult's law.	2
10	Applications of material balances to multiphase systems	6
11	Basic concepts of types of energy and calculations	2
12	Application of energy balance to non-reacting systems	6
13	Application of energy balance to reacting systems	6
14	Fuels and combustion	4
Total		**60**

List of Text Books/ Reference Books

1	Elementary Principles of Chemical Processes, Felder, R.M. and Rousseau
2	Chemical Process Principles, Hougen O.A., Watson K. M.
3	Basic Principles and Calculations in Chemical Engineering, Himmelblau,
4	Stoichiometry, Bhatt B.I. and Vora S.M.

Course Outcomes (students will be able to…..)	
CO1	convert units of simple quantities from one set of units to another set of units (K2)
CO2	calculate quantities and /or compositions, energy usages, etc. in various processes and process equipment such as reactors, filters, dryers, etc. (K3)
CO3	apply material balances in multiphase systems (K3)
CO4	apply energy balance to various systems (K3)

Mapping of Course Outcomes (Cos) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	0	2	1	3	3	3	3	3	3	1	3	2
CO2	K3	3	3	2	2	2	3	3	3	3	3	2	2	3	3
CO3	K3	3	1	2	2	1	3	3	3	2	3	3	1	3	3
CO4	K3	3	3	2	0	2	3	3	3	3	3	3	2	2	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PYP1101	**Course Title:** Physics Laboratory	**Credits = 2**		
			L	**T**	**P**
	Semester: II	**Total Contact Hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses

Applied Physics - I

List of Courses where this course will be prerequisite

This is a basic physics Laboratory course. This knowledge will be required in almost all subjects later on.

Description of relevance of this course in the B. Tech. Program

Students will be able to learn various concepts by doing experiments on different topics. This knowledge will be required in almost all subjects later on. This knowledge is also required for understanding various chemical engineering concepts that will be introduced in courses such as momentum transfer, reaction engineering, separation processes, thermodynamics, heat transfer, etc.

Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
1	Viscosity	5
2	Thermistor	6
3	Thermal conductivity	5
4	Ultrasonic interferometer	6
5	Photoelectric effect	5
6	Hall effect	6
7	Newton's rings	5
8	Dispersive power of prism	8
9	Laser diffraction	8
10	Resolving power of grating	6
Total		**60**

List of Text Books/ Reference Books

1	Physics : Vols. I and II – D. Halliday and R. Resnick, Wiley Eastern
2	Lectures on Physics: Vols. I, II and III – R. P. Feynman, R. B. Leighton and M. Sands, Narosa.
3	Concepts of Modern Physics – A. Beiser, McGraw-Hill.
4	Introduction to Modern Optics – G. R. Fowles ,Dover Publications.
5	Optical Fibre Communication – G. Keiser, McGraw-Hill.
6	A Course of Experiments with LASERs – R. S. Sirohi, Wiley Eastern
7	Optoelectronics – J. Wilson and J. F. B. Hawkes, 2nd ed, Prentice-Hall India.

8	Ultrasonics: Methods and Applications – J. Blitz, Butterworth
9	Applied Sonochemistry – T. J. Mason and J. P. Lorimer, Wiley VCH.
Course Outcomes (students will be able to…..)	
CO1	Apply various laws which they have studied through experiments (K3)
CO2	Measure transport properties like viscosity, conductivity, etc.(K4)
CO3	Explain the application of acoustic cavitation (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	1	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	2	3	3	2	3	3	3	0	2	3
CO3	K2	3	2	1	2	0	3	3	3	3	1	3	1	3	2
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

	Course Code: CHP1132	**Course Title: Organic Chemistry Laboratory**	**Credits = 2**		
			L	**T**	**P**
	Semester: II	**Total Contact Hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses

Standard XIIth Organic Chemistry Laboratory

List of Courses where this course will be prerequisite

All the Applied Chemistry Practicals

Description of relevance of this course in the B. Tech. Program

The course is relevant for training the students for working with binary mixtures. The students are exposed to basics of organic separations and identification of organic compounds based on their physicochemical properties. The laboratory training is crucial for the students to carry out work-up of organic reactions leading to separation of crude products followed by purification using recrystallization and/or distillation or related methods.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	a) Principles of qualitative separation of organic mixtures using physical properties, chemical properties and their combination b) Principles of quantitative separation of organic mixtures using physical properties, chemical properties and their combination	4 4
2	a) Separation of solid-solid water insoluble binary organic mixtures b) Separation of solid-solid partly water soluble binary organic mixtures c) Separation of solid-solid mixtures by fractional crystallization d) Separation of liquid-liquid mixtures by distillation e) Separation of liquid-liquid mixtures by solvent extraction	5X4 2X4 2X4 2X4 2X4
	Total	**60**

List of Textbooks/Reference Books

1	Arthur, Vogel. Textbook of Practical Organic Chemistry, 5th edition, publishers Longman group Ltd, 1989
2	F.G. Mann and B.C. Saunders, Practical Organic Chemistry, 4th edition published by Orient Longman
3	Keese, R, Martin P. B, and Trevor P. Toube. Practical Organic Synthesis: A Student's Guide. John Wiley & Sons, 2006.
Course Outcomes (Students will be able to…..)	
CO1	work safely in the organic chemistry laboratory.(K3)
CO2	separate binary organic mixtures by multiple techniques.(K4)
CO3	understand basic principles for separation of binary organic mixtures qualitatively and quantitatively.(K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4

CO1	K3	3	3	2	2	2	3	3	3	3	3	3	0	3	3
CO2	K4	3	3	2	3	2	3	3	0	3	3	3	2	2	3
CO3	K3	3	1	2	1	2	2	3	3	3	3	1	2	3	1
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: HUP1101	Course Title: Communication Skills	Credits = 2		
			L	T	P
	Semester: II	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

Standard XII English

List of Courses where this course will be prerequisite

All

Description of relevance of this course in the B. Tech. Program

This is an important course for the effective functioning of an Engineer and a Technolgist. Communication skills are required in all courses and professional career.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Development of communication skills in oral as well as writing	10
2	The writing skills should emphasize technical report writing, scientific paper writing, letter drafting, etc.	14
3	The oral communication skills should emphasize presentation skills.	10
4	Use of audio-visual facilities like powerpoint, LCD. for making effective oral presentation	14
5	Group Discussions	12
Total		**60**

List of Text Books/ Reference Books

1	Elements of Style – Strunk and White

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

CO1	Write grammar error free technical reports in MS Word or equivalent software (K3)
CO2	Make power point slides in MS PowerPoint or equivalent software (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	1	2	3	3
CO2	K3	3	3	2	0	2	3	1	3	3	2	3	2	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester III

	Course Code: BST1110	Course Title: Basics of Biology and Applications to Technology	Credits = 3		
			L	T	P
	Semester: III	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses
Standard XII Biology
List of Courses where this course will be prerequisite
Safety studies pertaining to Chemicals, Pharmaceuticals, Polymers, cosmetics, Lubricants, Textiles, etc.
Description of relevance of this course in the B. Tech. Program
This interdisciplinary course will help a student understand basics of Human biology along with certain terminologies to enable them to read contemporary research pertaining to important technological developments. The course will help a student to understand the safety evaluation of materials as per regulatory guidelines

	Course Contents (Topics and Subtopics)	Required Hours
1	Overview of basics of Human Anatomy and Physiology, the terminologies used etc. Definitions of Anatomy, Physiology, Histology, Biochemistry, Homoeostasis, Health, Disease, Toxicity, Safety, Genotoxicity, etc. Systems that make the human body, the rationale behind introducing the subject to the technology students of Pharma, foods, Polymers, Surface coatings, Oils, Textiles, Dyes	9
2	Overview of the cell functioning as a whole unit and its organelles with their functions and its applications to technology. An overview of normal cell division, cell death by apoptosis, necrosis , Cancerous growth, metabolites/ energy production , cellular secretions, different types of cells, cell repair, biomarkers, etc.	9
3	Overview of Biomaterials: Biodegradable, Biocompatible and their technological applications	6
4	Practical applications: design some simple experiments to evaluate toxicity using cellular experiments, organisms, animals etc. OECD guidelines. Concept of Safety studies and industrial relevance. (oral, dermal, inhalation)	6
5	Toxicity evaluation in terms of mortality, Genotoxicity, hypersensitivity (allergy), biocompatibility as per various international guidelines namely, ICH, OECD, ISO to name a few.	10
7	Irritation potential evaluation of Lubricants, surfactants, excipients, etc.	5
	Total	**45**

List of Textbooks/Reference Books	
1	Human Anatomy and Physiology R. K. Goyal, Ahmedabad, India.
2	Pharmacology H. P. Rang, M. M. Dale, J. M. Ritter
3	Ross and Wilson's Anatomy and Physiology in Health and Illness Anne Waugh and All
4	Online guidelines of OECD, ISO, ICH

Course Outcomes (Students will be able to…..)	
CO1	Understand and explain the basic concepts and terminologies of Biology (K2)
CO2	Appreciate interdisciplinary nature of biology and will be able to design and execute simple experiments (K3)
CO3	understand about the concept of toxicity/safety and its relevance to technology and its applications in everyday life (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	0	3	3	3	3	3	3	1	3	2
CO2	K3	3	3	2	2	2	3	1	3	3	2	1	2	2	3

CO3	K2	3	1	0	2	1	3	3	3	0	3	3	1	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: **GET1110**	**Course Title:** **Basic Mechanical Engineering**	**Credits = 3**		
			L	**T**	**P**
	Semester: III	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

None

List of Courses where this course will be Prerequisite

Material Technology (CET1704), Engineering Mechanics and Strength of Materials (GET1117), Environmental Science and Technology (HUT1106)

Description of relevance of this course in the B. Tech. Programme

To acquaint the students with synthesis, properties and applications of various industrial inorganic chemicals

Sr. No.	**Course Contents (Topics and subtopics)**	**Required Hours**
1	**Introduction to Thermodynamics:** First Law of Thermodynamics, Steady-flow energy equation, Second Law of Thermodynamics	3
2	**Properties of Steam and Boilers:** Steam formation, Types of steam, Steam Properties – Enthalpy, Simple numerical for finding enthalpy and dryness fraction Steam Boilers: Classification, Working principle of Cochran, Babcock & Wilcox, etc. boilers	6
3	**I. C. Engines:** Classification, Working of 2-stroke, 4-stroke C.I. and S.I. Engines with P-V diagrams, Definitions and simple numerical for determining indicated power, Brake power, Mechanical efficiency, Indicated thermal efficiency, and Brake thermal efficiency	6
4	**Prime Movers:** Classification of Prime movers, Working principle of steam, gas and water turbines, Concept of impulse and reaction steam turbines	4
5	**Compressors:** Classification of compressors, Reciprocating compressors, Single-stage and multistage compressors, P-V diagram, Rotary compressors, Fan, Blower & Compressors, Centrifugal and axial compressors, Application of compressors	4
6	**Pumps:** Classification of pumps, Reciprocating pumps, Centrifugal pumps, Axial pumps, Gear pumps, Maintenance of pumps	4
7	**Refrigeration:** COP of refrigerator and heat pumps, Classification of refrigerants, Nomenclature, Properties desired by refrigerants, Vapour compression refrigeration cycle, Methods of increasing COP of VCRS, Vapour absorption refrigeration systems	5
8	**Renewable Energy:** Role and importance of nonconventional and alternate energy sources such as solar, wind, ocean, bio-mass and geothermal	4
9	**Transmission of Power:** Introduction to various drives such as belt, rope, chain and gear drives, Introduction to mechanical elements such as keys, couplings and bearings in power transmission (No numericals)	5
10	**Properties and Applications of Engineering Materials:** Metals –ferrous, cast-iron, tool steels and stainless steels and non-ferrous aluminium, brass, bronze Polymers – Thermoplastic and thermosetting polymers Ceramics – Glass, optical fibre, glass, cermets Composites – fibre-reinforced composites, metal-matrix composites	4
Total		**45**

List of Text Books/ Reference Books

1	Nag, P. K. Engineering Thermodynamics; 5th Ed.; McGraw Hill Education (2013)
2	Morse, Frederick T. Power Plant Engineering; 3rd Ed.; Van Nostrand Reinhold Inc. (1953)
3	Ballaney, P. L. Thermal Engineering: Engineering Thermodynamics & Energy Conversion Techniques; 5th Ed.; Khanna Publishers (1966)
4	Lal, J. Hydraulic Machines Including Fluidics; 6th Ed.; Metropolitan Book Co. Pvt. Ltd. (2016)
5	Twidell, John; Weir, Tony. Renewable Energy Resources; 3rd Ed.; Routledge (2015)
6	Rai, G. D. Non-conventional Energy Sources; Khanna (1988)
7	Arora, C. P. Refrigeration and Air Conditioning; 4th Ed.; McGraw Hill (2021)
8	Rattan, S. S. Theory of Machines; 5th Ed.; McGraw Hill (2019)

Course Outcomes (Students will be able to…..)	
CO1	discuss the steam formation process and its properties. (K2)
CO2	understand basics of heat transfer, refrigeration and I. C. Engines. (K2)
CO3	understand mechanism of power transfer through belt, rope and gear drives and understand the properties of common engineering materials and their applications in engineering industry. (K3)
CO4	explain the working principles of power-absorbing devices such as pumps and compressors and explain need and importance of various renewable energy sources. (K2)

Mapping of Course Outcomes (Cos) with Programme Outcomes (Pos)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K2	3	1	0	2	1	3	1	3	3	3	3	1	3	2
CO3	K3	3	3	2	2	2	3	3	3	3	2	3	2	2	3
CO4	K2	3	2	1	2	0	3	3	2	3	3	3	1	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYT 1101	**Course Title: Technology of Intermediates I**	**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. Program

To make the students understand chemistry various intermediates used for chemical industry in general and Dyestuff industry.
To make them understand the unit processes and their relevance in chemical industries.
To enable them to analyses 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

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Chemical feedstock for Dyestuff industry- Basic Raw materials **a.** Fossil feedstock **b.** Petroleum and coal based raw materials **c.** Importance of BTX	04

2	Chemistry of Benzenoid intermediates- **a.** Electrophilic aromatic substitution reaction **b.** Orientation in aromatic substitutions	08
3	Introduction of Functional groups into benzene and technology involved **A.** Basic Unit processes a. Sulphonation 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	16
4	Naphthalene Introduction a. Nomenclature, Reactions, Reactivity rules	04
5	**Chemistry: Naphthalene intermediates** **a.** Synthesis of naphthalene **b.** Substitution pattern **c.** Reactions possible and criterion for the same	18
6	Technology and Reactions of naphthalene **a.** Nitration **b.** Sulphonation **c.** Halogenation **d.** Reduction (Key points are similar to benzene)	10
	Total	**60**
List of Textbooks/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	
Course Outcomes (Students will be able to…..)		

CO1	*Understand* the basics of dyestuff industry in terms of raw materials utilized (K2)
CO2	*Apprehend* basic benzene and naphthalene chemistry. (K2)
CO3	*Analyze* the various methods for synthesis of different intermediates used in dyes (K2)
CO4	*Know* the various technology and safety aspects for reactions. (K2)
CO5	*Identify* the substrates and chemistry to synthesize desired product (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	2	2	1	1	0	1	0	0	0	0	2	0	2	2
CO2	K2	2	2	1	1	0	1	0	0	0	0	2	0	2	2
CO3	K2	2	3	3	3	0	1	0	0	0	0	2	0	2	2
CO4	K2	3	2	3	3	0	3	2	0	0	0	2	0	2	2
CO5	K2	2	3	2	3	0	2	2	0	-	0	2	0	2	2

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code:	**Course Title:**	**Credits = 3**		
	CET1704	**Material Technology**	**L**	**T**	**P**
	Semester: III	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

Applied Physics – I (PYT1101), Applied Physics – I (PYT1103)

List of Courses where this course will be prerequisite

Equipment design, Final Year Project, Process Development and Engineering, Project Engineering and Economics

Description of relevance of this course in the B. Tech. Program

Selection of Material of Construction for a given application, Maintenance and corrective measures for various Engineering materials, Troubleshooting

Sr. No.	**Course Contents (Topics and subtopics)**	**Required Hours**
1	Engineering Materials: Classification, Fundamentals of Engineering properties of materials, Phase diagrams, Study of ferrous and nonferrous materials	12
2	Composite and smart materials	03
3	Structure-Property Relationship: Subatomic to macroscopic level, Modification and control of material properties	10
4	Theory of Failure of Materials: Fracture, creep and fatigue	08
5	Corrosion Engineering: Electrochemical principles, different types of corrosion, Polarization, Mechanisms of corrosion control and prevention, Preventive coatings. Corrosion behavior of industrial materials	08
6.	Criteria for selection of materials in Chemical Process industry	04
	Total	**45**

List of Textbooks

1	The Essence of Materials for Engineers, Robert W. Messler, Jr.
2	Materials Science and Engineering, Raghavan V.
3	Materials Science and Engineering, Van Vlack L.H.
4	Engineering Materials and Applications, Flin R.A., Trojan P.K.

List of Additional Reading Material/Reference Books

1	Material Science and Engg, Callister

2	Mechanical Metallurgy, Dieter
Course Outcomes (students will be able to…..)	
CO1	resolve the issues related to mechanical failure (K3)
CO2	troubleshoot corrosion-related industrial problems (K3)
CO3	learn from incidences (LFI) (K2)

Mapping of Course Outcomes (Cos) with Programme Outcomes (Pos)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	1	3	2	3	3
CO2	K3	3	3	2	0	2	3	3	2	3	3	0	2	2	3
CO3	K2	3	2	1	2	1	2	3	3	3	2	3	1	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: OLT 1102	**Course Title: SPL3:Chemistry of Oleochemicals and Surfactants**	**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)**	**Teaching Hours**
1.	Oleochemical and Surfactant raw materials and their derivatives as feedstock for Chemical Industries, Worldwide Statistics of Oleochemical and Surfactant Industries	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	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.	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	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	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.	12
7.	Synthesis, analysis and applications of Nonionic Surfactants: Fatty Alcohol ethers,	08

	Alcohol Polyglycol Ethers, Alkyl phenol ethers, Mono and diglycerides, Lecithin, Polyol esters (TWIN, SPAN, Sucrose polyester), Alkanolamides etc. 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	08
	Total	**60**
List of Text Books/ Reference Books		
1.	Synthetic Detergents, Davidson, A. S.; Milwidsky, B. 7th Ed. John Wiley and Sons, New York, (1987).	
2.	Handbook of Surfactants, Porter, M. R., Springer Science and Business Media (1993).	
3.	Surfactants in Consumer Products: Theory, Technology and Applications, Ed. J. Falbe, Springer-Verlag, Berlin (1987).	
4.	Industrial Applications of Surfactants-II, D. R. Karsa, Royal society of Chemistry (1990).	
5	Bailey's Industrial Oil and Fat Products, D. Swern, ed., Vol. I (1979), Vol. 2 (1982), 4th ed., John Wiley & Sons, Inc., New York,.	
6	Bailey's Industrial Oil and Fat Products, Sixth Edition Vol. 6: Industrial and Nonedible Products from Oils and Fats, Ed. FereidoonShahidi, Wiley Interscience Publication (2005).	
7	Fatty Acids in Industry, R. W. Johnson, and E. Fritz, eds., Marcel Dekker, Inc., New York, (1989).	
8	Richard M.; Marilyn E. K.; Pashley. Applied Colloid and Surface Chemistry, *John Wiley and Sons Ltd*, Chichester, UK (2004).	
9	Richard M.; Marilyn E. K.; Pashley. Applied Colloid and Surface Chemistry, *John Wiley and Sons Ltd*, Chichester, UK (2004).	
Course Outcomes (Students will be able to…..)		
CO1	Understand the technical significance of Oleochemical and Surfactant Industries. (K2).	
CO2	Conceptualize and develop the different modes of derivatizations of oleochemical and surfactants and its applications (K5).	
CO3	Analyse and illustrate the HLB, diverse interfacial phenomenon, molecular aggregations and phase behaviour of surfactants.(K4)	
CO4	Ability to identify and interpret the role of surfactants as specialty and high performance chemicals. (K5)	
CO5	Ability to design the synthesis of surfactant (K4)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+Psy	K3	K3+A	K2+A	K3	K6+A+Psy	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

		Course Title: Colour Physics and Colour Harmony	**Credits = 3**

	Course Code: PYT 1202		L	T	P
	Semester: III	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Organic chemistry, Technology of Intermediates I

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. 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 and Subtopics)	Required Hours
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 – KubelkaMunk 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, Munsellcolour 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
	Total	**45**

List of Textbooks/Reference Books

1	Colour Physics for Industry, R. McDonald, West Yorkshire, 1997.
2	Color: A Multidisciplinary Approach; Zollinger Heinrich Zurich, Verlag Helvetica ChemicaActa, 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…..)

CO1	Understand the colour perception and the effect of various parameters on it and various visual and colour processes in human beings (K1,K2)
CO2	~~Understand various visual and colour processes in human beings. (K1,K2)~~
CO3	Understand various systems to specify uniquely a colour stimulus and use them to do so.(K1,K2,K3)
CO4	Use knowledge of such colour systems to predict recipe (K2, K3)
CO5	Understand colour harmony to study various colour contrasts. (K1, K2)
CO6	Understand various colour harmony theories and the use of colour wheel. (K1, K2, K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PO13**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	2	3	3	3	2	2	2	1	1	0	3	2	3	3
CO2	K2	2	3	3	3	2	2	2	1	1	0	3	2	3	3
CO3	K3	3	3	3	3	2	2	2	1	1	0	3	2	3	3
CO4	K3	3	3	3	3	2	2	2	1	2	1	3	2	3	3
CO5	K3	2	3	3	3	3	3	2	1	2	1	3	2	3	3
CO6	K3	2	3	3	3	3	3	3	1	2	1	3	2	3	3
Course	K3	3	3	3	3	3	3	3	1	2	1	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code:	**Course Title:**	**Credits = 2**		
	DYP 1001	**Analysis of Inorganic Raw Materials used in Dyestuff industries**	**L**	**T**	**P**
	Semester: III	**Total Contact Hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses	
Organic chemistry, Technology of Intermediates I	
List of Courses where this course will be prerequisite	
All dyestuff technology courses	
Description of relevance of this course in the B. Tech. Program	
Students will understand the significance of uses of these inorganic raw materials in the chemical industry	
	Course Contents (Topics and Subtopics)	**Required Hours**
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
	Total	**60**
List of Textbooks/Reference Books		
1	Vogel's textbook of quantitative chemical analysis, G. H. JEFFERY J. BASSETT J. MENDHAM R C. DENNEY, Longman Scientific & Technical, 5th Edition	
Course Outcomes (Students will be able to…..)		

CO1	*Estimate* the amount of inorganic compounds present (K4)
CO2	*Check* the purity of compound (K3)
CO3	*Understand* the controlling and quantitative analysis of reducing agents (K2)
CO4	*Analyse* and identify the classes of metal containing reducing and oxidizing agents (K4)
CO5	*Identify* the reducing and oxidizing agents used for synthesis (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PO 13**	**PSO 2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K4	2	2	2	3	3	3	2	2	3	1	2	3	3	2
CO2	K3	2	2	2	3	3	3	2	2	3	1	2	3	3	2
CO3	K2	2	2	2	3	3	3	2	2	3	1	2	3	3	3
CO4	K4	3	3	3	3	3	3	2	2	2	1	2	3	3	3
CO5	K4	3	3	3	3	3	3	2	2	3	1	2	3	3	3
course	K4	3	3	3	3	3	3	2	2	3	1	2	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: PYP 1203	**Course Title: Colour Physics**	**Credits = 2**		
			L	**T**	**P**
	Semester: III	**Total Contact Hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses

Organic chemistry, Technology of Intermediates I

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. Program

Students will be trained to determine various parameters related to colour physics which are applicable in different fields.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Determination of unknown concentration of a dye in solution by Dubosque colorimeter.	6
2	Verification of B-L law (dependence of absorbance on concentration) by spectrophotometer.	6
3	Mixture analysis using spectrophotometer.	6
4	Determination of gloss of various samples using gloss meter	6
5	Determination of color of various textile samples in terms of Lovibond primaries and chromaticity co-ordinates using Lovibondtintometer	6
6	Specification of color of a textile sample in terms of 'Lab' at using color computer.	6

7	Finding color differences (ΔE) between set of samples vis a vis dye solution concentration	6
8	Finding color differences (ΔE) between set of samples vis a vis time of exposure.	6
9	Determination of colors of samples in terms of Munsell color system using Munsell Color Tree	6
10	Recipe prediction and matching of colored samples using CCM.	6
	Total	**60**
List of Textbooks/Reference Books		
1	Colour Physics for Industry, R. McDonald, West Yorkshire, 1997.	
2	Coloring of plastics: theory and practice by M.Ahmad Van Nostrand Reinhold, 1979	
Course Outcomes (Students will be able to…..)		
CO1	To understand colour specifying systems and schemes of quantification of colour.(K2)	
CO2	To measure the intensity of the transmitted light and correlate it with concept of chromophore and colour	
CO3	To use instruments to uniquely specify a colour in terms of nos.	
CO4	To explain various concepts of colour mixing, sources etc.	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	3	3	2	3	2	2	2	2	2	2	3	2	2	2
CO2	K3	3	3	3	3	3	3	2	2	2	3	3	3	3	3
CO3	K4	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Course	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; − No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester IV

	Course Code: GET1117	Course Title: Engineering Mechanics and Strength of Materials	Credits = 3		
			L	T	P
	Semester: IV	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Standard XII Physics and Mathematics, Applied Mathematics - I and - II, Applied Physics - I

List of Courses where this course will be Prerequisite

Material Technology, Strength of Materials, Environment Science and Technology

Description of relevance of this course in the B. Tech. (Pharm. Chem. Tech.) Programme

This subject will help students to understand use of basics of Applied Mechanics and Strength of Materials. As a practicing Engineer and Technologist, the students will relate different types of forces to be considered along with their quantification during design of equipment. It will also help in understanding the conditions of equilibrium and their application for analysing 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 including in thin cylindrical shells., advantages and disadvantages of various geometric sections available for Engineering design. In addition, the students will be acquainted with different advance fibre polymer composite materials used in industry for various applications and several performance- enhancing construction chemicals. In summary, this is a foundation course for a proficient Design Engineer and Technologist.

Sr. No.	Course Contents (Topics and subtopics)	Required 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.	6
3	Concept of Cetroid and 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.	4
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 philosophies.	6
6	Theory of Bending - Assumptions in derivation of basic equation, Basic equation, Section modulus, Bending stress distribution	3
7	Problems on shear stress - Concept, Derivation of basic formula Shear stress distribution for standard shapes Problems of Shear stress distribution	3
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	Thick and Thin cylinders - Concept of radial, longitudinal stresses, behaviour of thin cylinders Problems on thin cylindrical and spherical shells Behaviour of thick cylinders (Theory only)	4

10	Natural Materials, Manmade Materials Composite Materials – Types of composite materials and their uses in various industrial applications Different types of performance enhancing and special purpose construction chemicals Plasticizers and super-plasticizers Recycling of waste – value addition Testing of Materials and its relevance	6
Total		**45**

List of Text Books/ Reference Books

1	Thadani, B. N. Engineering Mechanics; Asia Publishing House (1966)
2	Popov, Egor P. Introduction to Mechanics of Solids; Macdonald (1968)
3	Beer. Mechanics of Materials; 7th Ed.; Mc Graw Hill India (2016)
4	Dadhe, V. G.; Jamdar, M. G.; Walavlkar, Y. N. Fundamentals of Applied Mechanics; Sarita Prakashan (1989)
5	Timoshenko, S.; Young, D. H.; Rao, J. V.; Pati, Sukumar. Engineering Mechanics; 5th Ed.; McGraw Hill Education (2017)
6	Singer, Ferdinand L.; Pytel, Andrew. Strength of Materials; 4th Ed.; Harper Colins Publishers (2012)
7	Kaw, Autar K. Mechanics of Composite Materials; 2nd Ed.; CRC Press (2006)
8	Shetty, M. S.; Concrete Technology: Theory and Practice; S. Chand & Co. Ltd. (2005)

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

CO1	quantify the actions and able to find reactions by applying conditions of equilibrium, find out the Centroid and Moment of Inertia for various cross sections used in engineering structures and for plane areas and be able to draw the Shear Force and Bending Moment diagram for different types of beams under simple and complex loading (K3)
CO2	calculate the forces, reactions, stresses, strains in components of the bodies of a complex engineering structure (K3)
CO3	find out the Bending Stresses at different positions and Shear Stress distribution across the cross section at various points and calculate the Slope and Deflection at different points under simple and complex loading (K3)
CO4	explain various materials used in various applications in engineering. cement composite – Concrete, Chemicals used to alter the properties of concrete (K2)
CO5	Ability to document the technical report .(K2)

Mapping of Course Outcomes (Cos) with Programme Outcomes (Pos)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	1	3	2	3	3
CO2	K3	3	3	1	2	1	3	3	2	3	3	3	2	1	3
CO3	K3	3	2	2	2	2	3	2	3	3	3	0	2	3	3
CO4	K2	3	2	0	2	1	3	3	3	3	3	3	1	3	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: CET1105	Course Title: Transport Phenomena	Credits = 4		
			L	T	P
	Semester: IV	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

XIIth Standard Physics and Mathematics

List of Courses where this course will be prerequisite

This is a basic course required in special subjects that deal with flow offluids, heat and mass transfer, etc.

Description of relevance of this course in the B. Tech. Program

This basic course introduces concepts of momentum, heat and mass transfer to students. Various other concepts such as pressure, momentum, energy are introduced as well. Laws related to conservation of momentum, energy, mass are taught. Applications of these laws to various engineering and technological situations and process equipments are explained with the help of several problems.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	Fluid Statics and Applications to Engineering importance	4
2	Applications of Bernoulli's Equation, Pressure-drop in pipes and Fittings,Meters, Fluid moving machinery such as pumps	10
3	Particle Dynamics, Flow through fixed and fluidized Beds	4
4	Equations of Continuity and Motion in laminar flows and its applicationsfor simple Couette flow and Poiseuille flow applications	6
5	Heat conduction, Convective heat transfer and concept of heat transfer coefficient	4
6	Design and Constructional Aspects of Exchangers: Types of flows - Concurrent, counter-current and cross flows, Log mean temperature difference, Double-pipe and Shell and tube heat exchangers Introduction to other heat exchangers like, PHE, finned tube heat exchangers, graphite block, etc.	10
7	Heat transfer aspects in agitated tanks, Condensers, Reboilers and evaporators	6
8	Fundamentals of Mass Transfer: Molecular diffusion in fluids, concept ofmass transfer coefficients, and interface mass transfer	4
9	Theories of mass transfer, Analogies for heat and mass transfer, Empirical correlations	4
10	Mass transfer applications in simple 1-D situations	8
	Total	**60**

List of Text Books/ Reference Books

1	Transport Phenomena, Bird R.B., Stewart W.E., Lightfoot E.N.
2	Fluid Mechanics, Kundu Pijush K.
3	Fluid Mechanics, F. W. White
4	Unit Operations of Chemical Engineering, McCabe, Smith

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

CO1	calculate friction factor, pressure drop, power (K3)
CO2	calculate flow and power required for pumps(K3)
CO3	calculate heat transfer coefficients and do basicsizing of double pipe and shell and tube heat exchangers (K3)
CO4	calculate mass transfer coefficients and estimate mass transfer rates in simple situations (K3)

Mapping of Course Outcomes (Cos) with Programme Outcomes (Pos)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	1	2	1	3	1	3	3	3	1	2	3	3
CO3	K3	3	1	2	2	2	2	3	2	3	3	3	2	2	3

CO4	K3	3	3	2	0	2	3	3	3	3	2	3	0	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: GET1105	**Course Title:** Electrical Engineering and Electronics	**Credits = 3**		
			L	**T**	**P**
	Semester: IV	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

Standard XII Physics and Mathematics courses

List of Courses where this course will be prerequisite

Various Technology Courses and Professional Career

Description of relevance of this course in the B. Tech. Program

In this course, students will get an insight to the importance of Electrical Energy in Chemical Plants. The students will understand basics of electricity alongside basic knowledge about Transformer and selection of different types of drives for a given application process. They will get basic knowledge of electronic devices and their applications in Power supplies, amplifiers and other circuits.

Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
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	3
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. Resonance in series RLC circuits, Power, power factor, series and parallel circuits	5
4	Three Phase systems: Star and delta connections, relationship between line and phase voltages and currents, Power in three phase circuits	5
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	5
7	Diodes and rectifiers: P-N junction diode characteristics, Zener diode, Half wave and full wave rectifiers, their waveforms, brief introduction to filters	4
8	Bi-polar junction transistor: Current components. Modes of operation, Input and output characteristics, Regions of operation, Transistor as an amplifier, classification of amplifiers	6
9	Introduction to Uni junction transistor, Characteristics, UJT relaxation oscillator	3
10	Silicon controlled rectifier, controlled rectification, characteristics, methods of turning-on. Applications	3
	Total	**45**

List of Textbooks/Reference Books

1	Electrical Engineering Fundamentals by Vincent Deltoro
2	Electronic devices and circuits by Boylstead, Nashelsky
3	Electrical Machines by Nagrath, Kothari
4	Electrical Machines by P.S. Bhimbra
5	Electrical Technology by B. L. Theraja, A.K.Therajavol I,II,IV
6	Thyristors and their applications by M. Ramamurthy
7	Power Electronics by P.S. Bhimbra

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

CO1	Explain the basic concepts of D.C circuits. Solve basic electrical circuit problems (K3)
CO2	Explain the basic concepts of single phase and three phase AC supply and circuits (K2)

CO3	Explain the basic concepts of transformers & motors used as various industrial drives (K2)
CO4	Explain the basic concepts of electronic devices and their applications (K2)

Mapping of Course Outcomes (Cos) with Programme Outcomes (Pos)														
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K2	3	2	0	2	1	3	3	3	3	2	3	0	3	2
CO3	K2	3	2	1	2	0	3	3	2	3	3	3	1	3	2
CO4	K2	3	0	1	2	1	2	3	3	1	3	1	1	2	2
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYT 1102	**Course Title:** Technology of Intermediates-II	**Credits = 4**		
			L	**T**	**P**
	Semester: IV	**Total Contact Hours: 60**	**3**	**1**	**0**

List of Prerequisite Courses

Organic chemistry, Technology of Intermediates I

List of Courses where this course will be prerequisite

All dyestuff technology courses

Description of relevance of this course in the B. Tech. Program

To make the students understand chemistry various intermediates used for chemical industry in general and Dyestuff industry in particular.

To make them understand the unit processes and their relevance in chemical industries.

To enable them to analyze 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.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Chemistry of Naphthalene	03
2	Unit Processes: a. Friedel Craft's Reaction b. Oxidation c. Ammonolysis d. Hydrolysis e. Diazotization and coupling d. Bucherer Reaction, Reverse	20
3	Synthesis of naphthol, naphthylamine sulphonic acids, Bon acid and its derivatives	20
4	Case studies	05
5	Active Methylene compounds	05
6	Technology and safety aspects	03
7	Separation techniques and agitation system	05
	Total	**60**

List of Textbooks/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
Course Outcomes (Students will be able to…..)	
CO1	*Understand* the basics of Naphthalene chemistry (K2)
CO2	*Conceptualize* basic unit processes for naphthalene and benzene (K2)
CO3	*Analyze* the various methods for synthesis of different intermediates used in dyes (K2)
CO4	*Master* the various technology and safety aspects for reactions. (K2)
CO5	*Know* various separation techniques used commercially and agitation systems for processes (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	2	2	2	2	1	1	1	0	0	0	3	0	2	2
CO2	K2	2	2	2	2	1	1	1	0	0	0	3	0	2	2
CO3	K2	2	2	2	2	2	2	2	0	0	0	3	0	2	2
CO4	K2	3	3	3	3	3	2	2	1	0	0	3	0	3	3
CO5	K2	3	3	3	3	3	2	2	1	0	0	3	1	3	3
Course	K2	3	3	3	3	3	2	2	1	0	0	3	1	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYT 1202	**Course Title: Chemical and Physical Constituents of Colorants**	**Credits = 3**		
			L	**T**	**P**
	Semester: IV	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

HSC (Science) and Chemistry of intermediates-I and Chemistry of intermediates-II

List of Courses where this course will be prerequisite

All dyestuff technology specialized courses.

Description of relevance of this course in the B. Tech. Program

Students will be able to understand the relation between the chemical structure and the colour.

	Course Contents (Topics and Subtopics)	**Required 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.	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-acceptor, acyclic and cyclic polyene, and cyanine type chromogens	03

3	Resonance theory of color, failures of resonance theory. Steric effects in electronic absorption spectra – some general considerations.	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	03
5	Simple donor-acceptor chromogens: general characteristics – donor group, unsaturated bridge, acceptor group. The carbonyl acceptor – merocyanine types of compounds.	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-hydrazonetautomerism in azo dyes	03
7	Color and chemical constitution of indigoid dyes. Introduction to cross-conjugated chromophores. Chromogens based on acycyclicand cyclic polyene systems: general characteristics with examples. Cyanine type chromogens.	03
8	Di- and triaryl methane colorants, heterocyclic analogues of di- and triaryl methane colorants. Simple color and constitution relationships.	03
9	Essentials of computational colour chemistry – brief introduction to one particle system. Schrodinger equation. Particle in a box.	03
10	Two particle system, Many particle systems – HartreeFock theory. Basis sets.	03
11	Electronic Structure theory. Molecular orbitals and light absorption. Semiempirical methods,	03
12	Limitations of HartreeFock method, Computational complexities in post HartreeFock (wavefunction based methods).	03
13	Introduction to Density Functional Theory and its application in colour chemistry	03
14	Excited State calculations, Configuration Interaction Singles.	03
15	Time Dependent Density Functional Theory.	03
	Total	**45**
List of Textbooks/Reference Books		
1	Chemistry of Synthetic Dyes and Pigments, Lubs H. A., Robert E Krieger Publishing	
2	Company, New York, 1977	
3	Chemistry of Synthetic Dyes – Vol I, Venkataraman, K., Academic Press, 1952	
4	Chemistry of Synthetic Dyes – Vol III, Venkataraman, K., Academic Press, 1972	
5	Colour and Chemical Constitution of Organic Dyes, Griffiths J., Academic Press, 1976	
6	Quantum Chemistry, Chandra A. K., Tata McGraw Hill, 1979	
Course Outcomes (Students will be able to…..)		
CO1	*Understand* the constitution of different colorants. (K2)	
CO2	*Analysis* the correlation of proposed absorption and observed absorption. (K2)	
CO3	*Identify* the colour changes with different classes of molecules. (K2)	
CO4	*Understand* the detail properties of colour changes with respective structural changes (K2)	
CO5	*Assess* the technical importance of colour chemistry (K2)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	2	2	2	2	0	0	0	0	0	0	3	0	2	2
CO2	K2	2	2	2	2	1	0	0	0	0	0	3	0	2	2

CO3	K2	2	2	2	2	1	1	1	1	1	1	3	1	3	2
CO4	K2	3	3	3	3	1	2	2	2	2	2	3	1	2	3
CO5	K2	2	2	2	2	1	2	2	2	2	2	3	1	3	3
Course	K2	3	3	3	3	2	2	2	2	2	2	3	1	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYT 1107	**Course Title:** Technology of quinonoid intermediates	**Credits = 3**		
			L	**T**	**P**
	Semester: IV	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

HSC (Science) and Chemistry of intermediates-I and Chemistry of intermediates-II

List of Courses where this course will be prerequisite

All dyestuff technology specialized courses.

Description of relevance of this course in the B. Tech. Program

The students will be introduced to the different chemical and technological aspects of accessing the intermediates of anthraquinone based dyes.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Introduction to Anthraquinone chemistry, Synthesis, mechanism, sources of Anthraquinones	15
2	Synthesis of Anthraquinone and anthraquinone derivatives	15
3	Reactions of Anthraquinone: Sulphonation, Nitration, Halogenation, Bucherer Reaction	15
	Total	**45**

List of Textbooks/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

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

CO1	*Define* and state different terminologies related to AQ (K2)
CO2	*Describe* and explain the Chemistry and technology of AQ based compounds (K2)
CO3	*Application* of AQ in pigments and dyes (K3)
CO4	*Outline* the synthesis of various commercially important products (K2)
CO5	*Develop* methods for the synthesis of quinonoid intermediates (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PO13**	**PSO2**

		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	2	2	2	2	0	1	1	0	0	0	3	0	2	3
CO2	K2	2	2	2	2	0	1	1	0	0	0	3	0	2	3
CO3	K3	3	3	3	3	1	1	1	1	2	1	3	1	3	2
CO4	K2	3	3	3	3	2	2	2	1	2	1	3	1	2	3
CO5	K3	3	3	3	3	2	2	2	1	2	1	3	1	3	3
course	K3	3	3	3	3	2	2	2	1	2	1	3	1	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: **GEP1106**	**Course Title:** **Electrical Engineering and Electronics Laboratory**	**Credits = 2**		
			L	**T**	**P**
	Semester: IV	**Total Contact Hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses

Standard XII Physics and Mathematics courses

List of Courses where this course will be prerequisite

Various Technology Courses and Professional Career

Description of relevance of this course in the B. Tech. Program

In this course, students will get an insight to the importance of Electrical Energy in Chemical Plants. The students will understand basics of electricity alongside basic knowledge about Transformer and selection of different types of drives for a given application process. They will get basic knowledge of electronic devices and their applications in Power supplies, amplifiers and other circuits.

	Course Contents (Topics and Subtopics)	**Required Hours**
	Suitable no of experiments out of the following will be conducted -	
1	Superposition Theorem	5
2	Thevenin's Theorem	5
3	Series RL circuit	4
4	Resonance in Series RLC circuit	5
5	H.W. and F.W. Rectifiers	4
6	Cathode Ray Oscilloscope	5
7	Input and output characteristic of npn transistor in CE mode	4
8	Load Test on Transformer	4
9	Three phase star connection	4
10	Three phase delta connection	4
11	Study of UJT relaxation oscillator	4
12	Design of UJT relaxation oscillator	4
13	Load Test on 3 phase induction motor	4
14	Study of Thermocouple	4
	Total	**60**

List of Textbooks/Reference Books

1	Electrical Engineering Fundamentals by Vincent Deltoro
2	Electronic devices and circuits by Boylstead, Nashelsky
3	Electrical Machines by Nagrath, Kothari
4	Electrical Machines by P.S. Bhimbra
5	Electrical Technology by B. L. Theraja, A.K.Therajavol I,II,IV
6	Thyristors and their applications by M. Ramamurthy
7	Power Electronics by P.S. Bhimbra

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

CO1	Explain concepts of basic working of D.C circuits (K2)

CO2	Explain the basic applications of single phase and three phase AC supply and circuits (K2)
CO3	Explain the working and utility of transformers and motors used as various industrial drives (K2)
CO4	Apply the basic principles in electronic devices and circuits (K3)

Mapping of Course Outcomes (Cos) with Programme Outcomes (Pos)														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	0	3	3	3	3	3	3	1	3	2
CO2	K2	3	2	1	1	1	3	3	3	3	3	3	0	2	2
CO3	K2	3	2	0	2	1	3	3	3	2	2	3	1	3	2
CO4	K3	3	3	2	2	2	3	3	2	3	3	3	2	3	3
Course	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code:	**Course Title:**	**Credits = 2**		
	MAP1201	**Computer Applications Laboratory**	**L**	**T**	**P**
	Semester: IV	**Total Contact Hours: 64**	**0**	**0**	**4**

List of Prerequisite Courses

HSC Standard Mathematics, Applied Mathematics – I (MAT1101)

List of Courses where this course will be prerequisite

This is a basic Mathematics course. This practical knowledge will be required in several subjects later.

Description of relevance of this course in the B. Tech. Program

Students will understand the basics of Python programming and get exposure to the use of spreadsheet programme and Excel for numerical computations and statistical analysis for engineering applications. The students will also explore R-programming for Regression Analysis, Testing of Hypothesis using of standard statistical inference. B. Tech programme requires students to analyze data and develop computer programmes to solve various problems in Engineering and Technology fields.

	Course Contents (Topics and subtopics)	**Hours**
1	Introduction to Spreadsheet Programmes, Use of formulae and Plotting Graphs of Function and Data Plotting in Excel	4
2	Exploring Basic Statistics and Hypothesis Testing with Spreadsheet	4
3	Numerical Solution of Linear and Non-Linear Equations in Excel	4
4	Basic Introduction to R and R Studio, Data Management in R	4
5	Plotting Graphs in R, Exploring Probability Distribution Function in R	4
6	Hypothesis Testing in R	4
7	Basic Regression Analysis in R	4
8	Introduction to Python, Installation of Python and jupyter notebook through Anaconda. Variables in Python, Exploring math and cmath modules	4
9	List, Tuples and Dictionaries in Python, if else and elif statements, Creating functions (using def and lambda functions)	4
10	For loops and while loops in Python, Use of break and continue statements with loops, Developing Python programmes using loops	4
11	Writing Python Programme to solve problems in basic numerical analysis such root finding, Numerical solutions of linear equations, Numerical integration, etc.	4
12	Use of Numpy and Scipy to deal with vectors, matrices and their operations	4
13	Use of Numpy and SciPy continued	4
14	Plotting graphs using matplotlib	4
15	Use of Pandas for data processing and analysis	4
16	Linear and multilinear regression using Python	4

Total		64
List of Textbooks/ Reference Books		
1	Carlberg, Conrad George. Statistical analysis: Microsoft Excel 2016; Que (2018).	
2	Langtangen, Hans Petter. A Primer on Scientific Programming with Python; 5th Ed.; Springer-Verlag Berlin Heidelberg (2016)	
3	Thareja, Reema; Python Programming - Using Problem Solving Approach; Oxford University Press (2017)	
4	Beazley, David; Jones, Brian K. Python Cookbook: Recipes for Mastering Python 3; O'Reilly Media (2013)	
5	VanderPlas, Jack; Python Data Science Handbook: Essential Tools for Working with Data; 1st Ed.; O'Reilly Media (2016)	
6	Dalgaard, Peter; Introductory Statistics with R; 2nd Ed.; Springer (2008)	
7	Navarro, Daniel; Learning Statistics with R (2013)	
8	Dennis, Brian; The R Student Companion; CRC Press (2012)	
9	Verzani, John; Using R for Introductory Statistics; 2nd Ed.; CRC Press (2014)	
Course Outcomes (Students will be able to…..)		
CO1	perform descriptive statistical analysis using Excel (K3)	
CO2	perform basic statistical tests using R (K3)	
CO3	perform linear regression using R (K3)	
CO4	write Python programs to implement basic numerical methods (K4)	
CO5	perform data processing and regression analysis using Python (K4)	

Mapping of Course Outcomes (Cos) with Programme Outcomes (Pos)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	0	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	2	1	2	3	3	3	3	3	1	2	0	3
CO3	K3	3	1	2	2	2	2	3	0	3	2	3	2	3	3
CO4	K4	3	3	0	3	2	3	3	3	3	3	3	0	3	3
CO5	K4	3	3	2	3	2	3	3	2	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester V

Chemical Reaction	Course Code: CET1401	Course Title: Chemical Engineering Operations	Credits = 3		
			L	T	P
	Semester: V	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Process Calculations (CET1507), Transport Phenomena (CET1105)

List of Courses where this course will be prerequisite

This is a basic course. It is required in many other courses that involve physical processes

Description of relevance of this course in the B. Tech. Programme

This is a basic Chemical Engineering course. The principles learnt in this course are required in almost all the forthcoming courses and throughout the professional career of students.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Distillation: Fundamentals of flash-, batch- and continuous distillation, Distillation columns internals, Steam and azeotropic distillation	12 – 15
2	Liquid-Liquid Extraction: Solvent selection, Construction of ternary diagrams, Staged calculations, Types of extraction equipment	6
3	Crystallization: Phase diagram (temp/solubility relationship), Evapo-rative and cooling crystallization, Introduction to different types of crystallizers	5
4	Filtration: Mechanism of filtration, Basic equation, Constant volume, Constant pressure filtration, Rate expressions with cake and filter cloth resistances, Compressible and incompressible cakes, Introduction to various types of filters	5
5	Drying: Drying mechanism, Drying rate curves, Estimation of drying time, ypes of dryers	5
6	Introduction to Other Aspects of Unit Operations: Content will be aimed towards understanding practical and safety aspects of unit operations and/or introducing other separation processes like: adsorption/ion exchange, membrane processes and gas absorption, etc.	9 – 6
7	Industrial Case Studies: Interactive discussion with experienced professionals from industry or equipment vendors with emphasis on applicability, importance and challenges of different unit operations	3
Total		**45**

List of Text Books/ Reference Books

1	Richardson, J.F., Coulson, J.M., Harker, J.H., Backhurst, J.R., 2002. Chemical engineering: Particle technology and separation processes. Butterworth-Heinemann, Woburn, MA.
2	Seader, J.D., Henley, E.J., 2005. Separation Process Principles, 2 ed. Wiley, Hoboken, N.J.
3	Svarovsky, L., 2000. Solid-Liquid Separation. Butterworth-Heinemann, Woburn, MA.
4	McCabe, W., Smith, J., Harriott, P., 2004. Unit Operations of Chemical Engineering, 7 ed. McGraw-Hill Science/Engineering/Math, Boston.
5	Green, D., Perry, R., 2007. Perry's Chemical Engineers' Handbook, Eighth Edition, 8 ed. McGraw-Hill Professional, Edinburgh.
6	Dutta, B.K., 2007. Principles of Mass Transfer and Separation Process. Prentice-Hall of India Pvt. Ltd, New Delhi.

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

CO1	perform basic sizing of continuous and batch distillation columns (K3)
CO2	analyze filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage (K4)
CO3	describe few industrial crystallization, filtration and drying equipment (K2)
CO4	describe the need and importance of other separation processes like adsorption, ion exchange and membrane (K2)
CO5	Apply the concept of unit operation in chemical industries (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4

CO1	K3	3	3	2	2	1	3	3	3	3	3	0	2	3	3
CO2	K4	3	3	2	3	2	3	2	3	3	2	3	2	3	3
CO3	K2	3	2	0	2	1	3	3	2	3	3	3	1	3	2
CO4	K2	3	2	1	2	0	3	3	3	3	1	3	1	2	2
CO5	K3	3	3	2	2	2	1	3	3	1	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: CET1212	**Course Title:** Chemical Reaction Engineering	**Credits = 3**		
			L	**T**	**P**
	Semester: V	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

Physical Chemistry – I and – II, Transport Phenomena

List of Courses where this course will be prerequisite

Environmental Engineering and Process Safety, Chemical Project Economics

Description of relevance of this course in the B.Tech. Program

The course is concerned with the utilization of chemical reactions on a commercial scale. This course is very relevant but not limited to the following industries: Inorganic chemicals, organic chemicals, petroleum & petrochemicals, Pulp & paper, Pigments & paints, rubber, plastics, synthetic fibres, Foods, Dyes and intermediates, Oils, oleo chemicals, and surfactants, Minerals, clean sing agents, Polymers and textiles, Biochemicals and biotechnology, Pharmaceuticals and drugs, Microelectronics, energy from conventional and non-conventional resources, Metals

Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
1	Kinetics of homogeneous reactions, Interpretation of batch reactor data, Single ideal reactors including design aspects	10
2	Multiple reactions, Temperature and pressure effects	5
3	Introduction to Non-ideal flow, RTD measurements, Models to predict conversions	5
4	Homogeneous and Heterogeneous Catalysis, Kinetics of Solid Catalyzed Reactions. Design of gas – solid catalytic reactors	15
5	Introduction to multiphase reactors	5
6	Mass Transfer with Chemical Reactions: Regimes of operation and Model contactors	5
	Total	**45**

List of Textbooks

1	Elements of Chemical Reaction Engineering – H. Scott Fogler

List of Additional Reading Material / Reference Books

1	Heterogeneous Reactions, Vol.I and II –L.K. Doraiswamy, M.M.Sharma

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

CO1	describe and apply the principles of various types of reactors (K3)
CO2	calculate rates of reactions based on given reaction scheme (K3)
CO3	design various components of reactors used in industrial practice (K3)
CO4	compare various reactors and select an appropriate reactor for a given situation (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	1	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	2	2	2	1	3	0	3	3	2	0	3	3
CO3	K3	3	3	2	1	2	3	3	3	3	3	3	2	3	3
CO4	K4	3	3	2	3	0	2	3	3	1	3	3	1	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYT 1103	Course Title: Technology of Azo Colorants	Credits = 4		
			L	T	P
	Semester: V	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

HSC (Science), Chemistry of intermediates-I and Chemistry of intermediates-II

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. Program

The subject is intended to make the students learn about the azo chromophore, their synthesis and properties as well as several dyes related to azo chromophore. The course will also focus on discussing the properties of several azo dyes as well as their synthesis routes and their structural importance along with the recent trends in the azo dyes as well as their technical importance.

	Course Contents (Topics and Subtopics)	Required 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	04
2	Direct dyes Dyeing of cotton Chemical constitution and substantivity Examples of bisazo dyes for cotton Manufacture of direct dyes Chemical constitution and fastness properties Drawbacks of direct dyes	08
3	Reactive dyes Concept of reactive dyeing as a way of improving wash fastness History of reactive dyes 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	18
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	10
5	Trisazo and polykisazo dyes	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	16

	Hydroxyethylation and handling of ethylene oxide Manufacture of disperse azo dyes Heterocyclic diazo and coupling components	
	Total	**60**
List of Textbooks/Reference Books		
1	Chemistry of Synthetic Dyes, Lubs H. A., NY 1995	
2	Chemistry of synthetic dyes vol I, Venkatraman K., NY 1952	
3	Chemistry of azo colorants Vol I and Vol II- P. Zollinger	
Course Outcomes (Students will be able to…..)		
CO1	*Explain* the and define the classes of dyes, substrates (K2)	
CO2	*Understand* the variety and chemistry of dyes and their application (K2)	
CO3	*Overview* of recent trends in the field of dyes containing azo groups (K2)	
CO4	*Differentiate* the Techniques of diazotization and variations available (K2)	
CO5	*Design* the synthesis of novel azo based dyes (K3)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	2	2	2	2	0	0	0	0	0	0	3	0	2	3
CO2	K2	2	2	2	2	0	0	0	0	0	0	3	0	2	3
CO3	K2	2	3	2	3	1	1	1	1	0	0	3	0	3	2
CO4	K2	2	3	2	3	1	1	1	1	1	1	3	1	3	2
CO5	K3	3	3	3	3	2	2	2	1	2	2	3	2	2	3
		3	3	3	3	2	2	2	1	2	2	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code:	**Course Title:**	**Credits = 3**		
	DYT 1207	**Chemistry and Technology of Quinonoid colorants**	**L**	**T**	**P**
	Semester: V	**Total Contact Hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
HSC (Science)					
List of Courses where this course will be prerequisite					
Dyes students					
Description of relevance of this course in the B. Tech. Program					
The students will get familiarize with the different quinonoid colorants, their synthesis and properties. As well as they will be able to understand the importance of anthraquinone scaffold in the dyes and pigments industry and will be able to successfully outline the synthetic schemes of several quinonoid colorants.					

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Introduction to Anthraquinone chemistry, Synthesis, mechanism, sources of Anthraquinones	10
3	Chemistry of Anthraquinonoid, Indigoid, polycyclic Quinonoids vat dyes	10
4	Disperse dyes, Reactive dyes, Acid dyes based on Quinonoid systems	15
5	Vat dyes and pigments	5
	Synthesis and technology for unit processes, material of construction, Work up	5
	Total	**45**
List of Textbooks/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
Course Outcomes (Students will be able to…..)	
CO1	*Define* and state different terminologies related to AQ (K2)
CO2	*Describe* the Chemistry and technology of AQ based compounds (K2)
CO3	*Application* of AQ in pigments and dyes (K2)
CO4	*Outline* the synthesis of various commercially important products (K3)
CO5	*Propose* methods for the synthesis of quinonoid dyes (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	2	2	2	2	0	1	0	0	0	1	3	0	2	3
CO2	K2	2	2	2	2	1	1	1	1	1	1	3	1	2	3
CO3	K2	3	3	3	3	2	2	2	1	1	1	3	2	3	2
CO4	K3	3	3	3	3	2	2	2	1	1	1	3	2	2	3
CO5	K3	3	3	3	3	2	2	2	1	1	1	3	2	2	3
Course	K3	3	3	3	3	2	2	2	1	1	1	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYT 1206	**Course Title: Structural Elucidation of Organic Molecular Spectroscopy**	**Credits = 3**		
			L	**T**	**P**
	Semester: V	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

Basic HSC (Science)

List of Courses where this course will be prerequisite

All dyestuff technology courses

Description of relevance of this course in the B. Tech. Program

The students will learn the basics of molecular spectroscopy and will be able to elucidate the molecular structure of unknown molecules by analyzing the several spectroscopic data.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Introduction to spectral methods of analysis. UV-Visible spectroscopy.	05
2	Nuclear Magnetic Resonance Spectroscopy: Principles, some basic terms. Shielding and 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.	10

3	IR-Spectroscopy: Basic theory, fingerprint region, treatment to identify functional groups, structure elucidation.	10
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.	05
5	Combined use of IR, NMR and Mass spectroscopy for structure elucidation.	10
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.	05
	Total	**45**
List of Textbooks/Reference Books		
1	Basic principles, sample preparation and related methods by Elsa Lundanes, Leon Reubsaet, Tyge Greibrokk	
2	Introduction to Spectroscopy by Donald L.Pavia, Gary M. Lampman, George S.Kriz, James R.Vyvyan	
3	Spectroscopic identification of Organic Compounds by Robert M.Silverstein, Francis X.Webster, David Kiemle	
Course Outcomes (Students will be able to…..)		
CO1	*Understand* the basic concepts of spectroscopy (K2)	
CO2	*Demonstrate* the knowledge in analyzing the UV and IR spectra (K2)	
CO3	*Analyze* the NMR spectra (K3)	
CO4	*Solve* complicated spectral problems (K4)	
CO5	*Assess* the mass spectroscopic spectra (K4)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	3	3	3	3	2	1	0	1	1	0	3	0	2	3
CO2	K2	3	3	3	3	2	1	0	1	1	0	3	0	2	3
CO3	K3	3	3	3	3	2	1	0	1	1	0	3	0	2	3
CO4	K4	3	3	3	3	2	1	0	1	2	2	3	2	3	2
CO5	K4	3	3	3	3	2	2	0	1	2	2	3	2	3	3
Course	K4	3	3	3	3	2	2	0	1	2	2	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: MAT1106	Course Title: Design and Analysis of Experiments	Credits = 4		
			L	T	P
	Semester: V	Total Contact Hours: 60	2	2	0

List of Prerequisite Courses

HSC Standard Mathematics, Applied Mathematics – I (MAT1101), Computer Applications Laboratory (MAP1201)

List of Courses where this course will be prerequisite

All subsequent technology and science courses

Description of relevance of this course in the B. Tech. Program

This course is required for graduating technocrats to function effectively and efficiently in Industry, Academia and other Professional Spheres.

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
	Module I (Statistical Theory of Design of Experiments)	
1	**Fundamental Principles of Classical Design of Experiments:** Strategy of Experimentation, Typical applications of experimental design, Basic principles, Guidelines for designing experiments	2
2	**Review of Probability and Basic Statistical Inference:** Concepts of random variable, Probability, Density function cumulative distribution function, Sample and population, Measure of central tendency, Mean, median and mode, Measures of variability, Concept of confidence level, Statistical Distributions: Normal, Log Normal & Weibull distributions, Hypothesis testing	4
3	**Experiments with a Single Factor: Analysis of Variance -** Fixed effect model and Random effect model, Model adequacy checking, Contrasts, Orthogonal contrasts, Regression Models and ANOVA, Violation of normality assumption: Kruskal-Wallis test Randomized block designs, Latin square designs, Balanced incomplete block designs	8
4	**Factorial Designs:** Definition, Estimating model parameters, Fitting response curves and surfaces	4
	Module II (Data Analysis using Software (R/Python))	
5	The 2^k Factorial design, Blocking and confounding in the 2^k Factorial design, Focus of 2^2 and 2^3 designs, Blocking and confounding in the 2k Factorial Design	8
6	Plackett Burman methods, Central Composite Design (CCD)	4
7	Descriptive Statistics, Probability Distribution and Testing of Hypothesis using R	6
8	Regression techniques, Diagnostic checks, ANOVA using R and implementation of contrasts	6
9	Construction of Balanced Incomplete Block Designs and data analysis using R	6
10	Analysis of factorial designs using R, Understanding output and interpretation	6
11	Factorial designs, Data analysis and interpretation.	6
	Total	**60**
	List of Textbooks/ Reference Books	
1	Montgomery, Douglas C. Design and Analysis of Experiments; 9th Ed.; John Wiley & Sons, Inc. (2017)	
2	Box, G. E.; Hunter, J. S.; Hunter, W. G. Statistics for Experimenters: Design, Innovation, and Discovery; 2nd Ed.; Wiley (2005)	
3	Lawson, John. Design and Analysis of Experiments with R; 1st Ed.; CRC Press (2015)	
4	Rasch, D.; Pilz, J.; Verdooren, R.; Gebhardt, A. Optimal Experimental Design with R; 1st Ed.; CRC Press (2011)	

5	Unpingco, J. Python for Probability, Statistics, and Machine Learning; 2nd Ed.; Springer (2019)
6	Anderson-Cook, Christine M.; Montgomery, Douglas C.; Myers, Raymond H. Response Surface Methodology: Process and Product Optimization using Designed Experiments; 4th Ed.; Wiley (2016)
7	Montgomery, Douglas C. Introduction to Statistical Quality Control; 7th Ed.; Wiley (2009)
8	Lazić, Živorad R. Design of Experiments in Chemical Engineering: A Practical Guide; 1st Ed.; Wiley-VCH (2005)
Course Outcomes (Students will be able to…..)	
CO1	Explain the basic principles of design of experiments (K2)
CO2	perform statistical analysis of single experiments and do post hoc analysis (K3)
CO3	conduct experiment and analyse the data using statistical methods (K4)
CO4	choose an appropriate design given the research problem (K5)
CO5	perform statistical analysis of different designs using R and interpret the results (K5)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	0	3	3	3	3	3	1	1	3	2
CO2	K3	3	3	2	2	2	3	3	3	0	3	3	2	3	3
CO3	K4	3	2	2	3	2	3	1	3	3	2	3	2	2	3
CO4	K5	3	3	3	3	3	3	3	3	3	3	0	3	3	3
CO5	K5	3	1	3	3	3	3	3	2	3	3	3	3	0	3
Course	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYP 1002	**Course Title: Analysis of Intermediates, Dyes and Fibers**	**Credits = 4**		
			L	**T**	**P**
	Semester: V	**Total Contact Hours: 120**	**0**	**0**	**8**
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. Program					
The students will be trained to analyse several intermediates of dyes, dyes and fibres by chemical tests.					

	Course Contents (Topics and Subtopics)	**Required Hours**
1	To analyze the purity of amine by the method of Diazotization– aniline, sulphanilic acid, chloroanilines, toluidines, anisidines, etc	8
2	Coupling experiments- Estimation of phenols and naphthols by bromination – phenol, 2-naphthol, R-acid, etc	8
3	Estimation of naphtholsulphonic acids and aminonaphtholsulphonic acids by diazo-coupling – Schaffer acid, R salt, gamma acid, J acid, etc	24
4	Estimation of dyes by reduction – Sunset Yellow, Ponceau 4R, Orange II, Tartrazine, etc	16
5	Identification of dyes – acid, basic, direct, acid mordant, vat, sulphur	16
6	Identification of fibres – cotton, wool, silk, nylon, polyester	20
7	To analyze the purity of amine by the method of Diazotization– aniline, sulphanilic acid, chloroanilines, toluidines, anisidines, etc	20

8	Coupling experiments- Estimation of phenols and naphthols by bromination – phenol, 2-naphthol, R-acid, etc	8
	Total	**120**
List of Textbooks/Reference Books		
1	Chemistry of Synthetic Dyes – Vol I, Venkataraman, K., Academic Press, 1952	
2	Synthesis and Application of Dyes, Rys and Zollinger	
3	The Chemistry of Synthetic Dyes – Vol II, Venkataraman K., Academic Press	
4	The Chemistry of Synthetic Dyes – Vol IV, Venkataraman K., Academic Press	
5	The Chemistry of Synthetic Dyes – Vol VI, Venkataraman K., Academic Press	
6	The Chemistry of Synthetic Dyes and Pigments, Lubs H. A., Robert E. Krieger Publishing Co	
Course Outcomes (Students will be able to…..)		
CO1	*Analyse* the purity of the amines used for dye synthesis. (K3)	
CO2	*Check* the presence of coupling components purity required for final dye synthesis. (K2)	
CO3	*Understand* the presence of diazo groups and reducible groups in the given dye structure. (K2)	
CO4	*Analyse* and identify the classes of dyes from the application-oriented perspective. (K3)	
CO5	*Identify* the substrates and chemistry of the fibres for dye affinity. (K3)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K3	2	3	3	3	2	2	2	0	2	1	3	3	3	2
CO2	K2	3	3	3	3	3	2	2	0	2	1	3	3	3	2
CO3	K2	3	3	3	3	3	2	1	0	2	1	3	3	2	3
CO4	K3	3	3	3	3	3	2	1	0	2	1	3	3	3	3
CO5	K3	3	3	3	3	3	2	1	0	2	1	3	3	3	3
Course	K3	3	3	3	3	3	2	2	0	2	1	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYP 1013	**Course Title: Chromatographic techniques**	**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 the Dyes Special Courses					
Description of relevance of this course in the B. Tech. Program					
The students will be introduced to the several chromatographic techniques essential for the monitoring, separation and purification of organic molecules after chemical transformations.					

	Course Contents (Topics and Subtopics)	**Required Hours**
1	TLC technique – preparation of TLC plate, finding rf value, separation of a mixture of two coloured organic compounds, detection of colourless compounds, separation of a mixture of a coloured and colourless compound and two colourless compounds	20
2	Separation and purification of organic compounds by column chromatographic techniques.	24
3	Use of flash chromatography for separation of mixture of organic molecules	16

	Total	60
List of Textbooks/Reference Books		
1	A text book of Practical Organic Chemistry including Qualitative Organic Analysis by Arthur Israel Vogel, Ed-3, Year 1984	
2	Chromatography: Basic principles, Sample preparations and Related Methods by Elsa Lundanes, Leon Reubsaet, Tyge Greibrokk	
Course Outcomes (Students will be able to…..)		
CO1	*Understand* the principle behind chromatographic techniques – TLC, paper and column – used for the separation of organic compounds (K2)	
CO2	*Learn* to use the appropriate techniques for a given separation scenario (K2)	
CO3	*Conduct* these processes in the lab independently for the separation of two or more organic compounds that may or may not be coloured (K3)	
CO4	*Apply* these techniques whenever separation of organic compounds needs to be done (K4)	
CO5	*Develop* methods for the separation using automated systems (K4)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	3	2	2	2	2	1	0	0	1	1	3	1	2	3
CO2	K2	3	2	2	2	2	2	0	0	1	1	3	1	3	2
CO3	K3	3	3	3	3	3	2	1	1	2	2	3	2	3	3
CO4	K4	3	3	3	3	3	2	1	1	2	2	3	3	3	3
CO5	K4	3	3	3	3	3	2	1	2	2	2	3	3	3	3
course	K4	3	3	3	3	3	2	1	2	2	2	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester VI

	Course Code: DYT 1105	Course Title: Technology of Sulphur and Cationic Colorants	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 the Dyes Special Courses
Description of relevance of this course in the B. Tech. Program
Students will be able to understand the chemistry and Technology of Sulphur and Cationic Colorants.

	Course Contents (Topics and Subtopics)	Required Hours
1	Sulphur Dyes, method of application, method of formation. Intermediates used in the manufacture of Sulphur dyes. Solubilized Sulphur Dyes	20
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.	10
3	Conventional basic dyes. Diphenylmethane and ketone-imine class. Synthesis. Disubstituted triohenylmethane dyes and trisubstittued triphenylmethane dyes.typical synthesis and manufacturing methods.	15
4	Basic dyes for acrylic fibres, rating dyes. Oxidative coupling methods. Synthesis of heterocyclic intermediates.	15
	Total	**60**

List of Textbooks/Reference 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
4	Color Chemistry –Synthesis, Properties and Applications of Dyes and Pigments, Zollinger H., 2nd ed., Weinheim – VCH, 1991

Course Outcomes (Students will be able to…..)	
CO1	*Understand* the constitution of Sulphur dyes. (K2)
CO2	*Interpret* the structural diversities in cationic dyes. (K2)
CO3	*Distinguish* the colour changes with different classes of cationic dyes. (K2)
CO4	*Conceptualize* the process in the manufacture of Sulphur dyes. (K2)
CO5	*Assess* the technical importance of cationic dyes and their manufacture. (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	1	2	2	2	1	0	1	0	0	0	2	0	2	3
CO2	K2	2	2	3	3	1	0	1	0	0	0	2	0	2	3
CO3	K2	1	3	3	3	1	0	1	0	0	0	2	0	2	3
CO4	K2	3	3	3	3	3	3	2	2	1	1	3	1	3	2
CO5	K2	3	3	3	3	3	3	2	2	1	1	3	2	3	2
	K2	3	3	3	3	3	2	2	2	1	1	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYT 1203	Course Title: Fluorescent Colorants	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. Program

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 analyse and identify the proper synthetic and industrial method and choose accordingly the further processes to make fluorescent dyes.

	Course Contents (Topics and Subtopics)	Required 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	12
2	Stilbene based optical whiteners and fluorescent dyes	16
3	Coumarin and carbostyryl based optical whiteners and fluorescent dyes	12
4	Pyrazoline, naphthaliminde, benzanthrone, and azabenzanthrone based fluorophores	08
5	Water soluble fluorescent dyes, Cyanine dyes, xanthenes, oxazines, and similar dyes. BODIPY and their Aza analogues	12
	Total	**60**

List of Textbooks/Reference Books

1	Molecular Fluorescence: Principles and Applications by B Valeur, Wiley VCH
2	Principles of Fluorescence Spectroscopy J R Lackowiz, Springer

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

CO1	*Understand* the basics of fluorescence (K2)
CO2	*Conceptualized* the basic fluorophores. (K2)
CO3	*Analyze* the various fluorophores for optical whitening, and functional applications (K3)
CO4	*Know* the various aspects of water-soluble fluorescent dyes in biology. (K2)
CO5	*Identify* the synthetic route for a desired fluorescent dye (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	2	2	2	2	1	1	0	0	0	0	2	0	2	3
CO2	K2	2	2	2	2	2	1	0	0	0	0	2	0	2	3
CO3	K3	2	3	3	2	2	1	2	0	2	2	2	2	3	2
CO4	K2	2	2	2	3	2	1	2	0	1	1	2	1	2	3
CO5	K2	2	3	3	3	2	2	2	1	2	2	3	2	3	3
Course	K3	2	3	3	3	2	2	2	1	2	2	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: TXT 1215	Course Title: Technology of Dyeing and Printing	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	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. Program

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.

	Course Contents (Topics and Subtopics)	Required Hours
1	General considerations of the application of different classes of synthetic dyes to important textile fibres	08
2	Introduction to physicochemical principles involved in dyeing.	02
3	Dye Class specific dyeing methods and dyeing machinery	15
4	Preparation of fabrics for Dyeing and printing, Ingredients of Print Paste, Selection of Ingredients of Print paste	10
5	Basic Styles of Printing	10
6	Methods of Printing	10
7	Fastness requirements of coloured fabrics	5
	Total	**45**

List of Textbooks/Reference Books

1	Experimental Dyeing by Giles, SDC
2	Textile Dyeing, V A Shenai
3	Textile Printing, V A Shenoi
4	Textile Fibres V A Shenoi

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

CO1	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)
CO2	understand dyeing machinery. (K2)
CO3	list and understand the function of the ingredients used in printing paste. (K2)
CO4	understand and explain basic styles of printing. (K2)
CO5	understand and describe methods of printing. (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	3	3	3	3	3	2	2	2	2	2	2	2	2
CO2	K2	3	3	3	3	3	3	2	2	2	2	2	2	2	2
CO3	K2	3	3	3	3	3	3	2	2	2	2	2	2	2	2
CO4	K2	3	3	3	3	3	3	2	2	2	2	2	2	2	2

CO5	K2	3	3	3	3	3	3	2	2	2	2	2	2	2	2
Course	K2	3	3	3	3	3	3	2	2	2	2	2	2	2	2

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: HUT1103	**Course Title:** Industrial Psychology and Human Resource Management	**Credits = 3**		
			L	**T**	**P**
	Semester: VI	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

None

List of Courses where this course will be prerequisite

Technology Courses in the forthcoming semesters

Description of relevance of this course in the B. Tech. Program

This course equips students with human resource management skills to be able to function effectively in their professional careers.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Introduction and Overview	2
2	Management Theories Taylor, Fayol, Weber, Hawthorne; Basic types of structures; Span of Control, Delegation, Authority, Responsibility	4
3	Recruitment Philosophies, Different methods of attracting candidates	3
4	Selection Application blanks, Interviews, Induction	2
5	Performance Management Goal setting process, Performance appraisal methods, Appraisal interviews, Rating errors	3
6	Training & Development Identifying training needs, Training methods (on the job and off the job techniques), Evaluation of training	3
7	Change Management Types of change, Theories of change management, Hurdles to change, Olmosk change strategies	3
8	Knowledge Management Innovation, Importance and benefits of Knowledge Management, Framework	3
9	Motivation Theories Classification of motives, Various theories (Maslow, Herzberg, ERG, Vroom, Equity and Nohria's 4 drive model)	4
10	Leadership Theories Blake Mouton model, Hersey Blanchard Model, Michigan Model	3
11	Organizational Culture Types of cultures, Understanding and influencing cultures	3
12	Conflict Management Stages of conflict, Types of conflict and sources of conflicts, Conflict resolution	3
13	Power &Politics Bases of power, Politicking strategies	3
14	Personality Theories of personality, Behaviour and personality styles	3
15	Perception Persception versus sensation, Perceptual process, Perceptual errors	3
	Total	**45**

List of Textbooks/Reference Books	
1	Innovation and Entrepreneurship, Peter Drucker
2	Essentials of organizational Behaviour, Srephen Robbins
3	Organizational Behaviour, Luthans
4	Select HBR cases and articles for review
5	Innovation and Entrepreneurship, Peter Drucker
Course Outcomes (Students will be able to…..)	
CO1	explain the fundamental concepts of industrial psychology and human resource management (K2)
CO2	analyze practical solutions (K4)
CO3	provide applicable solutions (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)														
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	0	3	3	3	3	3	3	1	3	2
CO2	K4	3	3	1	3	2	3	2	3	3	3	1	2	3	3
CO3	K3	3	3	2	2	2	3	3	3	2	3	3	2	1	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: HUT1106	**Course Title:** Environmental Science and Technology	**Credits = 3**		
			L	**T**	**P**
	Semester: VI	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

Various Technology Courses in previous semesters

List of Courses where this course will be prerequisite

Various Technology Courses in the forthcoming semesters

Description of relevance of this course in the B. Tech. Program

The course is very useful for the future Chemical Engineers and Technologists for assessing and appreciating impact of chemical processes and technologies on the Environment. The students will be exposed to the nitty-gritties of the impact of design principles on the Environment. Thorough understanding of these technology aspects is going to help in innovative solutions with positive impact on the environment.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Introduction to all prevailing international standards of Health, Safety, and Environment (HSE); Environmental laws and regulations; Standards (air quality, noise, water), ISO14000+	3
2	Environmental impact assessment, Life cycle assessment (LCA)	3
3	Pollution prevention in chemical manufacturing, effluent valorization	2
4	Air pollution; Air pollutants: sources (specific pollutants), effects, and dispersion modelling, air pollution, air quality, pollutants minimisation and control, fugitive emissions (source and control), Noise pollution	4
5	Wastewater treatment; Groundwater and surface water pollution, removal of specific water contaminants; Solid waste; Hazardous waste	4
6	Inherent safety; Major disasters (e.g. Flixborough, UK; Bhopal, India; Seveso, Italy; Pasadena, Texas; Texas City, Texas; Jacksonville, Florida; Port Wentworth, Georgia)	5
7	Toxicology; Industrial hygiene	2
8	Source models; Toxic release and dispersion models	5
9	Fires and explosions; Concepts to prevent fires and explosions	3

10	Chemical reactivity	2
11	Reliefs and reliefs sizing; Hazard identification; Risk assessment	4
12	Safety procedures and designs	4
13	Some case histories	4
	Total	**45**
List of Textbooks/Reference Books		
1	Environmental Studies by R. Rajagopalan, Oxford University Press.	
2	Essentials of Environmental Studies by Kurian Joseph & Nagendran, Pearson	
3	Education Renewable Energy by Godfrey Boyle, Oxford Publications	
4	Perspective of Environmental Studies, by Kaushik and Kaushik, New Age	
5	International Environmental Studies by. Anandita Basak, Pearson Education	
6	Textbook of Environmental Studies by Dave and Katewa, Cengage Learning	
7	Environmental Studies by Benny Joseph, Tata McGraw Hill	
8	Textbook of Environmental studies by Erach Books Bharucha, University Press.	
Course Outcomes (Students will be able to…..)		
CO1	calculate BOD / COD for a given composition of effluent stream, Estimation of bio Kinetics.	
CO2	calculate adiabatic lapse rate and determine conditions for suitability of atmospheric dispersion, effective stack height, chimney design.	
CO3	calculate concentrative of pollutant at any point in the neighbourhood of emission given atmospheric conditions like wind, dispersion, environmental factors, etc.	
CO4	calculate size/time/power required for primary clarifier, secondary treatment, tertiary treatment, sizing of different types of Biological treatments etc	
CO5	identify hazards in a given process and assess the same and provide solutions for operating safely.	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	2	3	3	2	3	3	3	2	3	3
CO2	K3	3	3	2	2	0	3	3	3	3	3	3	1	3	3
CO3	K3	3	3	0	2	2	3	1	3	3	1	3	2	2	3
CO4	K3	3	1	2	2	2	3	3	3	3	3	0	2	3	3
CO5	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: **DYP 1006**	**Course Title:** **Seminar**	**Credits = 3**		
			L	**T**	**P**
	Semester: VI	**Total Contact Hours: 60**	**0**	**0**	**4**
List of Prerequisite Courses					
All the previous dyestuff technology courses					
List of Courses where this course will be prerequisite					
All the B.Tech (dyestuff technology) courses in this semester and the subsequent semesters.					
Description of relevance of this course in the B. Tech. Program					
The course is intended to develop student's ability to read, understand any given topic related to dyestuff technology, collect literature, write a scientific report on that topic based on the provided guidelines and present the scientific merits and demerits of the matter. Students shall prepare critical reviews of selected topics in Chemical Technology and allied subjects and submit in the form of standard typed reports. Students shall also make oral presentations of the reviews.					
	Course Contents (Topics and Subtopics)		**Required Hours**		
1	Any topic related to dyestuff technology.		60		

	Total	60
	List of Textbooks/Reference Books	
1	nil	

Course Outcomes (Students will be able to…..)	
CO1	Develop a protocol for literature survey about a certain topic (K4)
CO2	Evaluate the literatures and interpret the scientific content (K5)
CO3	Apply the concept of dyestuff technology on a selected topic (K3)
CO4	Develop skills for presenting a scientific topic in dyestuff technology (K6)
CO5	Develop skills for writing a scientific document (K6)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K4	3	3	1	3	2	3	3	3	3	3	3	2	3	3
CO2	K5	3	2	3	3	3	0	3	3	3	3	2	3	3	3
CO3	K3	3	3	2	2	2	3	3	2	3	3	3	1	3	3
CO4	K6	3	1	3	3	0	3	3	3	1	3	0	3	3	3
CO5	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0– No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYP 1014	**Course Title: Preparation of intermediates**	**Credits = 2**		
			L	**T**	**P**
	Semester: VI	**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. Program					
Students will be trained to synthesize all the kinds of intermediates required for the synthesis of dyes and pigments.					

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Preparation of some fast bases and benzene intermediates	20
2	Preparation of some naphthalene intermediates	20
3	Preparation of 1-chloro-, 1,5-dinitro- and 1,4-diaminoanthraquinone	20
	Total	**60**
	List of Textbooks/Reference Books	
1	Fundamental Processes Of Dye Chemistry by Hans Eduard Fierz-David And Louis Blangey	
	Course Outcomes (Students will be able to…..)	
CO1	*Execute* the synthesis of different dye intermediates (K3)	
CO2	*Purify* and isolate the intermediates (K3)	
CO3	*Differentiate* the techniques of synthesis of different intermediate isomers (K2)	
CO4	*Design* the synthesis of dye intermediates (K3)	
CO5	*Apply* the theoretical knowledge in the practical synthesis, separation, and isolation of the dye intermediates (K4)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K3	2	3	3	2	3	2	2	0	2	0	3	3	2	3
CO2	K3	3	3	3	2	3	3	2	0	2	0	3	3	2	3
CO3	K2	2	3	3	2	3	3	2	0	2	0	3	3	3	2
CO4	K3	2	3	3	2	2	3	2	1	2	2	3	3	3	3
CO5	K4	3	3	3	3	3	3	3	2	3	2	3	3	3	3
Course	K4	3	3	3	3	3	3	3	2	3	2	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYP 1003	**Course Title: Experimental dyeing**	**Credits = 2**		
			L	**T**	**P**
	Semester: VI	**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. Program					
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)		**Required Hours**		
1	Application anionic, cationic and non-ionic colorants to synthetic and natural textile substrates		60		
	Total		**60**		
List of Textbooks/Reference Books					
1	Chemistry of Synthetic Dyes – Vol I, Venkataraman, K., Academic Press, 1952				
2	Synthesis and Application of Dyes, Rys and Zollinger				
3	The Chemistry of Synthetic Dyes – Vol II, Venkataraman K., Academic Press				
4	The Chemistry of Synthetic Dyes – Vol IV, Venkataraman K., Academic Press				
5	The Chemistry of Synthetic Dyes – Vol VI, Venkataraman K., Academic Press				
6	The Chemistry of Synthetic Dyes and Pigments, Lubs H. A., Robert E. Krieger Publishing Co				
Course Outcomes (Students will be able to…..)					
CO1	*Apply* water soluble dyes to hydrophilic substrates (K3)				
CO2	*Apply* water-insoluble dyes to hydrophilic substrates (K3)				
CO3	*Ability* to categorize the dyes according to the substrates. (K4)				
CO4	*Analyse* and identify the dyes on textiles (K4)				
CO5	*Identify* the requirements of the dyes as against the suitability of substrates for dyeing (K4)				

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K3	2	3	3	3	3	2	0	0	2	0	3	2	3	3

CO2	K3	2	3	3	3	3	2	0	0	2	0	3	2	3	2
CO3	K4	2	3	3	3	3	2	0	0	2	0	3	2	3	2
CO4	K4	2	3	3	3	2	2	1	0	2	0	3	2	2	3
CO5	K4	2	3	3	3	3	2	2	1	2	1	3	2	2	2
Course	K4	2	3	3	3	3	2	2	1	2	1	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester VII

	Course Code: CET1703	Course Title: Chemical Process Control	Credits = 3		
			L	T	P
	Semester: VII	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Material and Energy Balance Calculations, Applied Mathematics, Chemical Engineering Operations, Chemical Reaction Engineering

List of Courses where this course will be prerequisite

Chemical Engineering Laboratory, Projects

Description of relevance of this course in the B. Tech. Program

Process control plays a very critical role in the context of actual operation of a process plant. Most of the core chemical engineering courses focus on the steady state operation. In the real-life environment, process is continuously subjected to various disturbances which deviates the operation from the designed steady state. This course specifically prepares students to assess the impact of such disturbances and equip them with the tools available to tackle these situations.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Instrumentation: Principles of measurement; Pressure, Temperature, Level, Flow and composition measuring devices; Introduction to controllers (PLC, digital control, DCS), Introduction to control valves, Types of control valves, Control valve characteristics	9
2	Introduction to system dynamics, Concept of dynamic response, Linear systems, First, second and higher order system, Systems with dead-time, Definition of terms such as transfer function, Time constant, Gain of the process with practical examples Response of processes to standard inputs	9
3	Introduction to Process Control: Set point, disturbance, closed loop and open loop control, Feedback and feed-forward configurations, Poles and zeros of the transfer functions Basic control actions (ON/OFF, P, I and D), Effects of controller action on process response: Offset, closed-loop gain, controller gain effect of controller parameters	6
4	Stability analysis of feedback systems, Notion of stability, Criteria for stability	6
5	Control System Design: Introduction to controller design Identification of controlled, manipulated and disturbance variables, Pairing of inputs and outputs Controller selection for pressure, flow, temperature, level and composition control Criteria-based controller design, heuristic controller design, controller tuning	9
6	Multiple Loop and Traditional Advanced Control Systems: Cascade control, Ratio control, Feed-forward control, Selective control, Split-range control, Inferential control	6
	Total	**45**

List of Text Books/ Reference Books

1	Chemical Process Control: An Introduction to Theory and Practice, Stephanopolous G.
2	Process Modeling, Simulation, and Control for Chemical Engineers, Luyben W.L.
3	Process Dynamics and Control, Seborg, D.E. and Mellichamp, D.A. and Edgar, T.F. and Doyle, F.J.
4	Process Control: Modeling, Design, and Simulation, Bequette, B.W.
5	Process Control Instrumentation Technology, Johnson, C.D.

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

1	Specify the required instrumentation and control elements for a particular process (K3)
2	Develop input-output transfer function models for dynamics of processes (K4)
3	Characterize the dynamics and stability of processes based on mathematical analysis (K5)
4	Design and tune process controllers (K6)
5	Specify the required instrumentation and control elements for a particular process (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	0	3	3	3	2	3	3
CO2	K4	3	3	2	0	2	3	3	3	3	3	0	2	3	2
CO3	K5	3	2	3	3	1	3	1	3	3	1	3	3	3	3
CO4	K6	3	3	1	3	3	2	3	3	2	3	3	1	2	3
CO5	K3	3	1	2	2	2	3	3	3	3	3	3	2	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYT 1204	**Course Title: Heterocyclic intermediates and colorants**	**Credits = 3**		
			L	**T**	**P**
	Semester: VII	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

HSC (Science)

List of Courses where this course will be prerequisite

All dyestuff technology courses

Description of relevance of this course in the B. Tech. Program

The students will be introduced to the different heterocyclic scaffolds, their synthetic schemes, and reactivities as well as the utilization of several heterocyclic scaffolds for the synthesis of dyes and colorants will also be discussed in details.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Chemistry of three membered rings with one hetero atom – epoxides, aziridines and episulphides, preparation and reactions	02
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, electro cyclic reactions, photochemical reactions,oxy and amino derivatives etc.	08
3	Chemistry of condensed five-membered heterocycles – various syntheses of indoles, benzofuran and benzo[b]thiophenes. Electrophilic reactions, nucleophilic and radical substitutions	10
4	Chemistry of 1,2 and 1,3 azoles. 2-Methylbenzoxazole, 2-methylbenzothiazole, 2-methylbenzimidazole. Electrophilic reactions, nucleophilic and radical substitutions, quarternaryazolium salts, side chain reactivity	05
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.	05
6	Chemistry of 79olubiliz and isoquinoline – Skraup synthesis – 79olubiliz and quinaldine, N-methyaltion of quinaldine. Friedlander synthesis, Bischler-Napieralski synthesis – methyl isoquinoline, Pictet-Spengler synthesis. Electrophilic reactions, nucleophilic and radical substitutions on 79olubiliz and isoquinoline. Side chain reactivity of both of them.	05
7	Technically important heterocycles derivatives	05
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	05

	Total	45
	List of Textbooks/Reference 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,	
3	Eicher T., Hauptmann S. and Speicher A., Wiley-VCH GmbH & Co, KgaA, 2003	
4	Heterocyclic Chemistry – Vols I, II and III, Gupta R. R., Kumar M. and Gupta V., Springer,	
	Course Outcomes (Students will be able to…..)	
CO1	*Identify* the classes of heterocycles. (K2)	
CO2	*Design* synthetic route of different heterocycles. (K3)	
CO3	*Propose* the retrosynthetic pathway of different heterocycles. (K3)	
CO4	*Understand* the reactivity of different heterocycles. (K2)	
CO5	*Assess* the technical importance of heterocycles. (K3)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	1	1	2	1	1	0	2	0	0	0	3	0	2	3
CO2	K3	2	3	3	3	0	2	2	2	1	1	3	1	2	3
CO3	K3	2	3	3	3	2	2	2	2	2	2	3	2	2	3
CO4	K2	2	3	3	3	3	3	2	2	2	2	2	2	3	3
CO5	K3	3	3	3	3	3	3	2	3	2	2	3	2	3	2
Course	K3	3	3	3	3	3	3	2	3	3	2	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYT 1205	**Course Title:** Functional Applications of Organic Colorants	**Credits = 3**		
			L	**T**	**P**
	Semester: VII	**Total Contact Hours: 45**	**2**	**1**	**0**
	List of Prerequisite Courses				
HSC (Science)					
	List of Courses where this course will be prerequisite				
All dyestuff technology courses					
	Description of relevance of this course in the B. Tech. Program				
The students will be introduced to the concepts of functional organic colorants and their specific applications as well as will be exposed to the different classes of functional dyes and colorants.					
	Course Contents (Topics and Subtopics)		**Required Hours**		
1	Introduction to functional dyes. Indicator dyes, dyes used in other analytical techniques, laser dyes, liquid crystal dyes,		**10**		
2	Dyes in photography and electrophotograpy		**10**		
3	Dyes for ink jet printing, thermal printing		**05**		
4	Dyes used in light harvesting devices like solar cells and other related uses, holography, Imaging		**05**		
5	Non-linear optical properties of dyes and infrared absorbing dyes		**05**		
6	Quasi aromatic fluorescent compounds		**05**		
7	Colorants for Photodynamic theory		**05**		
	Total		**45**		
	List of Textbooks/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…..)	
CO1	*Grasp* broad idea about functional applications of dyes (K2)
CO2	*Understand* underlying properties for their application in commercial product (K2)
CO3	*Know* various colorants based on specific molecule engineering (K2)
CO4	*Apply* the knowledge in planning the synthesis of functional dyes (K3)
CO5	*Design* functional dyes based on the specific role (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	1	2	2	2	1	1	2	0	1	1	3	0	3	2
CO2	K2	1	3	2	2	1	1	2	1	1	1	3	0	3	2
CO3	K2	2	3	2	2	1	2	2	0	1	1	3	0	2	3
CO4	K3	3	3	3	2	2	2	3	1	2	2	3	2	3	3
CO5	K4	3	3	3	3	2	2	3	1	2	3	3	3	3	3
Course	K4	3	3	3	3	2	2	3	1	2	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYP 1012	**Course Title: In-plant Training**	**Credits = 6**		
			L	**T**	**P**
	Semester: VII	**Total duration: 12 weeks**	**0**	**0**	**0**
List of Prerequisite Courses					
	None				
List of Courses where this course will be Prerequisite					
	Project I (FDP 1027), Project II (FDP 1024)				
Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme					
The course is designed to – 1. develop a systematic thinking about an industrial problem; 2. develop skills for communication, networking, personal grooming & amp; professional conduct within an industrial environment, and 3. develop the attitude for individual and teamwork.					

Sr. No.	**Course Contents (Topics and subtopics)**	**Required weeks**
1	Each Student will be involved in R & D/ manufacturing (QA / QC / Plant Engineering /Stores and Purchase)/ marketing / finance/ consultancy/ Technical services/ Engineering / Projects, etc.	**12**

	Oral presentation & written report of the in-plant training will be evaluated along with industry feedback.	
	Total	**12**

Course Outcomes (Students will be able to…..)	
CO1	*Apply* the concept of project & production management in further planning (K3)
CO2	*Develop* critical thinking regarding the various operations involved in dyestuff technology and allied industry (K4)
CO3	*Solve* certain industrial challenges in dyestuff technology and allied field (K6)
CO4	*Present* and communicate an industrial problem effectively (K6)
CO5	*Write* a scientific report on the training (K6)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	2
CO3	K6	3	3	3	3	3	3	2	3	1	3	2	3	3	3
CO4	K6	3	3	2	3	3	3	3	0	3	3	3	3	2	3
CO5	K6	3	3	3	3	1	3	3	3	3	2	3	3	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: **HUT1203**	**Course Title:** **Industrial Management**	**Credits = 4**		
			L	**T**	**P**
	Semester: VII	**Total Contact Hours: 60**	**3**	**1**	**0**

List of Prerequisite Courses

None

List of Courses where this course will be prerequisite

None

Description of relevance of this course in the B. Tech. Program

This course is required for effective and holistic functioning of students in their professional career.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Greiner's Model of Organization Life Cycle Organic and mechanistic structures	3
2	Marketing Management Introduction, Porter's value chain, Porter's five forces, Porter's generic strategies	7
3	Introduction to the 4Ps of Marketing Product, Price, Place, Promotion	11
4	Production and Operations Management Concept of productivity, World class manufacturing, Business process reengineering, Kanban, JIT, Poka Yoke system, Maintenance practices	10
5	Quality Management The concept of quality, Quality control ,acceptance sampling and SQC Deing's 14 points, TQM, Insights into ISO-9000, ISO -14000,ISO-50000	6
6	Financial Management Accounting system, Balance-sheet evaluation, Fund-flow analysis, financial ratios an insight, Costing	15
7	Materials Management	4

	Value analysis, Purchasing and vendor development, Warehousing and inventory control methods	
8	Maintenance Management Classifications, Equipment and plant reliability and availability, Management of shut downs and turnarounds	4
	Total	**60**

List of Textbooks/Reference Books	
1	Industrial Management–I, Jhamb L. C. and Jhamb S.
2	Industrial Management, Spriegel U.S.
3	Operations Management for Competitive Advantage, Richard B. Chase, F. Robert Jacobs, Nicholas Acquilano
4	World Class Manufacturing - A strategic Perspective, B.S. Sahay, K.B.C. Saxena, Ashish Kumar
5	Management Finance, Varanasay Murthy
6	Essentials of Management,Koontz
7	Principles of Marketing, Kotler
8	Quality Planning and Analysis, Juran
9	Financial Management, Prasanna Chandra
10	Financial Management, R. M. Srivastava
11	Select HBR cases and articles for review
Course Outcomes (Students will be able to…..)	
CO1	explain the fundamental concepts of Marketing management and the various aspects therein (K2)
CO2	describe the fundamental concepts of Finance and analyse the balance sheet (K4)
CO3	explain various productivity techniques that when combined with engineering knowledge can be applied successfully in the industry (K2)
CO4	study real life practical problems, constraints and will be able to think in terms of various alternative solutions (K3)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K4	3	3	2	3	2	1	3	3	3	3	3	2	3	3
CO3	K2	3	2	0	2	1	3	3	2	3	3	0	1	3	2
CO4	K3	3	3	2	0	2	3	3	3	3	3	3	2	2	3
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code:	**Course Title:**	**Credits = 2**		
	CEP1714	**Chemical Engineering Laboratory**	**L**	**T**	**P**
	Semester: VII	**Total Contact Hours: 60**	**0**	**0**	**4**
List of Prerequisite Courses					
Process Calculations (CET1507), Transport Phenomena (CET1105), Chemical Engineering Operations (CET1401), Chemical Reaction Engineering (CET1212)					
List of Courses where this course will be prerequisite					
Other B. Tech. courses in this and the last semester					
Description of relevance of this course in the B. Tech. Program					

This course provides students the first-hand experience of verifying various theoretical concepts learnt in theory courses. It also exposes them to practical versions of typical chemical engineering equipments and servers as a bridge between theory and practice. This particular lab focuses on fluid dynamics, distillation, filtration, drying and sedimentation.		
Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
1	4 - 6 Experiments on fluid dynamics and heat transfer	24
2	3 - 5 Experiments on Chemical Engineering Operations	16
3	2 – 4 Experiments on Reaction Engineering	12
4	1 – 3 Experiments on process dynamics and control	8
Total		**60**
List of Text Books/ Reference Books		
1	McCabe W.L., Smith J.C., and Harriott P. Unit Operations in Chemical Engineering, 2014	
2	Bird R.B., Stewart W.E., and Lightfoot, E.N. Transport Phenomena, 2007	
3	Coulson J.M., Richardson J.F., and Sinnott, R.K. Coulson & Richardson's Chemical Engineering: Chemical engineering design, 1996.	
4	Green D. and Perry R. Perry's Chemical Engineers' Handbook, Eighth Edition, 2007.	
Course Outcomes (students will be able to…..)		
CO1	Learn how to experimentally verify various theoretical principles (K3)	
CO2	Visualize practical implementation of chemical engineering equipment (K4)	
CO3	Develop experimental skills (K4)	
CO4	Ability to document scientific and technical data	
CO5	Ability to demonstrate project management skill in performing the experiments	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	1	2	3	3	0	3	3	3	2	2	3
CO3	K4	3	3	2	3	2	2	3	3	3	3	2	2	3	2
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYP 1511	**Course Title: Preparation of dyes**	**Credits = 2**		
			L	**T**	**P**
	Semester: VII	**Total Contact Hours: 60**	**0**	**0**	**4**
List of Prerequisite Courses					
HSC (Science)					
List of Courses where this course will be prerequisite					
All dyestuff technology courses					
Description of relevance of this course in the B. Tech. Program					
This course will impart the students with sufficient skills in synthesizing different classes of dyes their purification process as well as their isolation techniques.					
	Course Contents (Topics and Subtopics)		**Required Hours**		
1	Preparation of azo dyes by employing various methods of diazotization – direct, indirect, with nitrosylsulphuric acid		20		
2	Preparation of azo dyes with different coupling components – acidic and alkaline coupling		16		
3	Preparation of some metal complex azo dyes and azo pigments		12		

4	Preparation of some basic dyes, sulphur dyes and reactive dyes	12
	Total	**60**
List of Textbooks/Reference Books		
1	Fundamental Processes Of Dye Chemistry by Hans Eduard Fierz-David And Louis Blangey	
Course Outcomes (Students will be able to…..)		
CO1	Execute the synthesis of different class of dyes (K3)	
CO2	Able to purify and isolate the dyes (K3)	
CO3	Differentiate the methods of synthesis of different classes of dyes (K3)	
CO4	Design the synthesis of dye (K4)	
CO5	Develop practical skills in the synthesis, separation and isolation of the dye (K4)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K3	2	3	3	3	3	3	2	3	3	2	3	2	3	2
CO2	K3	2	3	3	3	3	2	2	2	2	2	3	2	3	2
CO3	K3	2	3	3	3	3	3	2	3	3	2	3	2	3	3
CO4	K4	3	3	3	3	3	3	2	3	3	0	3	2	2	3
CO5	K4	3	3	3	3	3	3	2	2	3	1	3	3	3	3
course	K4	3	3	3	3	3	3	2	3	3	2	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYP 1007	**Course Title: Project -I**	**Credits = 2**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 60**	**0**	**1**	**4**
List of Prerequisite Courses					
Seminar (**DYP 1006**)					
List of Courses where this course will be Prerequisite					
Project II (**DYP 1008**)					
Description of relevance of this course in the B. Tech. (Dyestuff Technology) Programme					
1. Develop a skill to solve a research problem related to dyestuff technology 2. Develop skills for presenting a research work effectively. The course presents an opportunity to the students for fine-tuning their scientific communication skills, oral as well as written.					

Sr. No.	**Course Contents (Topics and subtopics)**	**Required Hours**
1	Teachers will communicate various research project topics to all the students based on interest and facilities available and relevance to the area of Dyestuff Technology. - Each student based on his/her interest and merit selects the research topic and is allotted a supervisor. - Review of literature, formulation of research project, hypothesis, objectives, methodology, possible expected outcomes, planning for experimentation, experimental trials, data generation and analysis.	**60**

	- Oral presentation & written report of the seminar will be evaluated.	
	Total	**60**
List of Textbooks/Reference Books		
1	Relevant research articles, patents, review articles, conference proceeding, book chapters and books	

Course Outcomes (Students will be able to…..)	
CO1	*Develop* critical thinking to identify the research gap for the project (K5)
CO2	*Formulate* a scientific question and approach to solve it (K6)
CO3	*Plan* the experimental methodology for the project (K5)
CO4	*Develop* skills to communicate the research plan effectively (K6)
CO5	*Develop* skills for writing a scientific document on the research work (K6)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+S	K3	K4
CO1	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K6	3	3	3	3	3	3	3	3	3	3	2	3	3	1
CO3	K5	3	2	3	3	3	3	3	1	3	3	3	3	3	3
CO4	K6	3	3	3	3	3	2	3	3	3	0	3	3	2	3
CO5	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Semester VIII

	Course Code: CET1504	Course Title: Chemical Project Engineering and Economics	Credits = 3		
			L	T	P
	Semester: VIII	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

Material and Energy Balance Calculations, Equip Design and Drawing I, Energy Engineering, Industrial Engineering Chemistry

List of Courses where this course will be prerequisite

Home Papers I and II

Description of relevance of this course in the B Tech. Program

This course is required for the future professional career.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Introduction to the green field projects and global nature of the projects Impact of currency fluctuations on Project justification and cash flows Concepts of 'Quality by Design' including typical design deliverables Understanding constructability, operability and maintainability during all stages of project execution Meaning of Project Engineering, various stages of project implementation	6
2	Relationship between price of a product and project cost and cost of production, EV Analysis. Elements of cost of production, monitoring of the same in a plant Meaning of Administrative expenses, sales expenses, etc. Introduction to various components of project cost and their estimation Introduction to concept of inflation, location index and their use in estimating plant and machinery cost Various cost indices	8
4	Project financing, debt:equity ratio, promoters, contributors, shareholders contribution, source of finance, time value of money Concept of interest, time value of money, selection of various alternative equipment or system based on this concept, Indian norms, EMI calculations Depreciation concept, Indian norms and their utility in estimate of working results of project. Working capital concept and its relevance to project	7
5	Estimate of working results of proposed project. Capacity utilization, Gross profit, operating profit, profit before tax, Corporate tax, dividend, Net cash accruals. Project evaluation: Cumulative cash flow analysis Break-Even analysis, incremental analysis, various ratios analysis, Discounted cash flow analysis	7
6	Process Selection, Site Selection, Feasibility Report	4
7	Project: Conception to Commissioning: milestones, Project execution as conglomeration of technical and nontechnical activities, contractual details. Contract: Meaning, contents, Types of contract. Lump- sum Turnkey (LSTK),Eng, Procurement and Construction(EPC),Eng, Procurement and Construction Management (EPCM).Mergers and Acquisitions	6
8	Reading of balance sheets and evaluation of techno-commercial project reports	3
9	PERT, CPM, Bar-charts and network diagrams	4
	Total	**45**

List of Text Books/ Reference Books

1	Chemical Project Economics,MahajaniV.V.andMokashi SM.
2	Plant Designand Economics for Chemical Engineers,Peters M.S.,TimmerhausK.D.
3	Process Plant and Equipment Cost Estimation, Kharbanda O.P.

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

CO1	calculate working capital requirement for a given project (K3)
CO2	calculate cost of equipment used in a plant total project cost (K3)
CO3	calculate cash-flow from a given project (K3)
CO4	select a site for the project from given alternatives (K4)
CO5	list out various milestones related to project concept to commissioning (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K3	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	3	2	2	2	3	3	3	3	3	2	2	2	3
CO3	K3	3	3	1	0	2	3	1	3	3	3	3	2	3	2
CO4	K4	3	3	2	3	2	2	3	3	3	3	3	2	3	3
CO5	K2	3	2	1	2	1	3	3	3	3	0	3	1	3	2
Course	K4	3	3	2	3	2	3	3	3	3	3	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYT 1106	**Course Title:** Case Studies in Dyestuff Technology	**Credits = 4**		
			L	**T**	**P**
	Semester: VIII	**Total Contact Hours: 60**	**3**	**1**	**0**

List of Prerequisite Courses

All the dyestuff courses taught in the previous semesters

List of Courses where this course will be prerequisite

All the dyestuff technology special courses

Description of relevance of this course in the B. Tech. Program

The students will be introduced to several practical aspects of the synthesis of dyestuff intermediates as well as dyes and pigments in the industry and the problem statements along with the solution will be discussed.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Practical Aspects of Nitration: The concentration of mixed acids, Importance of DVS Ratio, thumb rules for the commercial calculations of batches, Material of construction and its life cycle	10
2	Reduction in the dyestuff industry: Reagents used for reduction, Reaction conditions for different reagents, Comparisons of operating different reagents at industrial scale, Material of construction, shop-floor practices and safety measures	10
3	Case studies of the synthesis of Bromamine Acid, Synthesis of Bromamine acid laboratory scale and plant scale, Bromination commercial aspect, Sulfonation of Anthraquinones, Material of construction and safety protocols for using Bromine and strong acids.	10
4	Equipment sizing and material of construction, calculations for heat capacities of utilities, cost calculations and estimation of payback period for projects	10
5	Ammonolysis laboratory scale set up and scale up, ammonia generation and storage aspects, safety protocols for ammonolysis, industrial thumb rules for the ammonolysis	10
6	Reaction Mechanisms for all the processes described and their relevance in deciding parameters for arriving at the process. 1) Importance of Physical Organic Chemistry. 2) Reaction Thermodynamics and Kinetics. 3) Making choices during Process Design and Project implementation 4) Manufacturing practices followed with safety and hazop. 5) Effluent treatment.norms standard processes and practice. 6) Price of Reagents employed 7) Interdependence of all the parameters employed 8) Marketing and pricing. 9) Scale up and how to decide which parameters are important 10) Technology employed and its relevance with Development in other fields like Analysis, Material availability, Engineering progress , Locational factors.	10

	Total	60
List of Textbooks/Reference Books		
1	*BIOS Reports*	
2	*FIAT Reports*	
3	*CIOS Reports*	
4	*Organic Synthesis Collective Volumes I-V*	
5	*Shreve's Chemical Process Industries by George T Austin*	
6	*Unit Processes in Organic Synthesis by Philip Groggins*	
7	*Chemical, Biochemical, and Engineering Thermodynamics by Stanley I Sandler*	
8	*Marchs Advanced Organic Chemistry by Jerry March*	
Course Outcomes (Students will be able to…..)		
CO1	*Correlate* industry-oriented situations for synthesis or isolation of intermediates (K2)	
CO2	*Understand* practical aspects of selection of suitable methods and isolation techniques (K2)	
CO3	*Realize* the utility of the theoretical concepts in the practical situations (K2)	
CO4	*Formulate* strategies to solve the practical problem (K4)	
CO5	Assess the problem component and come up with a rational solution (K5)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	3	3	2	3	3	2	3	2	0	1	2	0	3	3
CO2	K2	3	3	3	3	3	2	3	2	0	1	2	0	3	3
CO3	K2	2	3	3	3	3	3	3	2	2	1	2	2	3	3
CO4	K4	3	3	3	3	3	3	3	2	2	3	3	3	3	3
CO5	K5	3	3	3	3	3	3	3	2	2	3	3	3	3	3
Course	K5	3	3	3	3	3	3	3	2	2	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYT 1108	**Course Title: Technology of Inorganic Pigments**	**Credits = 3**		
			L	**T**	**P**
	Semester: VIII	**Total Contact Hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
HSC (Science)					
List of Courses where this course will be prerequisite					
All dyestuff technology courses					
Description of relevance of this course in the B. Tech. Program					
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 behind their particular application. To enable them to know the raw materials available for the production of pigments, method for production, analysis and handling, and related toxicology.					
	Course Contents (Topics and Subtopics)		**Required 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.	10
2	White Pigments based on Titanium Oxide, Zinc oxide, and Zinc Sulfide; properties, production, raw materials, application in commercial products, and toxicology	08
3	Various colored pigments on metal oxides and hydroxides; synthesis, properties, uses and economic aspects	10
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	10
5	Inorganic pigments with special properties for examples Magnetic pigment, Luminescent pigments, Transparent pigments, Electroluminescent pigments, Special effect pigments, etc.	07
	Total	**45**
List of Textbooks/Reference Books		
1	Industrial Inorganic Pigments Edited by G. Buxbaum and G. Pfaff, Wiley VCH	
Course Outcomes (Students will be able to…..)		
CO1	Understand the physical and chemical properties of inorganic pigments (K2)	
CO2	understand underlying properties of white inorganic pigment for their application in commercial product (K2)	
CO3	Know various colour pigments based on metal oxide and hydroxide (K2)	
CO4	Gain knowledge on properties, production, application of various inorganic black pigments (K2)	
CO5	Conceptualize the idea on inorganic pigments that possess special properties (K2)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K2	1	1	0	1	1	1	1	0	0	0	3	0	3	2
CO2	K2	3	3	1	1	1	3	2	0	0	0	3	0	3	2
CO3	K2	2	2	3	2	1	3	2	0	0	0	3	1	2	3
CO4	K2	2	2	3	3	3	3	2	1	1	1	3	1	3	3
CO5	K2	3	3	3	3	2	3	2	1	1	1	3	1	3	3
Course	K2	3	3	3	3	3	3	2	1	1	1	3	1	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYT 1109	**Course Title: Technology of organic pigments**	**Credits = 3**		
			L	**T**	**P**
	Semester: VIII	**Total Contact Hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
The student should have cleared B.Tech sixth semester from the Dyestuff Technology Department					
List of Courses where this course will be prerequisite					
All dyestuff technology courses					
Description of relevance of this course in the B. Tech. Program					
The following are the relevance of the course-					

- 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

	Course Contents (Topics and Subtopics)	Required Hours
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	10
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.	5
	Total	**45**
List of Textbooks/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.	
Course Outcomes (Students will be able to…..)		
CO1	*Differentiate* between dyes and pigments (K2)	
CO2	*Conceptualize* the basic pigmentary properties like hue, tinctorial strength, blooming, bleeding, stability, optical properties, polymorphism, etc. (K2)	
CO3	*Classify* the pigments based on chemical constitution and color (K3)	
CO4	*Correlate* and predict various application properties of pigments (K3)	
CO5	*Grasp* the standardization and after treatment methods of pigments (K3)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	2	3	2	2	1	3	1	2	1	1	3	1	3	3
CO2	K2	2	3	2	3	2	2	2	2	1	1	3	1	3	3
CO3	K3	3	2	2	3	2	2	2	2	1	1	2	1	2	2
CO4	K3	3	3	3	2	2	3	3	3	1	1	3	2	3	2
CO5	K3	3	3	2	3	2	3	2	3	1	1	3	1	3	2
Course	K3	3	3	3	3	2	3	3	3	1	1	3	2	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code:	Course Title:	Credits = 3		
		Pre-approved Open Electives from MOOCs / NPTEL	L	T	P
	Semester: VIII	Total Contact Hours: 45	2	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. Program
-

	Course Contents (Topics and Subtopics)	Required Hours
1	-	-
2	-	-
3	-	-
4	-	-
5	-	-
	Total	**45**

List of Textbooks/Reference Books	
1	As prescribed by the course instructor
Course Outcomes (Students will be able to…..)	
CO1	As prescribed by the course instructor
CO2	As prescribed by the course instructor
CO3	As prescribed by the course instructor
CO4	As prescribed by the course instructor

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)													
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PO13
CO1	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	-	-	-	-	-	-
CO3	-	-	-	-	-	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	-	-	-	-	-

	Course Code: DYP 1008	Course Title: Project -II	Credits = 4		
			L	T	P
	Semester: VII	Total contact hours: 120	0	0	8

List of Prerequisite Courses	
	Project I (**DYP 1007**)
List of Courses where this course will be Prerequisite	
Relevant courses of Semester VIII	
Description of relevance of this course in the B. Tech. (Dyestuff Tech.) Programme	
1. Develop a skill to execute & solve a research problem in dyestuff technology 2. Develop skills for presenting a research outcome effectively	

Sr. No.	Course Contents (Topics and subtopics)	Required Hours
1	The topic of the research with defined objectives and hypothesis should be explored by scientifically planned rational experiments. Students should have actual experimental data collected on the chosen research topic.	**80**

2	-Oral presentation of proposed research work with data generated during actual trial targeted towards the objectives -Submission of report of research proposal	**40**
	Total	**120**

Course Outcomes (Students will be able to…..)	
CO1	*Perform* experiments & troubleshoot to generate reliable data (K5)
CO2	*Apply* different statistical tools for scientific data analysis (K4)
CO3	*Evaluate* critically the experimental data and draw meaningful inferences (K5)
CO4	*Develop* skills to communicate the research outcome effectively (K6)
CO5	Develop skills for writing a complete document on the project work (K6)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3+S	K3	K3+A	K2+A	K3	K6+A+P	K3	K4
CO1	K5	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K4	3	3	2	3	2	3	3	3	2	3	3	2	3	3
CO3	K5	3	3	3	3	3	0	3	3	3	3	3	3	3	3
CO4	K6	3	3	3	3	3	3	1	3	3	3	3	2	3	3
CO5	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Course	K6	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0– No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: DYP 1009	**Course Title: Preparation, analysis and application of dyes, optical brightners and functional colorants**	**Credits = 4**		
			L	**T**	**P**
	Semester: VIII	**Total Contact Hours: 120**	**0**	**0**	**8**

List of Prerequisite Courses

HSC (Science)

List of Courses where this course will be prerequisite

All dyestuff technology courses

Description of relevance of this course in the B. Tech. Program

This course will familiarize the students with different dyes, optical brighteners, functional colorants and their methods of synthesizing them, characterizing them as well as applying them in textile material or use them as functional dyes.

	Course Contents (Topics and Subtopics)	**Required 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, Diaminostilbenedisolphonic acid)	40
2	Preparation, analysis and application of some dyes (Examples: Preparation of Indophenol blue, Synthesis of Acid Blue 40, Metal complex dyes, Synthesis of Xanthene dyes, Preparation of dis azo dye, Synthesis of Azocoumarin dye, Synthesis of Malachite Green etc.)	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 (Example:Preparation of coumarin based functional colorants)	20
	Total	**120**

List of Textbooks/Reference Books

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

Course Outcomes (Students will be able to…..)	
CO1	*Design* the synthetic route for the preparation of dyes and intermediates (K3)
CO2	*Conduct* experiments in the lab independently for the synthesis of dyes, intermediates and optical brighteners (K3)
CO3	*Execute* the process with utmost efficiency and precession (K3)
CO4	*Evaluate* the purity, and characterize the products via instrumental methods (K5)
CO5	*Apply* of the synthesized products for diverse uses (K4)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K3	3	3	3	3	1	3	3	1	3	1	3	2	2	3
CO2	K3	3	3	3	3	3	3	2	0	3	1	3	2	3	2
CO3	K3	3	3	3	3	3	3	2	0	3	1	3	3	2	3
CO4	K5	3	2	2	3	3	2	1	2	3	1	3	1	2	2
CO5	K4	3	3	3	3	3	3	3	1	3	1	3	2	3	3
Course	K5	3	3	3	3	3	3	3	2	3	1	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Annexure A

Institute Elective Offered by DYT

Semester VI (DYT1721)

	Course Code: DYT 1721	**Course Title:** Organic Reaction mechanism and reagent chemistry	**Credits = 3**		
			L	**T**	**P**
	Semester: VI	**Total Contact Hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
HSC (Science)					
List of Courses where this course will be prerequisite					
All chemistry, chemical science and dyestuff technology related courses					
Description of relevance of this course in the B. Tech. Program					
The students will be trained to write the reaction mechanisms of different chemical transformations as well as the uses of several reagents for functional group transformation will also be discussed.					

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Study of intermediates: Carbocations, carbanions, carbenes, nitrenes, free radicals their stability, formation and reactions.	10
2	Discussion on mechanism of organic reactions and problem solving (class work as well assignment): Molecular rearrangements, cyclixsation reactions. Reagents used in oxidation and reductions. C-C bond forming reactions, palladium catalysed coupling reaction.	20

3	Discussion and revision of concepts – substitution and elimination reactions, electrophilic and nucleophilic aromatic substitution reactions, free radical reaction.	8
4	Neighbouring group participation; 1,2 and 1,4 addition to conjugated systems.	8
	Total	**45**
List of Textbooks/Reference 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	
Course Outcomes (Students will be able to…..)		
CO1	*Identify* the classes of organic molecular structure. (K2)	
CO2	*Design* synthetic route of different organic molecules. (K3)	
CO3	*Propose* the retrosynthetic pathway of different organic molecules. (K3)	
CO4	*Analyse* the reaction mechanism (K4)	
CO5	*Assess* the best possible route for the synthesis (K3)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	3	3	3	3	0	0	1	0	0	0	2	3	2	2
CO2	K3	3	3	3	3	1	1	1	1	1	1	3	3	2	3
CO3	K3	3	3	3	3	1	1	1	1	1	1	2	3	2	3
CO4	K4	3	3	3	3	2	2	1	2	1	1	2	3	2	3
CO5	K3	3	3	3	3	2	2	1	2	2	2	3	3	2	3
Course	K4	3	3	3	3	2	2	1	2	2	2	3	3	2	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Annexure B

Institute Elective Offered by DYT

Semester VII (DYT1812)

	Course Code: DYT 1812	Course Title: Introduction to Green Chemistry	Credits = 3		
			L	T	P
	Semester: VII	Total Contact Hours: 45	2	1	0
List of Prerequisite Courses					
Industry visits for unit process study.					
List of Courses where this course will be prerequisite					
All courses relevant to chemical science and chemical engineering					
Description of relevance of this course in the B. Tech. Program					
To introduce various existing processes and technology of Dyes and pigment field to students					

	Course Contents (Topics and Subtopics)	Required 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	10
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	15
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.	10
4	Catalysis and Green Chemistry, heterogeneous catalysis, homogeneous catalysis, phase transfer catalysis, biocatalysis, photocatalysis	10
	Total	**45**
List of Textbooks/Reference Books		
1	Solvent-free Organic Synthesis, Tanaka K., WILEY-VCH, Verlag, 2003.	
2	Green Solvents for Chemistry: Perspectives and Practice, Oxford University Press, U.K., 2003.	
3	Green Chemistry: Theory and Practice, Anastas P. T. and Warner J. C., Oxford University Press, U.K., 1998.	
4	Introduction to green Chemistry, Matlack A. S., Marcel Dekker, Inc., New York, 2001.	
5	Green Chemistry: An Introductory Text, Lancaster M., Royal Society of Chemistry, Cambridge, U.K., 2002	
Course Outcomes (Students will be able to…..)		
CO1	*Understand* the Green aspects of chemistry (K2)	
CO2	*Utilize* and modify the processes to have green and better environmental protective aspect. (K3)	
CO3	*Design* Safer and healthy atmosphere building (K3)	
CO4	*Analyze* energy efficient chemical transformation (K4)	
CO5	*Demonstrate* the sustainable strategies for the chemical synthesis (K5)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	1	3	2	3	2	2	3	3	0	0	3	1	3	2
CO2	K3	3	3	3	3	3	3	3	2	2	1	2	2	3	2
CO3	K3	3	3	3	3	3	3	3	3	2	2	2	2	3	3
CO4	K4	3	3	3	3	3	3	3	3	2	2	3	3	2	3
CO5	K5	3	3	3	3	3	3	3	3	2	2	3	3	2	3
Course	K5	3	3	3	3	3	3	3	3	2	2	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

Annexure C

Programme Electives Offered by DYT

Semester VIII (DYT1722 or DYT1208)

	Course Code: (DYT 1722)	Course Title: Computational colour chemistry	Credits = 3		
			L	T	P
	Semester: VIII	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)

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. Program

To make the students understand computational material science in general and computational color chemistry.

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.

	Course Contents (Topics and Subtopics)	Required 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.	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.	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.	08
4	Problems associated with the many electron systems. Hartree-Fock formalism for many electron systems.	08
5	Quantum mechanical concepts relevant to 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.	06
6	Semiempirical methods of calculation of absorption spectra. Configuration Interaction Singles. Hartree-Fock method in Time Dependent Domain. Density Functional Theory and its Time Dependent formalism.Post- HartreeFock methods.	12
		45

List of Textbooks/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
Course Outcomes (Students will be able to…..)	
CO1	understand the basics of color and chemical constitution (K2)
CO2	acquire basics of computational material science knowledge (K2)
CO3	*analyze* the various quantum mechanical tools to understand color of dyes (K2)
CO4	*know* the various methodologies in computational spectroscopy (K2)

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)															
		PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	3	3	1	3	2	1	1	0	1	1	1	3	2	2
CO2	K2	3	3	1	3	2	1	1	0	1	1	1	3	2	3
CO3	K3	3	3	2	3	2	2	1	1	1	1	2	3	3	2
CO4	K2	3	3	2	3	2	2	1	1	1	1	1	3	3	3
Course	K2	3	3	2	3	2	2	1	1	1	1	2	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution
K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

	Course Code: (DYT 1208)	**Course Title: Chemistry and Technology of Agrochemicals**	**Credits = 3**		
			L	**T**	**P**
	Semester: VIII	**Total Contact Hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
HSC (Science) and Organic chemistry I and II					
List of Courses where this course will be prerequisite					
All Speciality chemicals course					
Description of relevance of this course in the B. Tech. Program					
This course will provide introduction to the concepts of crop protecting chemicals, their classification, formulation, design strategy, modes of action and synthetic schemes.					

	Course Contents (Topics and Subtopics)	**Required Hours**
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.	10
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.	10

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 **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.	10
4	**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.	10
5	**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.	5
	Total	**45**
List of Textbooks/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	H. B. Scher: *Advances in pesticides formulation Technology. ACS, NO.254*.	
4	W. Valukenburg : *Pesticide formulations (Dekker).*	
5	H. A. Moye: *Analysis of pesticide residues*	
Course Outcomes (Students will be able to…..)		
CO1	*Define* and *state* different terminologies related to agrochemicals (K2)	
CO2	*Describe* and *explain* the general requirements for pesticides design, their formulation techniques, application procedures and residue analysis (K2)	
CO3	*Differentiate* agrochemicals based on application and chemical constitution (K2)	
CO4	*Outline* the synthesis of various commercially important pesticides (K2)	
CO5	*Illustrate* the potential environmental risk and involvement of green chemistry and pest management strategies in agrochemistry(K2)	

Mapping of Course Outcomes (COs) with Programme Outcomes (POs)

		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
		K3	K4	K6	K5	K6	K3	K3 +S	K3	K3 +A	K2+ A	K3	K6+ A+P	K3	K4
CO1	K2	2	2	2	2	2	2	3	1	0	0	2	0	2	2
CO2	K2	3	3	3	3	3	3	3	1	0	0	3	1	2	2

CO3	K2	2	2	2	3	2	2	3	2	1	0	3	1	3	3
CO4	K2	2	3	3	3	3	3	3	3	2	2	3	2	2	3
CO5	K2	3	3	3	3	3	3	3	3	3	3	3	3	2	2
Course	K2	3	3	3	3	3	3	3	3	3	3	3	3	3	3

3, Strong Contribution; 2, Moderate Contribution; 1, Low Contribution; 0− No Contribution

K, knowledge level from cognitive domain; A, Affective domain; S, Psychomotor domain

INSTITUTE OF CHEMICAL TECHNOLOGY

Degree of Bachelor of Technology in Dyestuff Technology (B. Tech- Dyestuff Technology) Syllabus

The institute revamped the syllabi of various courses in 2009. All the courses are credit based and the evaluations are grade based. The credit system is a systematic way of describing an educational programme by attaching credits to its components. The definition

of credits is based on student workload, learning outcomes and contact hours. It is a student-centric system based on the student workload required to achieve the objectives of

a programme. Each theory course consists of lectures and tutorials. During tutorial sessions it is expected that the problem solving / case studies / relevant real life applications / student presentations / home assignments / individual or group projects are discussed in presence of the teacher. Teacher can have the freedom to interchange lectures / tutorials depending upon the need. Each laboratory course consists of practical hours and/or extra lecture hours depending upon the need. The institute gives emphasis on continuous evaluation with considerable freedom to the teacher in deciding the mode of evaluation of the students. It is desirable to revise the syllabi of various courses every 5 – 6 years. Accordingly, the B. Tech (Dyestuff Technology) syllabus was revised in. The revised syllabus came into effect for first year students from the academic year, commencing July 2015. The Bachelor of Technology is a four year program, after 12^{th} grade. The structure consists of subjects common to all branches, and includes basic sciences, engineering and some humanities and management components. In this document, the

structure of the syllabus divided into 8 semesters (including the evaluations and related information), is followed by the detailed syllabus for special subjects, within the dyestuff technology domain. There were several motivations for the syllabus revision:

- Syllabus to be benchmarked with respect to other institutions
- Program objectives to be defined for the course
- Course objectives to be defined for each subject
- Map showing how the course objectives meet the program objectives
- Map showing the linkage between different courses
- AICTE / NBA accreditation guidelines requirement

So far, the intake of B. Tech (Dyestuff Technology) was based on two different qualifying examinations: AIEEE and MHCET. From the academic year 2014, all the incoming students will be coming through a qualifying criterion based on combination of JEE-Main and state board examinations.

Syllabi of Bachelor of chemical engineering and chemical technology courses of various universities and institutions around the world, MIT, UCB, UCSB, UMN, UWM, RMIT, IITB, IITKGP, IITG, etc. was analyzed to identify the weightages given to different components in the syllabus. A summary of this analysis is as follows:

Subject	% of the total credits in different universities
Physics	2.0-7.5
Chemistry	2.8-15.9
Mathematics	8.1-17.4
Biology	1.5-4.5
Communication Skills	1.5-3.8
Humanities and Management	2.1-12.6
General Engineering	1.5-10.8
Core Chemical Engineering/Core Technology	36.1-57.6
Electives	4.6-16.5

Feedback about the course contents as well as overall structure was taken from various experts (alumni as well as others), who are working in the areas of chemical Engineering and technology and especially in the dyestuff and pigment industry from industry and academic Institutions. These experts were from diverse backgrounds (R&D, production, design, consultancy, engineering, technology, etc. Some of the salient points of the feedback are:

ICT students have excellent background in chemistry, industrial aptitude, and core chemical engineering subjects.

- Analytical abilities and mathematical aptitude needs to be further strengthened
- Students need to be exposed to newer and emerging areas in chemical engineering and technology, such as, nanotechnology, biotechnology, product design, sustainability, energy engineering, etc.
- Industry relevant applications, such as, chemical process safety, scale-up, engineering standards and codes, P&ID, etc. need to be covered

- Students need to be exposed to standard commonly used softwares, such as, MATLAB, ASPEN, etc.
- Syllabus needs to have more electives and flexibility for student to choose courses as per liking, electives can be grouped to form one area of expertise
- Communication skills, interpersonal skills, and team work need to be strengthened
- Knowledge in management related subjects needs to be enhanced; e.g. finance, human resource, IP, etc.

The weightages of different modes of assessments shall be as under:

	In-Semester Evaluation			
	Continuous Assessment (C.A)	One Mid Semester Examination (M.S)	End Semester Examination (E.S)	Possible components of continuous assessment
Theory Subject	20%	30%	50%	Quizzes, online tests, class tests (open or closed book), home assignments, group assignments, viva-voce, group projects and assignments, etc.
Practicals	50%	-	50%	Attendance, *VIVA-VOCE*, journal, assignments, project, experiments, tests, etc.

Students' Evaluations

(a) It is expected that the teacher would conduct at least two assessments as a part of continuous assessment in a semester

(b) The teacher will announce at the beginning of the respective course the method of conducting the tests under the continuous assessment mode and the assignment of marks for various components of continuous assessment

(c) In-semester performance of all students should be displayed and sent to the academic office by the teacher at least 15 days before the end-semester examination.

(d) For the theory courses, two mid-semester tests for each course will be held as per the schedule fixed in the Academic Calendar.

(e) A mid-semester examination of 30 marks will be conducted for 2 hour duration. A mid semester examination of 15 marks will be conducted for 1 hour duration.

(f) The end semester examination will cover the full syllabus of the course and will be conducted as per the institutional time table at the end of each semester.

(g) An end semester examination of 50 marks will be conducted for 3 hours duration. An end semester examination of 25 marks will be conducted for 2 hours duration.

Detailed discussions were conducted by the syllabus revision committee of the department and the following Programme Education Objectives (PEO), Programme Outcomes (PO) and Graduate Attributes (GA) were decided. The syllabus revision was carried out in view of the following PEO, PO and GA:

Program Education Outcomes (PEOs)

PEO's for Dyestuff Technology (B.Tech) courses are as follows:

Sr. No.	Programm Education Outcomes
1	Our graduates are expected to think critically, creatively and apply the fundamentals of chemistry, applied technology and engineering to chemical and allied industries, especially the dyestuff industry, for the benefit of country in general, economy, society and environment in particular.
2	Our graduates are expected to adopt to evolving technologies and stay in tune with current needs of the country and society
3	Our graduates are expected to work for implementation of new technologies for the benefit of mankind in general, economy, society & environment in particular
4	Our graduates are expected to be innovative and have good entrepreneurship, communication, interpersonal and managerial skills

Program Outcomes (PO's)

PO's for Dyestuff Technology (B.Tech) courses are as follows

Sr. No.	Graduate Attribute	Programme Outcomes (POs)
1	Engineering knowledge	The graduates will be able to apply knowledge of basic sciences (Mathematics, Physics, Chemistry and Biology) and engineering courses in getting solutions to issues pertaining to chemical and allied industries.
2	Problem analysis	The graduates should be able to systematically break up complex problems in realizable steps and solve them.
3	Design & Development of Solutions	The graduates will be able to design a system or a component of a system or provide an engineering solution for a specific task within realistic constraints
4	Investigation of Problem	The graduates will be able to design and conduct experiments as well as analyze and interpret data. The graduates should be able to systematically break up complex problems in realizable steps and solve them.
5	Modern tools usage	The graduate will be able to use modern tools, softwares, equipment etc. to analyze and obtain solution to the problems.
6	Engineer and society	The graduates will be able to study the impact of process

		industry on the global, economic, and societal context
7	Environment & sustainability	The graduates should practice their profession considering environmental protection and sustainability
8	Ethics	Graduates are expected to practice professional skills in an ethical manner
9	Individual & team work	The graduates should have competence to undertake designated task on individual or team basis as per the requirement.
10	Communication	The graduates will be able to communicate effectively their points of view
11	Lifelong learning	The graduates will acquire attitude for life- long learning
12	Project management & finance	The graduates should actively participate in project and financial management

Programme Specific Outcomes for Dyestuff Technology(PO's)

Sr. No.		Programme Specific Outcomes (PO's)
13	Specialization in dye synthesis, analyses, applications and knowledge of dyeing techniques	Our graduates are totally in tune with the current needs of the dyestuff industry and have considerable problem solving acumen.
14	Core organic chemistry, technology development and implementation	Our graduates have a strong foundation in chemistry, and thus combined with their engineering skills are independently able to develop new dyestuff and allied chemical industry related technologies and successfully implement them at an industrial scale

Syllabus Structure for B.Tech (Dyestuff Technology) Course

Semester I

No.	Subjects	Hours/week (L + T)	Marks	Credits
MAT 1101	Applied Mathematics-I	2+2	100	4
PYT 1101	Applied Physics-I	3+1	100	4
CHT 1401	Analytical Chemistry	2+1	50	3
CHT 1432	Physical Chemistry	2+1	50	3
	TOTAL	14	300	14
GEP 1101	Engineering Graphics-I	8	100	4
CHP 1343	Physical and analytical chemistry laboratory	4	50	2
HUP 1104	Communication Skills	4	50	2
	Total Practical	16	200	8
		30	500	22

Semester II

No.	Subjects	Hours/week (L + T)	Marks	Credits
CHT 1132	Organic Chemistry	3+1	100	4

CHT 1342	Physical Chemistry-II	2+1	50	3
CET 1507	Process Calculations	2+2	100	4
MAT 1102	Applied Mathematics-II	2+2	100	4
PYT 1103	Applied Physics-II	2+1	50	3
	TOTAL	18	400	18
CHP 1132	Organic Chemistry Laboratory	4	50	2
PYP 1101	Physics Laboratory	4	50	2
	Total Practicals	8	100	4
		26	500	22

Semester III

No.	Subjects	Hours/week (L + T)	Marks	Credits
DYT 1101	Technology of Intermediates	3+1	100	4
OLT 1102	Chemistry of Oleochemicals and Surfactants	3+1	100	4
DYT 1202	Chemical and Physical Constituents of Colorants	2+1	50	3
CHT 1136	Aromatic and Heteroaromatic Chemistry	3+1	100	4
	TOTAL THEORY	19	450	19
DYP 1001	Analysis of Inorganic Raw Materials used in Dyestuff Industry	4	50	2
MAP 1202	Computer Applications Lab	4	50	2

	TOTAL PRACTICAL	8	100	4
	Total	27	550	23

Semester IV

No.	Subjects	Hours/week (L + T)	Marks	Credits
GET 1116	Engg. Mechanics and Strength of Materials	3+1	100	4
PYT 1202	Colour Physics and Colour Harmony	2+1	50	3
CET 1105	Transport Phenomena	3+1	100	4
GET 1105	Basic Electrical Engg and Electronics	2+1	50	3
DYT 1102	Technology of Intermediates II	3+1	100	4
	TOTAL THEORY	18	400	18
GEP 1106	Electrical Engg and Electronics Lab	4	50	2
PYP 1203	Colour Physics Lab	4	50	2
	TOTAL PRACTICAL	8	100	4
	Total	26	500	22

Semester V

No.	Subjects	Hours/week (L + T)	Marks	Credits
CET 1401	Chemical Engineering Operations	2+1	50	3
CET 1212	Chemical Reaction Engineering	2+1	50	3

DYT 1103	Technology of Azo colorants	3+1	100	4
DYT 1104	Technology of Quinonoid colorants	3+1	100	4
TXT 1215	Technology of dyeing and printing	3+1	100	4
	TOTAL THEORY	18	400	18
DYP 1002	Analysis of intermediates, dyes and fibers	8	100	4
DYP 1003	Experimental Dyeing	4	50	2
	TOTAL PRACTICAL	12	150	6
	Total	30	550	24

Semester VI

No.	Subjects	Hours/week (L + T)	Marks	Credits
DYT 1203	Fluorescent Colorants	3+1	100	4
DYT 1204	Heterocyclic intermediates and colorants	2+1	50	3
HUT 1103	Industrial Psychology and Human Resource Management	2+1	50	3
HUT 1104	Industrial Management	3+1	50	3
HUT 1106	Environmental Science and Technology	2+1	50	3
	Elective- I	2+1	50	3

	TOTAL THEORY	20	350	19
DYP 1004	Preparation of intermediates and dyes	8	100	4
TXP 1013	Wet processing of textiles	4	50	2
DYP 1005	Process and plant design	4	50	2
	TOTAL PRACTICAL	16	200	8
	Total	36	550	27

Elective 1- Chemistry and Technology of Specialty organic intermediates and fine chemicals (DYT 1531) OR Career options and literature survey (**DYP 1611**)

Semester VII (Will be of 10 weeks duration)

No.	Subjects	Hours/week (L + T)	Marks	Credits
CET 1703	Chemical Process Control	2+1	50	3
DYT 1105	Technology of cationic and sulfur colorants	3+1	100	4
DYT 1206	Structural Elucidation of organic compounds	2+1	50	3
	Elective-II	2+1	50	3
HUT 1105	Industrial Management-II	2+1	50	3
MAT 1106	Design and Analysis of Experiments	2+1	50	3
	TOTAL THEORY	19	350	19
CEP 1714	Chem. Eng. Laboratory	4	50	2

DYP 1006	Seminar	4	50	2
DYP 1007	Project I	8	100	4
DYP 1012	In-Plant Training	--	50	3
	TOTAL PRACTICAL	16	250	11
	Total	34	600	30

Semester VIII

No.	Subjects	Hours/week (L + T)	Marks	Credits
CET 1504	Project Engineering and Economics	2+1	50	3
DYT 1106	Case Studies in dyestuff industries	2+1	50	3
DYT 1205	Functional application of organic colorants	2+1	50	3
DYT 1107	Technology of pigments	2+1	100	4
HUT 1107	Value Education	2+1	50	3
	Elective-III	2+1	50	3
	TOTAL THEORY	21	350	19
DYP 1008	Project II	8	100	4
DYP 1009	Preparation, analysis and application of Dyes, optical brighteners and functional colorants	8	100	4
	TOTAL PRACTICAL	16	200	8

	Total	**37**	**550**	**27**

Elective II- **Reaction mechanism and reagent chemistry (DYT 1721)** OR Computational colour chemistry

Elective III- **Introduction to green chemistry (DYT 1812)** OR Chemistry and Technology of Inorganic Pigments (DYT 1711)

Semester I

	Course Code: CHT1341	**Course Title:** Physical Chemistry I	**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					
Description of relevance of this course in the B. Tech. (Dyes) Programme					
The course will enable the students to understand chemical and phase equilibria , direction of spontaneity and calculation of equilibrium compositions, effect of experimental parameters on phase and chemical equlibria					

	Course Contents (Topics and subtopics)	**Reqd. hours**
1	Introduction- Thermodynamic systems , work , heat and energy, state and path functions	2
2	First law of thermodynamics – Enthalpy and heat capacities, application of first law to gases, standard states	2
3	Second and third laws of thermodynamics -. Statements and applications, entropy and calculation of entropy changes, absolute entropies ,verification of third law, molecular basis of thermodynamics	3
4	Spontaneous process and equilibrium: Criteria for spontaneous processes, equilibrium states, , Maxwell relations , Gibbs and Helmholtz free energy and their temperature relations, free energy and equilibrium constant , calculation of free energy changes , free energy and entropy of mixing, thermochemistryHesses law, Ellingham diagrams	3

5	Multicomponent systems -. Partial molar quantities and chemical potential, Gibbs Duhem equation, thermodynamics of solutions, ideal and non ideal solutionFugacity, activity and activity coefficients, thermodynamic properties of electrolytes in solutions	2
6	Phase equlibria -. Gibbs Phase rule, equilibrium between phases Gibbs enegy and phase transitions, classification of phase transitions, , one component systems – phase diagrams, Clausius- Clapeyron equation, Henry's law and Raoult's law, solubility and extraction	5
7	Two and three component systems – liquid- liquid and liquid vapour systemspressure -composition and temperature- composition phase diagrams, solidliquid phase diagrams , three component phase diagrams, colligative properties	5
8	Electrochemistry – thermodynamics of electrochemical systemselectrochemical cells, determination of electrode potentials, types of electrochemical cells, activity and activity coefficients, theory of dissociation of electrolytes, ionic equlibria	8
	List of Text Books/ Reference Books	
1	Physical chemistry – Robert G Mortimer – Elsevier publications	
2	Basic chemical thermodynamics- E. Brian smith – Oxford University press	
3	Introduction to Chemical Engineering Thermodynamics- J.M.smith , Van Ness	
4	Chemical nad Engineering thermodynamics – Milo Koretsky, Wiley publications	
5	Phase rule and its applications-Alexander Findlay, Dover publications	

Semester I															
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**

CO1	comprehend the laws of thermodynamics and related concepts and to explain the molecular basis for the same (K2)	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	apply the concepts of partial molar quantities to explain the behaviour of pure substances and solutions (K3)	3	3	2	2	2	3	1	3	0	3	2	2	2	3
CO3	apply principles of phase equilibria in two- and three-component systems (K3)	3	3	1	2	2	0	3	3	2	3	3	2	3	3
CO4	elucidate the effect of thermodynamic quantities on chemical equilibria and relate it to properties of chemical systems (K2)	2	2	0	2	0	3	3	3	3	3	3	1	2	2
CO5	Able to solve complex physical chemistry problems	2	2	2	2	2	2	2	2	1	1	1	1	2	2
CHT1341		3	3	2	2	2	3	3	3	3	3	3	2	3	3

	Course Code: CHT1401	**Course Title:** Analytical chemistry	**Credits = 3**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
	HSC (Science)				
List of Courses where this course will be prerequisite					
	Other Chemistry Courses, Physical and Analytical Chemistry Laboratory				
Description of relevance of this course in the B. Tech. (Dyes) Programme					
To introduce the principles and applications of analytical chemistry					

	Course Contents (Topics and subtopics)	Reqd. hours
1	Introduction – Analytical procedures- hazards and handling, treatment of waste, good laboratory practices	4
2	Aspects of analysis- errors – systematic and random errors, statistical treatment of experimental results, least square method, correlation coefficients Sampling – basics and procedures, preparation of	5
3	Applied analysis – analytical procedures in environmental monitoring, water, soil and air quality, BOD and COD determinations,	5
4	Instrumental methods – Criteria for selecting instrumental methods - precision, sensitivity, selectivity, and detection limit, transducers, sensors and detectors, signals and noise	4
5	Molecular spectral methods – Uv-visible, molecular fluorescence, IR and FT-IR Mass spectroscopy	8
6	Atomic spectral methods – atomic emission and absorption methods	3
7	Thermal methods – TGA, DTA and DSC	4
8	Chromatographic and other separation methods – GC, HPLC , ion exchange and size exclusion chromatography , super critical fluid extraction	12
	List of Text Books/ Reference Books	
1	D.A. Skoog, D.M. West, F.J. Holler, S.R. Crouch, Fundamentals of Analytical Chemistry	
2	J.G. Dick, Analytical Chemistry, R.E. Krieger Pub	
3	Environmental Chemistry, A. K. De, Wiley	
4	Chromatography	
5	Thermal Methods	

Semester I	

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	Apply the knowledge of sampling, data analysis and select proper analytical method	3	3	2	2	2	3	3	0	3	3	0	2	3	3
CO2	Explain the principles of UV Visible and Fluorescence spectroscopic methods	3	1	0	1	1	0	3	3	2	3	3	0	2	2
CO3	Explain the principles of electrochemical methods	3	2	1	2	0	3	3	3	3	2	3	1	3	2
CO4	Explain the principles of chromatographic methods	3	2	1	1	1	3	2	3	3	3	3	1	1	2
CO5	Analyse and Interprete the data	2	2	2	1	1	2	2	2	2	1	1	1	2	2
CHT1401		3	2	2	2	2	3	3	3	3	3	3	2	3	3

	Course Code: MAT1101	**Course Title:** Applied Mathematics I	**Credits = 4**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
	HSC (Science)				
List of Courses where this course will be prerequisite					
	This is a basic Mathematics course. This knowledge will be required in almost all subjects later on				
Description of relevance of this course in the B. Tech. (Dyes) Programme					
This is a basic Mathematics course. This knowledge will be required in almost all subjects later on. This knowledge is also required for solving various mathematical equations that need to be solved in several chemical engineering courses such as MEBC, momentum transfer, reaction engineering, separation processes, thermodynamics, etc.					

	Course Contents (Topics and subtopics)	Reqd. hours
1	Solutions of system of linear equations (Gauss-elimination, LU-decomposition etc.) Numerical methods for solving non-linear algebraic / transcendental etc. Newton‘s method, Secant, Regula Falsi,	10
2	Interpolation and extrapolation for equal and non-equal spaced data (Newtons Forward, Newtons backward and Lagrange) Numerical integration (trapezoidal rule, Simpson‘s Rule)	10
3	Probability of Statistics:Functions of random variables, probability distribution functions, expectation, moments Statistical hypothesis tests, t-tests for one and two samples, F-test, $\chi 2$ -test Statistical Methods for Data Fitting: Linear, multi-linear, non-linear regression	10
4	Differential Calculus: Higher order differentiation and Leibnitz Rule for the derivative, Taylor‘s and Maclaurin‘s theorems, Maxima/Minima, convexity of functions, Radius of curvature;	10
5	Functions of two or more variables, Limit and continuity, Partial differentiation, Total derivatives, Taylor‘s theorem for multivariable functions and its application to error calculations, Maxima/Minima, Jacobian.	10
6	Integral Calculus: Beta and Gamma functions, Differentiation under the integral sign, surface integrals, volume integrals	10
	List of Text Books/ Reference Books	
1	Advanced Engineering Mathematics, Erwin Kreyszig, John-Wiely.	
2	Advanced Engineering Mathematics S. R. K. Iyengar, R. K. Jain, Narosa	
3	Introductory Methods Of Numerical Analysis, S. S. Sastry, PHI.	
4	A First Course in Probability, Sheldon Ross, Pearson Prentice Hall	
5	Probability and Statistics in Engineering , W.W. Hines, D. C. Montgomery, D.M. Goldsman, John-Wiely	

Semester I	

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	understand the notion of differentiability and be able to find maxima and minima of functions of one and several variables (K3)	3	3	2	0	2	3	3	2	3	3	3	2	3	3
CO2	compute surface and volume integrals (K3)	3	3	2	2	2	3	1	1	3	3	2	1	3	3
CO3	Understand and explain the notion of vectors and vector spaces (K2)	3	2	1	2	1	2	3	3	3	3	3	0	3	2
CO4	solve systems of linear equations and eigenvalue problems analytically and numerically (K3)	3	3	2	1	2	3	2	0	0	0	3	2	3	3
CO5	fit relationship between two data sets using linear, non-linear regression (K3)	3	3	1	2	2	3	3	2	3	3	1	2	3	3
MAT1101		**3**	**3**	**2**	**2**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**2**	**3**	**3**

	Course Code: PYT1101	**Course Title:** Applied Physics I	**Credits = 4**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
	HSC (Science)				
List of Courses where this course will be prerequisite					
	Applied Physics – II, Physics Laboratory, Chemical Engineering Thermodynamics, Momentum and Mass Transfer, Heat Transfer, Material Science and Engineering, Structural Mechanics, etc				
Description of relevance of this course in the B. Tech. (Dyes) Programme					

This is a basic physics course. This knowledge will be required in almost all subjects later on. This knowledge is also required for understanding various chemical engineering concepts that will be introduced in courses such as momentum transfer, reaction engineering, separation processes, thermodynamics, heat transfer, etc.		This is a basic physics
	Course Contents (Topics and subtopics)	**Reqd. hours**
1	Solid State Physics Crystal structure of solids: unit cell, space lattices and Bravais lattice, Miller indices, directions and crystallographic planes, Cubic crystals: SSC, BCC, FCC, Hexagonal crystals:	15
2	Fluid Mechanics Basic concepts of density and pressure in a fluid, ideal and real fluids, Pascal's law, absolute pressure and pressure gauges, basic concepts of surface tension and buoyancy,	15
3	Optics and Fibre Optics Diffraction: Introduction to interference and example; concept of diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits; diffraction grating, characteristics of diffraction grating and its applications.	10
4	Lasers Introduction to interaction of radiation with matter, principles and working of laser: population inversion, pumping, various modes, threshold population inversion, types of laser: solid state, semiconductor, gas; application of lasers.	10
5	Ultrasound Generation of ultrasound: mechanical, electromechanical transducers; propagation of ultrasound, attenuation, velocity of ultrasound and parameters affecting it, measurement of velocity, cavitation, applications of ultrasound.	10
List of Text Books/ Reference Books		
1	Physics:Vols. I and II – D. Halliday and R. Resnick, Wiley Eastern	
2	Lectures on Physics: Vols. I, II and III – R. P. Feynman, R. B. Leighton and M. Sands, Narosa.	
3	Concepts of Modern Physics – A. Beiser, McGraw-Hill	
4	Introduction to Modern Optics – G. R. Fowles , Dover Publications	
5	A Course of Experiments with LASERs – R. S. Sirohi, Wiley Eastern.	

6	Optical Fibre Communication – G. Keiser, McGraw-Hill
7	Optoelectronics – J. Wilson and J. F. B. Hawkes, 2nd ed, Prentice-Hall India
8	Ultrasonics: Methods and Applications – J. Blitz, Butterworth.
9	Applied Sonochemistry – T. J. Mason and J. P. Lorimer, Wiley VCH

Semester I															
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	apply acoustic cavitation of Chemical Engineering Processes (K3)	3	3	2	2	2	1	1	3	3	3	3	2	3	3
CO2	apply Bernoulli equation in simple pipe flows (K3)	3	1	2	1	2	3	3	3	3	3	0	2	1	3
CO3	explain the principles of lasers, types of lasers and applications (K2)	3	2	1	2	0	3	3	3	3	2	3	1	3	2
CO4	calculate resolving power of instruments (K3)	2	3	2	1	2	2	0	2	3	3	3	2	0	3
CO5	describe principles of optical fibre communication (K2)	3	2	1	2	0	0	3	3	1	3	1	1	3	2
PYT1101		3	3	2	2	2	3	3	3	3	3	3	2	3	3

	Course Code: CHP1343	**Course Title:** Physical and Analytical Chemistry Laboratory	**Credits = 4**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses		
	H.S.C. Chemistry laboratory courses	
Description of relevance of this course in the B. Tech. (Dyes) Programme		
Students will become familiar with laboratory experimental skills , plan and interpretation of experimental tasks, understand the relevance of principles of physical chemistry in chemical processes		
	Course Contents (Topics and subtopics)	**Reqd. hours**
1	Experiments based on chemical reaction kinetics, phase equlibria and electrolyte systems, surface and interfacial phenomena such as surface tension and CMC Measurements.	4h per session
List of Text Books/ Reference Books		
1	Practical physical Chemistry – B.Viswanthan and P.S. Raghavan	
2	Practical physical Chemistry- Alexander Findlay	

Semester I															
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	identify and determine physicochemical parameters using simple tools.(K3)	3	3	2	2	2	3	3	3	2	3	3	2	3	3
CO2	interpretation of data and drawing scientific conclusions, dryers, etc.(K4)	3	3	1	3	1	2	3	1	3	3	0	2	3	3
CO3	Ability to set up reaction independently	3	2	2	2	2	2	2	1	2	2	2	2	1	2
CO4	Ability to conduct the experiments individually	2	2	2	2	1	2	2	2	2	2	1	1	2	2
CO5	Ability to analyze the results	2	3	1	2	2	2	2	2	2	2	1	2	2	2

CHP1342		3	3	2	3	2	3	3	3	3	3	3	2	3	3

	Course Code: GEP1101	**Course Title:** Engineering Graphics	**Credits = 4**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 60**	**2**	**0**	**6**
List of Prerequisite Courses					
	Basic Geometry				
List of Courses where this course will be prerequisite					
	Engineering Graphics – II, Equipment Design and Drawing-I, Equipment Design and Drawing-II, Home Paper – II, Structural Mechanics,				
Description of relevance of this course in the B. Tech. (Dyes) Programme					
A student of Chemical Engineering is required to know the various processes and also the equipment used to carry out the processes. Some of the elementary processes like filtration, size reduction, evaporation, condensation, crystallization etc., are very common to all the branches of technology. These and many other processes require machines and equipments. One should be familiar with the design, manufacturing, working, maintenance of such machines and equipments. The subject of "drawing" is a medium through which, one can learn all such matter, because the "drawings" are used to represent objects and processes on the paper. Through the drawings, a lot of accurate information is conveyed which will not be practicable through a spoken word or a written text. Drawing is a language used by engineers and technologists. This course is required in many subjects as well as later on in the professional career.					
	Course Contents (Topics and subtopics)		**Reqd. hours**		
1	Orthographic projections		-		
2	Sectional views		-		

3	Isometric projections	-
4	Missing views (or interpretation of views.)	-
5	Projection of solids	-
6	Sections of solids	-
7	Development of surface	-
8	Interpenetration of solids	-
List of Text Books/ Reference Books		
1	Engineering Drawing by N.D.Bhat	
2	Engineering Drawing by N.H.Dubey	

Semester I															
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	prepare multi view orthographic projections of objects by visualizing them in different positions. (K3)	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	draw sectional views and develop surfaces of a given object. (K3)	3	2	2	2	2	3	3	3	1	2	3	2	3	1
CO3	prepare pictorial drawings using the principles of isometric projections to visualize objects in three dimensions. (K3)	3	3	2	2	1	1	3	3	3	3	3	2	2	3
CO4	prepare assembly drawing. (K3)	3	3	2	2	2	3	0	2	3	3	3	2	3	1
CO5	obtain Multiview projections and solid models of objects using CAD tools (K3)	3	2	2	0	2	3	3	3	1	3	0	2	3	3
GEP1101		3	2	2	0	2	3	3	3	1	3	0	2	3	3

	Course Code: HUP1101	**Course Title:** Communication Skills	**Credits = 4**

			L	T	P
	Semester: I	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
	XIIth Standard English				
Description of relevance of this course in the B. Tech. (Dyes) Programme					
This is an important course for the effective functioning of an Engineer. Communication skills are required in all courses					
	Course Contents (Topics and subtopics)		**Reqd. hours**		
1	Development of communication skills in oral as well as writing.		-		
2	The writing skills should emphasize technical report writing, scientific paper writing, letter drafting, etc.		-		
3	The oral communication skills should emphasize presentation skills.		-		
4	Use of audio-visual facilities like powerpoint, LCD. for making effective oral presentation.		-		
5	Group Discussions		-		
List of Text Books/ Reference Books					
1	Elements of style – Strunk and white				

Semester I	

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	Write grammar error free technical reports in MS Word or equivalent software (K3)	3	3	2	2	2	3	3	3	3	3	1	2	3	3
CO2	Make power point slides in MS PowerPoint or equivalent software (K3)	3	3	2	0	2	3	1	3	3	2	3	2	3	3
CO3	Ability to present own view in front of the audience	2	2	2	1	2	2	2	2	1	2	1	2	2	2
CO4	Ability to use advanced grammar tools for writing technical report	2	2	2	1	2	2	1	2	2	2	1	2	3	3
CO5	Ability to use latest software for technical report writing	2	1	2	2	1	2	2	2	2	1	2	2	3	3
HUP1101		3	3	2	2	2	3	3	3	3	3	3	2	3	3

Semester II

	Course Code: CHT1342	**Course Title:**	**Credits = 4**		
			L	**T**	**P**
	Semester: II	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
	Physical Chemistry –I, HSC Chemistry				
List of Courses where this course will be prerequisite					
Description of relevance of this course in the B. Tech. (Dyes) Programme					
Relevance of reaction rates and parameters affecting the same , concept of interfaces and surfaces and the importance of disperse systems					

	Course Contents (Topics and subtopics)	**Reqd. hours**
1	Chemical kinetics – Introduction, concept of reaction rates and order, experimental methods in kinetic studies, differential and integral methods to formulate rate equations of zero, first and second order	2
2	Experimental methods of kinetic studies	1

3	Complex reactions- parallel, consecutive and reversible	2
4	Kinetics and reaction mechanism- steady state and rate determining step Mechanism of thermal photochemical chain reactions, polymerization reactions	2
5	Surface reactions – Adsorption, kinetics of surface reactions- Hishelwood and Rideal models of surface reactions	2
6	Theories of reaction rates and temperature effects- collision theory and TST Theory of unimolecular reactions	3
7	Kinetics of reactions in solutions- solvent effects	2
8	Fast reactions – experimental techniques	1
9	Surface and interfacial Chemistry – introduction,surface tension andsurface free energy, methods of determining surface and interfacial tensions	2
10	Thermodynamics of surfaces – surface excess, Gibbs adsorption equation, curved surfaces- bubbles, droplets and foams, Kelvin, Young Laplace and Thomson equations, homogeneous nucleation	3
11	Liquid- liquid and solid liquid interfaces – contact angle, wetting and spreading, adhesion and cohesion, contact angle measurements and hysterisis	3
12	Surfactants: Types, adsorption at surfaces and interfaces, surfactant aggregates, factors affecting aggregation phenomena, applications of surfactants and mixed surfactant systems	3
13	Disperse systems - Emulsions microemulsions and foams-. Thermodynamics and stability, HLB values , colloids - preparation, stability, characterization, surface charges and electrical double layer	4
List of Text Books/ Reference Books		
1	Chemical Kinetics – K.J.Laidler	
2	Principles of Chemical Kinetics – James E House	
3	Surfaces interfaces and colloids- Drew Myers- Wiley VCH	

4	Colloids and interfaces with polymers and surfactants - Jim Goodwin, wiley
5	Surfactants and interfacial phenomena- Milton J Rosen – Wiley Interscience
6	Industrial utilization of surfactants principles and applications – M.J. Rosen and M Dahanayake, AOCS Press
7	Principles of colloids and surface Chemistry – Paul C Hemenz and Raj Rajagopalan- Marcel Dekker
8	Foundations of Colloid science – Robert J Hunter – Oxford university Press

Semester I															
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	comprehend fundamental knowledge in chemical kinetics with basics of order, molecularity and temperature effect (K2)	3	2	1	2	0	3	3	3	3	3	3	0	3	2
CO2	examine kinetics for complex, fast as well as surface reactions and comprehend different theories in kinetics (K4)	3	1	2	3	2	3	3	3	3	1	3	2	3	3
CO3	comprehend fundamental knowledge and thermodynamics in surface and interfacial chemistry (K3)	3	3	0	2	2	3	3	2	2	3	3	1	3	2
CO4	evaluate the behavior of surface-active agents and disperse systems based on the knowledge of interfacial phenomena (K4)	3	2	2	3	2	0	3	3	3	3	2	2	3	3
CO5	Ability to solve complex physical chemistry problems	2	2	2	2	2	1	2	2	2	2	1	2	2	2
CHT1342		3	3	2	3	2	3	3	3	3	3	3	2	3	3

	Course Code: CHT1132	**Course Title:** Organic Chemistry	**Credits = 4**		
			L	**T**	**P**

	Semester: II	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
	Organic Chemistry –I, HSC Chemistry				
List of Courses where this course will be prerequisite					
	-				
Description of relevance of this course in the B. Tech. (Dyes) Programme					
-					

	Course Contents (Topics and subtopics)	**Reqd. hours**
1	Mechanisms of organic reactions: Types of Organic Reaction, Reactive intermediates; their generation, structure, stability and general reactions. Acidity and basicity. Mechanisms of simple organic	12
2	Stereochemistry: Stereodescriptors, Elements of symmetry, stereochemistry of compounds containing one and two carbon atoms. Racemates and their resolution, conformation of cyclic and acyclic	5
3	Aromaticity: Huckel's theory of Aromaticity. Aromaticity of simple benzenoid and non benzenoid species.	4
4	Aromatic compounds: Sources. BTX, Aromatic hydrocarbons. General mechanisms of aromatic electrophilic and nucleophilic substitution reactions. Orientation of electrophile in arenes.	6
5	Friedel-Crafts and related reactions: Friedel-Crafts alkylation and acylation reactions. Aromatic formylation reactions. Aromatic carboxylation.	5
6	Chemistry of enolates: Mechanism of aldol and related reactions	5

7	Chemistry of ethers, epoxides, sulphonic acids.	4
8	Amines: Methods of preparation, chemistry of aromatic diazonium salts	4
	List of Text Books/ Reference Books	
1	Organic Chemistry, J. McMurry, Brooks/Cole	
2	Organic Chemistry, T.W.G. Solomons, C.B. Fryhle, John Wiley and Sons Inc.	
3	Organic Chemistry, L.G. Wade Jr, Pearson Education	
4	StereoChemistry of Carbon compounds, E.L. Eliel, Mcgraw-Hill	
5	Organic Chemistry, Paula Y. Bruice, Pearson Education	

Semester I															
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	Explain the aromatic chemistry and interpret the outcome of general transformations (K3)	3	3	2	2	2	3	3	3	0	3	3	2	3	3
CO2	Appreciate and visualize the reactions involving radicals such as cyclizations, pericyclic reactions in synthesis (K3)	3	3	2	2	1	3	3	3	3	3	3	2	0	3
CO3	Understand the importance of heterocycles, learn the properties and synthetic routes, interpret IUPAC of compounds and decipher outcomes of various transformations involving heterocycles (K3)	3	3	2	1	2	2	1	3	2	3	3	2	3	3
CO4	Apply the knowledge obtained through the course to predict the outcome of reactions and devise solutions to unknown problems (K3)	3	2	0	2	2	3	3	3	3	3	3	1	3	3
CO5	Ability to solve complex organic chemistry problems	2	2	1	1	2	2	2	1	2	2	2	2	2	2
CHT1132		3	3	2	3	2	3	3	3	3	3	3	2	3	3

	Course Code: CET 1507	**Course Title:** Process Calculation	**Credits = 4**		
			L	**T**	**P**
	Semester: II	**Total contact hours: 60**	**2**	**2**	**0**
List of Prerequisite Courses					
	XIIth Standard Mathematics, Chemistry, Physics				
List of Courses where this course will be prerequisite					
	This is a basic Course. This knowledge will be required in ALL subjects later on.				
Description of relevance of this course in the B. Tech. (Dyes) Programme					
This is a basic course. This knowledge will be required in almost all subjects later on. This subject introduces the various concepts used in Chemical Engineering to the students. The knowledge of this subject is required for in ALL B. Tech. courses, etc. It can be applied in various situations such as process selection, economics, sustainability, environmental impacts					

	Course Contents (Topics and subtopics)	**Reqd. hours**
1	Introduction to Chemical process calculations, overview of single stage and multistage operations, concept of process flow sheets	2
2	Revision of Units and Dimensions, Dimensional analysis of equations, Mathematical techniques	4
3	Mole concept, composition relationship, types of flow rates	2
4	Material balance in non-reacting systems: application to single and multistage processes	8

5	Stoichiometry	2
6	Material balance in reacting systems: application to single and multistage processes	6
7	Behaviour of gases and vapors	4
8	Introduction to psychrometry, humidity and air-conditioning calculations.	6
9	Calculation of X-Y diagrams based on Raoult's law	2
10	Applications of material balances to Multiphase systems	6
11	Basic concepts of types of Energy and calculations	2
12	Application of Energy balance to non-reacting systems	6
13	Application of Energy balance to reacting systems	6
14	Fuels and combustion	4
List of Text Books/ Reference Books		
1	Elementary Principles of Chemical Processes, Felder, R.M. and Rousseau, R.W	
2	Chemical Process Principles, Hougen O.A., Watson K. M.	
3	Basic Principles and Calculations in Chemical Engineering, Himmelblau	
4	Stoichiometry, Bhatt B.I. and Vora S.M.	

Semester I															
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	convert units of simple quantities from one set of units to another set of units (K2)	3	2	0	2	1	3	3	3	3	3	3	1	3	2

CO2	calculate quantities and /or compositions, energy usages, etc. in various processes and process equipment such as reactors, filters, dryers, etc. (K3)	3	3	2	2	2	3	3	3	3	3	2	2	3	3
CO3	apply material balances in multiphase systems (K3)	3	1	2	2	1	3	3	3	2	3	3	1	3	3
CO4	apply energy balance to various systems (K3)	3	3	2	0	2	3	3	3	3	3	3	2	2	3
CO5	Evaluate the feasibility of the process	2	2	2	1	1	2	1	1	2	1	1	2	1	2
CET1507		3	3	2	2	2	3	3	3	3	3	3	2	3	3

	Course Code: MAT1102	**Course Title:** Applied Mathematics II	**Credits = 4**		
			L	**T**	**P**
	Semester: II	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
	XIIth Standard Mathematics, Applied Mathematics - I				
List of Courses where this course will be prerequisite					
	This is a basic Mathematics course. This knowledge will be required in almost all subjects later on				
Description of relevance of this course in the B. Tech. (Dyes) Programme					
This is a basic Mathematics course. This knowledge will be required in almost all subjects later on. This knowledge is also required for solving various mathematical equations that need to be solved in several chemical engineering courses such as MEBC, momentum transfer, reaction engineering, separation processes, thermodynamics, etc.					This is a basic Mathe

	Course Contents (Topics and subtopics)	Reqd. hours
1	Differential Equations: Solution of Higher order ODE with constant and variable coefficients and its applications to boundary and initial value problems, Series solution of differential equations,	20
2	Numerical methods for solution of initial values problems using RK method, Euler's method and Taylor series method.	20
3	Finite difference methods: Forward difference, backward difference, central differences, application of finite difference methods to ODE Boundary value problem	20

	List of Text Books/ Reference Books
1	Advanced Engineering Mathematics, Erwin Kreyszig, John-Wiely
2	Advanced Engineering Mathematics S. R. K. Iyengar, R. K. Jain, Narosa.
3	Elements of Applied Mathematics. Volume 1, P.N.Wartikar and J.N.Wartikar, Pune Vidyarthi Graha
4	Introductory Methods Of Numerical Analysis, S. S. Sastry, PHI.
5	Numerical Solution of differential Equations, M. K. Jain, Wiley Eastern

Semester I															
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO 1	solve system of linear algebraic equations.	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO 2	do numerical integrations of functions.	3	3	2	3	2	3	3	3	3	3	3	2	3	2
CO 3	solve higher order ODE by analytical methods.	3	2	1	2	1	3	3	2	3	3	3	1	3	3
CO 4	solve initial value problems using numerical methods.	3	3	3	2	2	2	3	3	3	3	3	2	3	2

CO 5	apply Fourier series and Laplace transform techniques to solve ODE and PDE.	3	2	2	3	2	3	3	3	2	3	3	2	3	3
MAT1102		3	3	2	2	2	3	3	3	3	3	3	2	3	3

	Course Code: PYT 1103	**Course Title:** Applied Physics II	**Credits = 4**		
			L	**T**	**P**
	Semester: II	**Total contact hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
	XIIth Standard Physics, Applied Physics – I, Physics Laboratory,				
List of Courses where this course will be prerequisite					
	This is a basic physics course. This knowledge will be required in almost all subjects later on				
Description of relevance of this course in the B. Tech. (Dyes) Programme					
This is a basic physics course. This knowledge will be required in almost all subjects later on. This knowledge is also required for understanding various chemical engineering concepts that will be introduced in courses such as momentum transfer, reaction engineering, separation processes, thermodynamics, heat transfer, etc.					
	Course Contents (Topics and subtopics)		**Reqd. hours**		
1	Quantum Mechanics Introduction to quantum physics, black body radiation, explanation using the photon concept, photoelectric effect, Compton effect, de Broglie hypothesis, waveparticle duality,		25		

2	Dielectric and Magnetic Properties of Materials Introduction to the ≗del' operator and vector calculus, revision of the laws of electrostatics, electric current and the continuity equation, revision of the laws	20

List of Text Books/ Reference Books	
1	Physics:Vols. I and II – D. Halliday and R. Resnick, Wiley Eastern.
2	Lectures on Physics: Vols. I, II and III – R. P. Feynman, R. B. Leighton and M. Sands, Narosa.
3	Concepts of Modern Physics – A. Beiser, McGraw-Hill
4	Solid State Physics – A. J. Dekker, 1957, MacMillan India.
5	Perspectives of Modern Physics – A. Beiser, 1969, McGraw-Hill

Semester I															
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	do simple quantum mechanics calculations (K3)	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	define various terms related to properties of materials such as, permeability, polarization, etc (K2)	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO3	state some of the basic laws related to quantum mechanics as well as magnetic and dielectric properties of materials (K2)	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO4	Correlate the concepts of physics in chemical industry	2	2	1	2	1	2	2	1	3	2	3	1	3	2
CO5	Rationalize the physical effects in the real life application	2	2	2	2	2	2	2	1	2	3	2	2	2	3
PYT1103		3	3	2	2	2	3	3	3	3	3	3	2	3	3

	Course Code PYP1101	**Course Title:** Physics Laboratory	**Credits = 4**

			L	T	P
	Semester: II	**Total contact hours: 60**	**0**	**0**	**4**
List of Prerequisite Courses					
	Applied Physics - I				
List of Courses where this course will be prerequisite					
	This is a basic physics Laboratory course. This knowledge will be required in almost all subjects later on.				
Description of relevance of this course in the B. Tech. (Dyes) Programme					
This is a basic physics course. Students will be able to learn various concepts by doing experiments on different topics. This knowledge will be required in almost all subjects later on. This knowledge is also required for understanding various chemical engineering concepts that will be introduced in courses such as momentum transfer, reaction engineering, separation processes, thermodynamics, heat transfer, etc					

	Course Contents (Topics and subtopics)	**Reqd. hours**
1	Viscosity	-
2	Thermistor	-
3	Thermal conductivity	-
4	Ultrasonic interferometer	-
5	Photoelectric effect	-
6	Hall effect	-
7	Newton‘s rings	-
8	Dispersive power of prism	-
9	Laser diffraction	-

10	Resolving power of grating	-
	List of Text Books/ Reference Books	
1	Physics:Vols. I and II – D. Halliday and R. Resnick, Wiley Eastern	
2	Lectures on Physics: Vols. I, II and III – R. P. Feynman, R. B. Leighton and M. Sands, Narosa	
3	Concepts of Modern Physics – A. Beiser, McGraw-Hill.	
4	Introduction to Modern Optics – G. R. Fowles , Dover Publications	
5	A Course of Experiments with LASERs – R. S. Sirohi, Wiley Eastern.	
6	Optical Fibre Communication – G. Keiser, McGraw-Hill	
7	Optoelectronics – J. Wilson and J. F. B. Hawkes, 2nd ed, Prentice-Hall India.	
8	Ultrasonics: Methods and Applications – J. Blitz, Butterworth.	
9	Applied Sonochemistry – T. J. Mason and J. P. Lorimer, Wiley VCH.	

Semester I															
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	Apply various laws which they have studied through experiments (K3)	3	3	2	2	1	3	3	3	3	3	3	2	3	3
CO2	Measure transport properties like viscosity, conductivity, etc.(K4)	3	3	2	3	2	3	3	2	3	3	3	0	2	3
CO3	Explain the application of acoustic cavitation (K2)	3	2	1	2	0	3	3	3	3	1	3	1	3	2
CO4	Ability to set up the reaction independently	3	2	1	2	1	2	1	2	2	1	2	2	2	2
CO5	Ability to perform the reaction and Interprete the results	2	2	2	2	1	2	2	2	1	1	2	1	2	2
PYP1101		3	3	2	3	2	3	3	3	3	3	3	2	3	3

CHP1132 Organic Chemistry Laboratory Synthesis of simple organic compounds to demonstrate various unit processes. Separation and purification of binary mixtures by physical and chemical methods. Purification of organic compounds.

Semester I															
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	work safely in the organic chemistry laboratory.(K3)	3	3	2	2	2	3	3	3	3	3	3	0	3	3
CO2	separate binary organic mixtures by multiple techniques.(K4)	3	3	2	3	2	3	3	0	3	3	3	2	2	3
CO3	understand basic principles for separation of binary organic mixtures qualitatively and quantitatively.(K3)	3	1	2	1	2	2	3	3	3	3	1	2	3	1
CO4	Ability to perform the experiment following the reported procedure	2	3	2	2	2	2	2	1	1	2	1	1	3	2
CO5	Ability to isolate the product and purify it	3	3	3	2	2	2	1	1	1	3	2	2	2	2
CHP1132		3	3	2	3	2	3	3	3	3	3	3	2	3	3

Semester III

	Course Code: CHT-1124	**Course Title: Industrial Inorganic Chemistry (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 as percent ionic character, bond length, bond angle.	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 reaction by Ion-electron method and Oxidation number method	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, hydroformylation, carbonylation etc.	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) solvolysis (v) precipitation reaction.	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 biological relevance.	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.

Semester III	Industrial Inorganic Chemistry **CHT1124**													
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**

CO1	Explain various industrial chemicals of nitrogen, sulfur, hydrogen, phosphorus and halogens (K2)	3	2	1	2	0	3	2	3	3	3	3	1	3	2
CO2	Explain and apply the concept the alkali and alkaline-earth metal based industrial chemicals, iron metallurgy (K3)	3	3	2	2	2	3	3	1	3	3	2	2	3	3
CO3	Explain inorganic solid materials like glass, silicone, cement, ceramics, etc. (K2)	3	2	0	2	1	3	3	3	3	0	3	1	2	1
CO4	Explain the concept of nuclear fuel and power industry (K2)	3	2	1	2	1	2	3	3	3	3	1	1	3	2
CO5	Ability to comprehend the use of complex inorganic materials in industrial processes	2	2	3	2	3	2	2	3	3	2	2	2	3	2
CHT1124		3	3	2	2	2	3	3	3	3	3	3	2	3	3

S Y BTech (Sem III)	
Total No of Credits 4	No hours 3 (Lectures) + 1 (Tutorial) = 60
Subject Code **CHT1136**	
Aromatic and Heteroaromatic Chemistry CHT1136	

	Description	L+T
1	Structure, Reactivity and Mechanism (Resonance effect, hyperconjugative effect, Concepts of Arrhenious equation, Rate constant, Gibbs free enery, Reaction kinetics, Reaction Profile), Acid base concepts (Lewis acid, Lewis base, Brønsted Lowry acid base concept etc)	3+1
2	Concept of aromaticity, descriptors of aromaticity, general discussion on the reactivity of aromatic compounds.	3+1
3	Electrophilic aromatic substitution reactions – mechanism, electrophilicity versus acidity, strength of electrophiles and their gradation.	6+2
4	Reactions involving sulphur electrophiles, nitrogen electrophiles, carbon electrophiles (including one carbon electrophiles), and halogen electrophiles.	6+2

5	Orientation in electrophilic substitution reactions on monosubstituted and disubstituted aromatic compounds. Reactivity of monosubstituted aromatic compounds and their gradation. Hammet equation. Typical synthetic strategies in obtaining di and trisubstituted aromatic compounds.	9+3
6	Nucleophilic aromatic substitution reactions – mechanism, nucleophilicity versus basicity, commonly encountered nucleophilic aromatic substitution reactions.	6+2
7	Cyclisation reactions involving electrophilic and nucleophilic substitution reactions as a means of obtaining fused aromatic and heteroatomatic compounds.	3+1
8	Rearrangement reactions involving electrophilic and nucleophilic aromatic substitution reactions and their synthetic utility.	3+1
9	Multistep, sequential reactions for dyestuff intermediates. Unusual aromatic substitutions like halogen exchange reactions and reactions involving diazonium salts.	6+2

References:

1. A guide book to the mechanisms in organic cheimistry-Longman_Wiley: Peter Sykes
2. Advanced Organic Chemistry-Carey and Sandburg
3. Advanced Organic Chemistry, Reactions, Mechanisms and Structures-Jerry March
4. Organic Chemistry-Clayden, Greeves, Warren and Wothers
5. Organic chemistry-Paula Y. Bruice
6. Organic Chemistry-I. L. Finar
7. Organic Chemistry-Graham Solomons

Semester III	Aromatic and Heterocyclic Chemistry **CHT1136**

CO	Course Objectives	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	Understand and apply the key concepts from general chemistry including electronegativity, resonance, hyperconjugation, aromaticity, acid-base concept, thermodynamics and kinetics to organic reactions.	3	2	3	3	2	1	2	2	1	1	1	2	3	3
CO2	Learn the basic mechanisms of substitution, addition, elimination, rearrangement and cyclization reactions (ArSn1, Sn2, E1, E2, E1cb) involved in organic molecules	3	2	3	3	2	1	1	2	2	1	1	2	2	3
CO3	Draw products and reaction mechanisms for many reactions including all aromatic compounds, carbonyl-containing compounds, amines, etc.	3	1	2	2	2	1	1	1	2	1	2	2	3	3
CO4	Design multistep synthesis of organic molecules.	3	2	2	2	2	2	1	1	2	1	2	3	3	2
CO5	Explain the organic reaction.	2	2	3	3	2	2	1	1	2	2	2	3	2	3
CHT1136		3	2	3	3	2	2	2	2	2	2	2	3	3	3

	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 Courses					
	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. No.	**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

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

Semester III	Analysis of Inorganic Raw Materials used in Dyestuff industries **DYP1001**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**

CO1	*Estimate* the amount of inorganic compounds present (K4)	2	2	2	3	3	3	2	2	3	1	2	3	3	2
CO2	*Check* the purity of compound (K3)	2	2	2	3	3	3	2	2	3	1	2	3	3	2
CO3	*Understand* the controlling and quantitative analysis of reducing agents (K2)	2	2	2	3	3	3	2	2	3	1	2	3	3	3
CO4	*Analyse* and identify the classes of metal containing reducing and oxidizing agents (K4)	3	3	3	3	3	3	2	2	2	1	2	3	3	3
CO5	*Identify* the reducing and oxidizing agents used for synthesis (K4)	3	3	3	3	3	3	2	2	3	1	2	3	3	3
DYP1001		3	3	3	3	3	3	2	2	3	1	2	3	3	3

	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 b. Nitration c. Reduction d. Halogenation **B.Sulphonation:** (i) Reaction phenomenon and conditions (ii) Sulphonating agents and solvents	C3, C4	K4, K5	Marker and Board, Projector	16

	(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	C2,C3	K2	Marker and Board	18

	c. Reactions possible and criterion for the same				
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

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

Semester III	Technology of Intermediates 1 **DYT1101**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Understand* the basics of dyestuff industry in terms of raw materials utilized (K2)	2	2	1	1	0	1	0	0	0	0	2	0	2	2
CO2	*Apprehend* basic benzene and naphthalene chemistry. (K2)	2	2	1	1	0	1	0	0	0	0	2	0	2	2
CO3	*Analyze* the various methods for synthesis of different intermediates used in dyes (K2)	2	3	3	3	0	1	0	0	0	0	2	0	2	2

CO4	*Know* the various technology and safety aspects for reactions. (K2)	3	2	3	3	0	3	2	0	0	0	2	0	2	2
CO5	*Identify* the substrates and chemistry to synthesize desired product (K2)	2	3	2	3	0	2	2	0	-	0	2	0	2	2
DYT1101		2	2	1	1	0	1	0	0	0	0	2	0	2	2

	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. $n \rightarrow \pi^*$, donor-acceptor, acyclic and cyclic polyene, and cyanine type chromogens	CO3	K2, K3 & A2	Chalk and board, Tutorial	03
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-hydrazonetautomerism 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 acycyclicand 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 – HartreeFock 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 HartreeFock method, Computational complexities in post HartreeFock (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

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.

	MAP 1201 Engineering Applications of Computers (Lab)	Marks: 50
Semester IV	Computer Programming Languages: FORTRAN, C, C++, etc.	32
	Softwares : Wordprocessing, Spreadsheets, Database, etc.	8
	Softwares for Libraries etc.	8
	Introduction to Computer Hardware, Architecture, Networking	12

Semester III	Engineering Applications of Computers **MAP1202**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	perform descriptive statistical analysis using Excel (K3)	3	3	2	2	0	3	3	3	3	3	3	2	3	3
CO2	perform basic statistical tests using R (K3)	3	3	2	1	2	3	3	3	3	3	1	2	0	3
CO3	perform linear regression using R (K3)	3	1	2	2	2	2	3	0	3	2	3	2	3	3
CO4	write Python programs to implement basic numerical methods (K4)	3	3	0	3	2	3	3	3	3	3	3	0	3	3
CO5	perform data processing and regression analysis using Python (K4)	3	3	2	3	2	3	3	2	3	3	3	2	3	3
MAP1202		3	3	2	3	2	3	3	3	3	3	3	2	3	3

	Course Code: OLT 1102	Course Title: Chemistry of Oleochemicals and Surfactants (Marks 100)	Credits = 4		
			L	T	P
	Semester: III	Total contact hours: 60, Marks : 100	3	1	0
List of Prerequisite Courses					
	All the Oils, Oleochemicals& Surfactants Special Courses				
Description of relevance of this course in the B. Tech. (All Branches)					
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, SulphatedAlkanolamides), 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	CO5, CO6	Chalk and board/ LCD, Tutorial	08

	and diglycerides, Lecithin, Polyol esters (TWIN, SPAN, Sucrose polyester), Alkanolamides etc. 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

Semester III	Chemistry of Oleochemicals and Surfactants **OLT1102**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	Understand the technical significance of Oleochemical and Surfactant Industries. (K2).	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	Conceptualize and develop the different modes of derivatizations of oleochemical and surfactants and its applications (K5).	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO3	Analyse and illustrate the HLB, diverse interfacial phenomenon, molecular aggregations and phase behaviour of surfactants.(K4)	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO4	Ability to identify and interpret the role of surfactants as specialty and high performance chemicals. (K5)	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO5	Ability to design the synthesis of surfactant (K4)	2	2	2	2	1	1	1	0	0	1	1	2	2	2
OLT1102		3	3	3	3	3	3	3	3	3	3	3	3	3	3

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 philosophies.		5		

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, SaritaPrakashan 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	

Semester IV	Engineering Mechanics and Strength of Materials **GET1301**														
CO	Course Objectives	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	quantify the actions and able to find reactions by applying conditions of equilibrium, find out the Centroid and Moment of Inertia for various cross sections used in engineering structures and for plane areas and be able to draw the Shear Force and Bending Moment diagram for different types of beams under simple and complex loading (K3)	3	3	2	2	2	3	3	3	3	1	3	2	3	3
CO2	calculate the forces, reactions, stresses, strains in components of the bodies of a complex engineering structure (K3)	3	3	1	2	1	3	3	2	3	3	3	2	1	3
CO3	find out the Bending Stresses at different positions and Shear Stress distribution across the cross section at various points and calculate the Slope and Deflection at different points under simple and complex loading (K3)	3	2	2	2	2	3	2	3	3	3	0	2	3	3
CO4	explain various materials used in various applications in engineering. cement composite – Concrete, Chemicals used to alter the properties of concrete (K2)	3	2	0	2	1	3	3	3	3	3	3	1	3	2
CO5	Ability to document the technical report .(K2)	2	2	2	2	3	2	2	2	3	2	2	3	2	2
GET1301		3	3	2	2	2	3	3	3	3	3	3	2	3	3

	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	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	C3, C4	K3	Marker and Board	30

	(iii) Reactor design and safety aspect **c.** Ammonolysis (i) Reaction conditions (ii) Substrate requirement and 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

Semester IV	Technology of Intermediates-II **DYT1102**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Understand* the basics of Naphthalene chemistry (K2)	2	2	2	2	1	1	1	0	0	0	3	0	2	2

CO2	*Conceptualize* basic unit processes for naphthalene and benzene (K2)	2	2	2	2	1	1	1	0	0	0	3	0	2	2
CO3	*Analyze* the various methods for synthesis of different intermediates used in dyes (K2)	2	2	2	2	2	2	2	0	0	0	3	0	2	2
CO4	*Master* the various technology and safety aspects for reactions. (K2)	3	3	3	3	3	2	2	1	0	0	3	0	3	3
CO5	*Know* various separation techniques used commercially and agitation systems for processes (K2)	3	3	3	3	3	2	2	1	0	0	3	1	3	3
DYT1102		3	3	3	3	3	2	2	1	0	0	3	1	3	3

	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 Courses					
	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)		**Req. 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 Lovibondtintometer	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

Semester IV	Color Physics Lab **PYP1103**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	To understand colour specifying systems and schemes of quantification of colour.	3	3	2	3	2	2	2	3	2	1	3	2	2	2
CO2	To measure the intensity of the transmitted light	3	3	3	3	3	3	2	3	1	1	3	3	3	3
CO3	To use instruments to uniquely specify a colour in terms of nos.	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO4	To explain various concepts of colour mixing, sources etc.	3	3	3	3	3	3	3	1	3	1	3	3	3	3
CO5	To correlate intensity of transmitted light with concept of chromophore and colour	3	2	3	3	3	3	2	3	2	3	3	3	2	2
PYP1103		3	3	3	3	3	3	3	3	3	3	3	3	3	3

	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 – KubelkaMunk 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, Munsellcolour 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 ChemicaActa, 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	

Semester IV	Color Physics and Color Harmony **PYT1202**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	To understand colour specifying systems and schemes of quantification of colour.(K2)	3	3	2	3	2	2	2	1	2	1	3	2	2	2

CO2	To measure the intensity of the transmitted light	3	3	3	3	3	3	2	1	1	1	3	3	3	3
CO3	To use instruments to uniquely specify a colour in terms of nos.	3	3	3	3	3	3	3	1	1	1	3	3	3	3
CO4	To explain various concepts of colour mixing, sources etc.	3	3	3	3	3	3	3	1	1	1	3	3	3	3
CO5	To correlate intensity of transmitted light with concept of chromophore and colour	3	2	3	3	3	3	2	1	2	1	3	3	2	2
PYT1202		3	3	3	3	3	3	3	1	2	1	3	3	3	3

	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 Courses					
	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		**Req. 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. Particle Dynamics, Flow through Fixed and Fluidised Beds.	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 transfer.	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 methods for shell and tube heat exchangers, Finned tube exchangers.	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.

Semester IV	Transport Phenomenon **CET1105**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	calculate friction factor, pressure drop, power (K3)	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	calculate flow and power required for pumps(K3)	3	3	1	2	1	3	1	3	3	3	1	2	3	3
CO3	calculate heat transfer coefficients and do basicsizing of double pipe and shell and tube heat exchangers (K3)	3	1	2	2	2	2	3	2	3	3	3	2	2	3
CO4	calculate mass transfer coefficients	3	3	2	0	2	3	3	3	3	2	3	0	3	3
CO5	estimate mass transfer rates in simple situations (K3)	3	2	2	3	2	2	3	2	2	3	2	2	3	3
CET1105		3	3	2	2	2	3	3	3	3	3	3	2	3	3

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

Semester IV	Electrical Engineering and Electronics Lab **GEP1106**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	Explain concepts of basic working of D.C circuits (K2)	3	2	1	2	0	3	3	3	3	3	3	1	3	2
CO2	Explain the basic applications of single phase and three phase AC supply and circuits (K2)	3	2	1	1	1	3	3	3	3	3	3	0	2	2
CO3	Explain the working and utility of transformers and motors used as various industrial drives (K2)	3	2	0	2	1	3	3	3	2	2	3	1	3	2
CO4	Apply the basic principles in electronic devices and circuits (K3)	3	3	2	2	2	3	3	2	3	3	3	2	3	3
CO5	Comprehend the use of complex electronic devices in chemical plant	3	3	2	2	2	3	3	2	3	2	2	2	2	3
GEP1106		3	3	2	2	2	3	3	3	3	3	3	2	3	3

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

All subsequent courses

Course expectations

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.

Sr.No.	Topic	Hrs.
1	Basic Laws: Kirchoff'scurrent 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. Resonance in series RLC circuits, Power, power factor, series and parallel circuits.	5
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.Therajavol I,II,IV
Thyristors and their applications by M.Ramamurthy
Power Electronics by P.S. Bhimbra

Semester IV	Electrical Engineering and Electronics **GET1105**														
CO	Course Objectives	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	Explain the basic concepts of D.C circuits. Solve basic electrical circuit problems (K3)	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	Explain the basic concepts of single phase and three phase AC supply and circuits (K2)	3	2	0	2	1	3	3	3	3	2	3	0	3	2
CO3	Explain the basic concepts of transformers & motors used as various industrial drives (K2)	3	2	1	2	0	3	3	2	3	3	3	1	3	2
CO4	Explain the basic concepts of electronic devices and their applications (K2)	3	0	1	2	1	2	3	3	1	3	1	1	2	2
CO5	Comprehend the use of complex electronic devices in chemical plant	3	2	2	2	3	2	2	3	2	3	2	2	2	2
GET1105		3	3	2	2	2	3	3	3	3	3	3	2	3	3

Semester V

	Course Code: CET1212	Course Title: Chemical Reaction Engineering	Credits = 3		
			L	T	P
	Semester: V	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses
Physical Chemistry – I and – II, Transport Phenomena
List of Courses where this course will be prerequisite
Environmental Engineering and Process Safety, Chemical Project Economics
Description of relevance of this course in the B.Tech. Program
The course is concerned with the utilization of chemical reactions on a commercial scale. This course is very relevant but not limited to the following industries: Inorganic chemicals, organic chemicals, petroleum & petrochemicals, Pulp & paper, Pigments & paints, rubber, plastics, synthetic fibres, Foods, Dyes and intermediates, Oils, oleo chemicals, and surfactants, Minerals, clean sing agents, Polymers and textiles, Biochemicals and biotechnology, Pharmaceuticals and drugs, Microelectronics, energy from conventional and non-conventional resources, Metals

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	Kinetics of homogeneous reactions, Interpretation of batch reactor data, Single ideal reactors including design aspects	10
2	Multiple reactions, Temperature and pressure effects	5
3	Introduction to Non-ideal flow, RTD measurements, Models to predict conversions	5
4	Homogeneous and Heterogeneous Catalysis, Kinetics of Solid Catalyzed Reactions. Design of gas – solid catalytic reactors	15
5	Introduction to multiphase reactors	5
6	Mass Transfer with Chemical Reactions: Regimes of operation and Model contactors	5
Total		**45**

List of Textbooks	
1	Elements of Chemical Reaction Engineering – H. Scott Fogler
List of Additional Reading Material / Reference Books	
1	Heterogeneous Reactions, Vol.I and II –L.K. Doraiswamy, M.M.Sharma
	Course Outcomes (students will be able to…..)
CO1	describe and apply the principles of various types of reactors (K3)
CO2	calculate rates of reactions based on given reaction scheme (K3)
CO3	design various components of reactors used in industrial practice (K3)
CO4	compare various reactors and select an appropriate reactor for a given situation (K4)

Semester VII	Chemical Reaction Engineering 1 **CET1212**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	describe and apply the principles of various types of reactors (K3)	3	3	2	2	1	3	3	3	3	3	3	2	3	3
CO2	calculate rates of reactions based on given reaction scheme (K3)	3	2	2	2	2	1	3	0	3	3	2	0	3	3
CO3	design various components of reactors used in industrial practice (K3)	3	3	2	1	2	3	3	3	3	3	3	2	3	3
CO4	compare various reactors and select an appropriate reactor for a given situation (K4)	3	3	2	3	0	2	3	3	1	3	3	1	3	3
CO5	Validate the feasibility of the chemical process in plant	2	3	3	2	2	2	2	2	2	1	2	1	2	2
CET1212		3	3	2	3	2	3	3	3	3	3	3	2	3	3

	Course Code:	**Course Title:**	**Credits = 3**		
	CET1401	**Chemical Engineering Operations**	**L**	**T**	**P**
	Semester: V	**Total Contact Hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
Process Calculations (CET1507), Transport Phenomena (CET1105)					
List of Courses where this course will be prerequisite					

This is a basic course. It is required in many other courses that involve physical processes		
Description of relevance of this course in the B. Tech. Programme		
This is a basic Chemical Engineering course. The principles learnt in this course are required in almost all the forthcoming courses and throughout the professional career of students.		
Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
1	Distillation: Fundamentals of flash-, batch- and continuous distillation, Distillation columns internals, Steam and azeotropic distillation	12 – 15
2	Liquid-Liquid Extraction: Solvent selection, Construction of ternary diagrams, Staged calculations, Types of extraction equipment	6
3	Crystallization: Phase diagram (temp/solubility relationship), Evapo-rative and cooling crystallization, Introduction to different types of crystallizers	5
4	Filtration: Mechanism of filtration, Basic equation, Constant volume, Constant pressure filtration, Rate expressions with cake and filter cloth resistances, Compressible and incompressible cakes, Introduction to various types of filters	5
5	Drying: Drying mechanism, Drying rate curves, Estimation of drying time, ypes of dryers	5
6	Introduction to Other Aspects of Unit Operations: Content will be aimed towards understanding practical and safety aspects of unit operations and/or introducing other separation processes like: adsorption/ion exchange, membrane processes and gas absorption, etc.	9 – 6
7	Industrial Case Studies: Interactive discussion with experienced professionals from industry or equipment vendors with emphasis on applicability, importance and challenges of different unit operations	3
Total		**45**
List of Text Books/ Reference Books		
1	Richardson, J.F., Coulson, J.M., Harker, J.H., Backhurst, J.R., 2002. Chemical engineering: Particle technology and separation processes. Butterworth-Heinemann, Woburn, MA.	
2	Seader, J.D., Henley, E.J., 2005. Separation Process Principles, 2 ed. Wiley, Hoboken, N.J.	
3	Svarovsky, L., 2000. Solid-Liquid Separation. Butterworth-Heinemann, Woburn, MA.	
4	McCabe, W., Smith, J., Harriott, P., 2004. Unit Operations of Chemical Engineering, 7 ed. McGraw-Hill Science/Engineering/Math, Boston.	
5	Green, D., Perry, R., 2007. Perry's Chemical Engineers' Handbook, Eighth Edition, 8 ed. McGraw-Hill Professional, Edinburgh.	

6	Dutta, B.K., 2007. Principles of Mass Transfer and Separation Process. Prentice-Hall of India Pvt. Ltd, New Delhi.
	Course Outcomes (students will be able to…..)
CO1	perform basic sizing of continuous and batch distillation columns (K3)
CO2	analyze filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage (K4)
CO3	describe few industrial crystallization, filtration and drying equipment (K2)
CO4	describe the need and importance of other separation processes like adsorption, ion exchange and membrane (K2)
CO5	Apply the concept of unit operation in chemical industries (K3)

Semester VIII	Chemical Engineering Operations **CET1401**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	perform basic sizing of continuous and batch distillation columns (K3)	3	3	2	2	1	3	3	3	3	3	0	2	3	3
CO2	analyze filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage (K4)	3	3	2	3	2	3	2	3	3	2	3	2	3	3
CO3	describe few industrial crystallization, filtration and drying equipment (K2)	3	2	0	2	1	3	3	2	3	3	3	1	3	2
CO4	describe the need and importance of other separation processes like adsorption, ion exchange and membrane (K2)	3	2	1	2	0	3	3	3	3	1	3	1	2	2
CO5	Apply the concept of unit operation in chemical industries (K3)	3	3	2	2	2	1	3	3	1	3	3	2	3	3
CET1401		3	3	2	3	2	3	3	3	3	3	3	2	3	3

	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		
	All subsequent BTech courses	
	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	8
2	Coupling experiments- Estimation of phenols and naphthols by bromination – phenol, 2-naphthol, R-acid, etc	8
3	Estimation of naphtholsulphonic acids and aminonaphtholsulphonic acids by diazo-coupling – Schaffer acid, R salt, gamma acid, J acid, etc	8
4	Estimation of dyes by reduction – Sunset Yellow, Ponceau 4R, Orange II, Tartrazine, etc	8
5	Identification of dyes – acid, basic, direct, acid mordant, vat, sulphur	8
6	Identification of fibres – cotton, wool, silk, nylon, polyester	8
7	To analyze the purity of amine by the method of Diazotization– aniline, sulphanilic acid, chloroanilines, toluidines, anisidines, etc	10
8	Coupling experiments- Estimation of phenols and naphthols by bromination – phenol, 2-naphthol, R-acid, etc	10

	Analysis of Intermediates, Dyes and Fibers **DYP1002**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Analyse* the purity of the amines used for dye synthesis. (K3)	2	3	3	3	2	2	2	0	2	1	3	3	3	2

CO2	*Check* the presence of coupling components purity required for final dye synthesis. (K2)	3	3	3	3	3	2	2	0	2	1	3	3	3	2
CO3	*Understand* the presence of diazo groups and reducible groups in the given dye structure. (K2)	3	3	3	3	3	2	1	0	2	1	3	3	2	3
CO4	*Analyse* and identify the classes of dyes from the application-oriented perspective. (K3)	3	3	3	3	3	2	1	0	2	1	3	3	3	3
CO5	*Identify* the substrates and chemistry of the fibres for dye affinity. (K3)	3	3	3	3	3	2	1	0	2	1	3	3	3	3
DYP1002		3	3	3	3	3	2	2	0	2	1	3	3	3	3

	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		

	Experimental dyeing **DYP1003**														
CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	*Apply* water soluble dyes to hydrophilic substrates (K3)	2	3	3	3	3	2	0	0	2	0	3	2	3	3
CO2	*Apply* water-insoluble dyes to hydrophilic substrates (K3)	2	3	3	3	3	2	0	0	2	0	3	2	3	2
CO3	*Ability* to categorize the dyes according to the substrates. (K4)	2	3	3	3	3	2	0	0	2	0	3	2	3	2
CO4	*Analyse* and identify the dyes on textiles (K4)	2	3	3	3	2	2	1	0	2	0	3	2	2	3
CO5	*Identify* the requirements of the dyes as against the suitability of substrates for dyeing (K4)	2	3	3	3	3	2	2	1	2	1	3	2	2	2
DYP1003		2	3	3	3	3	2	2	1	2	1	3	2	3	3

	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 bisazo 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 Proof of fibre-dye reaction	CO3			18

	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 Heterocyclic diazo and coupling components	CO2,CO3, CO4			16

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

	Technology of azo colorants **DYT1103**														
CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	*Explain* the and define the classes of dyes, substrates (K2)	2	2	2	2	0	0	0	0	0	0	3	0	2	3
CO2	*Understand* the variety and chemistry of dyes and their application (K2)	2	2	2	2	0	0	0	0	0	0	3	0	2	3
CO3	*Overview* of recent trends in the field of dyes containing azo groups (K2)	2	3	2	3	1	1	1	1	0	0	3	0	3	2
CO4	*Differentiate* the Techniques of diazotization and variations available (K2)	2	3	2	3	1	1	1	1	1	1	3	1	3	2
CO5	*Design* the synthesis of novel azo based dyes (K3)	3	3	3	3	2	2	2	1	2	2	3	2	2	3
DYT1103		3	3	3	3	2	2	2	1	2	2	3	3	3	3

	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

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

	Technology of Quinonoid colorants **DYT1104**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Define* and state different terminologies related to AQ (K2)	2	2	2	2	0	1	0	0	0	1	3	0	2	3
CO2	*Describe* the Chemistry and technology of AQ based compounds (K2)	2	2	2	2	1	1	1	1	1	1	3	1	2	3
CO3	*Application* of AQ in pigments and dyes (K2)	3	3	3	3	2	2	2	1	1	1	3	2	3	2
CO4	*Outline* the synthesis of various commercially important products (K3)	3	3	3	3	2	2	2	1	1	1	3	2	2	3
CO5	*Propose* methods for the synthesis of quinonoid dyes (K3)	3	3	3	3	2	2	2	1	1	1	3	2	2	3
DYT1104		3	3	3	3	2	2	2	1	1	1	3	2	3	3

	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		
• Syllabus: 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		
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 ShenoiAssessment method: 1. Unit Test 2. Assignment 3. Seminar 4. Literature survey including patents and research paper		

	Technology of dyeing and printing (including substrates) **TXT1215**															
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**

CO1	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)	3	3	3	3	3	3	2	2	2	2	2	2	2	2
CO2	understand dyeing machinery. (K2)	3	3	3	3	3	3	2	2	2	2	2	2	2	2
CO3	list and understand the function of the ingredients used in printing paste. (K2)	3	3	3	3	3	3	2	2	2	2	2	2	2	2
CO4	understand and explain basic styles of printing. (K2)	3	3	3	3	3	3	2	2	2	2	2	2	2	2
CO5	understand and describe methods of printing. (K2)	3	3	3	3	3	3	2	2	2	2	2	2	2	2
TXT1215		3	3	3	3	3	3	2	2	2	2	2	2	2	2

Semester VI

	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 Courses				
	All organic chemistry courses				
	List of Courses where this course will be prerequisite				
	All subsequent dyestuff technology courses				

Sr.No.	Main topic	Sub topic	Hrs.
1	TLC (Thin layer chromatography)	• Preparation of simple and rugged TLC plates • 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	10
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	5
3	Column chromatography	• Preparation of a column • Separation of 2 coloured compounds	5

		• Separation of a mixture of a coloured and colourless compound • Separation of 2 colourless compounds	
4	Preparation of dyes and intermediates	• Dye and intermediate synthesis	40

Sr. 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	10
2	Paper chromatography	CO1, CO2, CO3, CO4	K3, K4, K5, K6 S3	Laboratory Practical	5
3	Column chromatography	CO1, CO2, CO3, CO4	K3, K4, K5, K6 S3	Laboratory Practical	3
	Synthesis	CO1-CO5	K3, K4, K5, K6 S3	Laboratory Practical	40

	Chromatographic Techniques and Preparation of Dyes and Intermediates **DYP1004**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Understand* the principle behind chromatographic techniques – TLC, paper and column – used for the separation of organic compounds	3	3	3	2	2	2	1	1	1	2	1	2	2	3
CO2	*Learn* to use the appropriate technique for a given separation scenario	3	2	2	3	2	2	0	2	2	2	1	2	3	2
CO3	*Conduct* these processes in the lab independently for the separation of two or more organic compounds that may or may not be coloured	3	2	2	2	3	2	1	1	1	2	2	1	2	3
CO4	*Apply* these techniques whenever separation of organic compounds needs to be done	2	3	2	2	3	1	0	1	1	2	3	2	3	3
CO5	Perform separation of complex mixture	3	2	3	2	2	1	1	1	1	2	3	3	2	2
DYP1004		3	3	3	3	3	2	1	2	2	2	3	3	3	3

	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				

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

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

	Process and Plant Design **DYP1005**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	To understand the unit processes and their industrial scale up	2	3	3	2	3	2	2	3	2	2	2	2	1	3
CO2	Transfer of technology from pilot scale to plant scale by designing process with study of process parameters	2	2	2	2	2	3	3	2	3	2	1	3	2	3
CO3	Calculations based on real industry situation with volume based understanding	3	3	2	3	2	3	3	2	3	1	3	3	2	2
CO4	Ability to design considering the safety issues	3	3	3	2	3	2	3	2	3	1	3	3	2	2
CO5	Demonstrate knowledge in choosing appropriate materials for the construction and plant design	3	2	2	3	3	2	3	2	2	1	3	3	3	3
DYP1005		3	3	3	3	3	3	3	3	3	2	3	3	3	3

	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, and azabenzanthrone based fluorophores	C2, C5	K2, K3	Marker and Board, Ball and stick model	08

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

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

	Fluorescent Colorants **DYT1203**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Understand* the basics of fluorescence (K2)	2	2	2	2	1	1	0	0	0	0	2	0	2	3
CO2	*Conceptualized* the basic fluorophores. (K2)	2	2	2	2	2	1	0	0	0	0	2	0	2	3
CO3	*Analyze* the various fluorophores for optical whitening, and functional applications (K3)	2	3	3	2	2	1	2	0	2	2	2	2	3	2
CO4	*Know* the various aspects of water-soluble fluorescent dyes in biology. (K2)	2	2	2	3	2	1	2	0	1	1	2	1	2	3
CO5	*Identify* the synthetic route for a desired fluorescent dye (K2)	2	3	3	3	2	2	2	1	2	2	3	2	3	3
DYT1203		2	3	3	3	2	2	2	1	2	2	3	2	3	3

	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		
	All BTech courses	

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,electrocyclicreactions,photochemicalreactions,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, quarternaryazolium 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 106olubiliz and isoquinoline – Skraup synthesis – 106olubiliz and quinaldine, N-methyaltion of quinaldine. Friedlander synthesis, Bischler-Napieralski synthesis – methyl isoquinoline, Pictet-Spengler synthesis. Electrophilic reactions, nucleophilic and radical substitutions on 106olubiliz 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)				

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
1. Heterocyclic Chemistry – Vols I, II and III, Gupta R. R., Kumar M. and Gupta V., Springer, 2005
2. Fundamental process of Dye Chemistry- Fierz David

Assessment method:

5. Unit Test
6. Assignment
7. Seminar

	Heterocyclic colorants and intermediates **DYT1204**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**

CO1	*Identify* the classes of heterocycles. (K2)	1	1	2	1	1	0	2	0	0	0	3	0	2	3
CO2	*Design* synthetic route of different heterocycles. (K3)	2	3	3	3	0	2	2	2	1	1	3	1	2	3
CO3	*Propose* the retrosynthetic pathway of different heterocycles. (K3)	2	3	3	3	2	2	2	2	2	2	3	2	2	3
CO4	*Understand* the reactivity of different heterocycles. (K2)	2	3	3	3	3	3	2	2	2	2	2	2	3	3
CO5	*Assess* the technical importance of heterocycles. (K3)	3	3	3	3	3	3	2	3	2	2	3	2	3	2
DYT1204		3	3	3	3	3	3	2	3	3	2	3	2	3	3

	Course Code: Elective I	**Course Title: Heterocyclic colorants**	**Credits = 4**		
			L	**T**	**P**
	Semester: VI	Total contact hours: 40	**3**	**1**	**0**
List of Prerequisite Courses					
	Applied Physics –I & II				
List of Courses where this course will be prerequisite					
	All Btech courses of Dyestuff Technology				

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 and flavor intermediates	10
3.	Brief discussion on fine chemical industry with examples of some global fine chemical companies	05

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	

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. 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.
Evaluation based on assignments and short presentations and discussions

	Chemistry and Technology of Specialty Organic Intermediates and Fine chemicals **Elective-I**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Define* and *state* different terminologies related to fine chemicals	3	3	2	2	2	2	2	1	1	1	1	1	1	3
CO2	*Describe* and *explain* the general requirements for specialty chemicals and their techniques and application procedures	3	2	3	1	2	3	1	1	1	1	2	2	2	2
CO3	*Classify and differentiate* chemicals based on application and chemical constitution	2	2	2	2	1	2	1	1	1	2	2	1	2	2
CO4	Outline the synthesis of various compounds	2	2	2	1	2	2	1	2	2	2	2	2	2	2
CO5	*Justify* and *illustrate* the involvement of green chemistry and advancement strategies	2	2	2	2	2	2	2	2	1	2	2	1	2	3
Elective-I		3	3	3	2	2	**3**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**3**

	Course Code: HUT1106	**Course Title:**	**Credits = 3**		
		Environmental Science and Technology	**L**	**T**	**P**
	Semester: VI	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses		
Various Technology Courses in previous semesters		
List of Courses where this course will be prerequisite		
Various Technology Courses in the forthcoming semesters		
Description of relevance of this course in the B. Tech. Program		
The course is very useful for the future Chemical Engineers and Technologists for assessing and appreciating impact of chemical processes and technologies on the Environment. The students will be exposed to the nitty-gritties of the impact of design principles on the Environment. Thorough understanding of these technology aspects is going to help in innovative solutions with positive impact on the environment.		
	Course Contents (Topics and Subtopics)	**Required Hours**
1	Introduction to all prevailing international standards of Health, Safety, and Environment (HSE); Environmental laws and regulations; Standards (air quality, noise, water), ISO14000+	3
2	Environmental impact assessment, Life cycle assessment (LCA)	3
3	Pollution prevention in chemical manufacturing, effluent valorization	2
4	Air pollution; Air pollutants: sources (specific pollutants), effects, and dispersion modelling, air pollution, air quality, pollutants minimisation and control, fugitive emissions (source and control), Noise pollution	4
5	Wastewater treatment; Groundwater and surface water pollution, removal of specific water contaminants; Solid waste; Hazardous waste	4
6	Inherent safety; Major disasters (e.g. Flixborough, UK; Bhopal, India; Seveso, Italy; Pasadena, Texas; Texas City, Texas; Jacksonville, Florida; Port Wentworth, Georgia)	5
7	Toxicology; Industrial hygiene	2
8	Source models; Toxic release and dispersion models	5
9	Fires and explosions; Concepts to prevent fires and explosions	3
10	Chemical reactivity	2
11	Reliefs and reliefs sizing; Hazard identification; Risk assessment	4
12	Safety procedures and designs	4
13	Some case histories	4

	Total	**45**
List of Textbooks/Reference Books		
1	Environmental Studies by R. Rajagopalan, Oxford University Press.	
2	Essentials of Environmental Studies by Kurian Joseph & Nagendran, Pearson	
3	Education Renewable Energy by Godfrey Boyle, Oxford Publications	
4	Perspective of Environmental Studies, by Kaushik and Kaushik, New Age	
5	International Environmental Studies by. Anandita Basak, Pearson Education	
6	Textbook of Environmental Studies by Dave and Katewa, Cengage Learning	
7	Environmental Studies by Benny Joseph, Tata McGraw Hill	
8	Textbook of Environmental studies by Erach Books Bharucha, University Press.	
Course Outcomes (Students will be able to…..)		
CO1	calculate BOD / COD for a given composition of effluent stream, Estimation of bio Kinetics.	
CO2	calculate adiabatic lapse rate and determine conditions for suitability of atmospheric dispersion, effective stack height, chimney design.	
CO3	calculate concentrative of pollutant at any point in the neighbourhood of emission given atmospheric conditions like wind, dispersion, environmental factors, etc.	
CO4	calculate size/time/power required for primary clarifier, secondary treatment, tertiary treatment, sizing of different types of Biological treatments etc	
CO5	identify hazards in a given process and assess the same and provide solutions for operating safely.	

	Environmental Science and Technology **HUT1106**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	calculate BOD / COD for a given composition of effluent stream, Estimation of bio Kinetics.	3	3	2	2	2	3	3	2	3	3	3	2	3	3
CO2	calculate adiabatic lapse rate and determine conditions for suitability of atmospheric dispersion, effective stack height, chimney design.	3	3	2	2	0	3	3	3	3	3	3	1	3	3
CO3	calculate concentrative of pollutant at any point in the neighbourhood of emission given atmospheric conditions like wind, dispersion, environmental factors, etc.	3	3	0	2	2	3	1	3	3	1	3	2	2	3

CO4	calculate size/time/power required for primary clarifier, secondary treatment, tertiary treatment, sizing of different types of Biological treatments etc	3	1	2	2	2	3	3	3	3	3	0	2	3	3
CO5	identify hazards in a given process and assess the same and provide solutions for operating safely.	3	3	2	3	2	3	3	3	3	3	3	2	3	3
HUT1106		3	3	2	3	2	3	3	3	3	3	3	2	3	3

	Course Code: HUT1103	**Course Title:** Industrial Psychology and Human Resource Management	**Credits = 3**		
			L	**T**	**P**
	Semester: VI	**Total Contact Hours: 45**	**2**	**1**	**0**

List of Prerequisite Courses

None

List of Courses where this course will be prerequisite

Technology Courses in the forthcoming semesters

Description of relevance of this course in the B. Tech. Program

This course equips students with human resource management skills to be able to function effectively in their professional careers.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Introduction and Overview	2
2	Management Theories Taylor, Fayol, Weber, Hawthorne; Basic types of structures; Span of Control, Delegation, Authority, Responsibility	4
3	Recruitment Philosophies, Different methods of attracting candidates	3
4	Selection Application blanks, Interviews, Induction	2

5	Performance Management Goal setting process, Performance appraisal methods, Appraisal interviews, Rating errors	3
6	Training & Development Identifying training needs, Training methods (on the job and off the job techniques), Evaluation of training	3
7	Change Management Types of change, Theories of change management, Hurdles to change, Olmosk change strategies	3
8	Knowledge Management Innovation, Importance and benefits of Knowledge Management, Framework	3
9	Motivation Theories Classification of motives, Various theories (Maslow, Herzberg, ERG, Vroom, Equity and Nohria's 4 drive model)	4
10	Leadership Theories Blake Mouton model, Hersey Blanchard Model, Michigan Model	3
11	Organizational Culture Types of cultures, Understanding and influencing cultures	3
12	Conflict Management Stages of conflict, Types of conflict and sources of conflicts, Conflict resolution	3
13	Power &Politics Bases of power, Politicking strategies	3
14	Personality Theories of personality, Behaviour and personality styles	3
15	Perception Persception versus sensation, Perceptual process, Perceptual errors	3
	Total	**45**
List of Textbooks/Reference Books		
1	Innovation and Entrepreneurship, Peter Drucker	

2	Essentials of organizational Behaviour, Srephen Robbins
3	Organizational Behaviour, Luthans
4	Select HBR cases and articles for review
5	Innovation and Entrepreneurship, Peter Drucker
Course Outcomes (Students will be able to…..)	
CO1	explain the fundamental concepts of industrial psychology and human resource management (K2)
CO2	analyze practical solutions (K4)
CO3	provide applicable solutions (K3)

	Industrial Psychology and Human Resource Management **HUT1103**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	explain the fundamental concepts of industrial psychology and human resource management (K2)	3	2	1	2	0	3	3	3	3	3	3	1	3	2
CO2	analyze practical solutions (K4)	3	3	1	3	2	3	2	3	3	3	1	2	3	3
CO3	provide applicable solutions (K3)	3	3	2	2	2	3	3	3	2	3	3	2	1	3
CO4	Understanding the human resource management problems through case studies	**2**	**2**	**1**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**1**	**1**
CO5	Ability to provide viable solutions that will make a better workspace	**2**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**2**	**2**	**2**	**1**	**2**	**2**
HUT1103		3	3	2	3	2	3	3	3	3	3	3	2	3	3

Course Code: HUT1104	**Course Title:** Industrial Management– I	**Credits =3**		
		L	**T**	**P**
Semester: VI	**Total contact hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses				
Industrial Management II, Textile Process House Management				

	strial Management II, Textile Process House Management
Description of relevance of this course in the B.Tech.Program	
This course isessential for effective functioning of students in their professional career	

Sr.No.	Topic	Hrs.
1	Introduction:Principles, thoughts and contributions of FW Taylor, Henry Fayol and Elton Mayo. Responsibilities of management: society and development. Functions of Management:	10
2	Planning, Motivating,Leading,Controlling;Business organization structures, limitations,relative merits &demerits. 10 2 Organisational ProcessandBehaviour:IntroductionandMeaningofOrganization,Organizationasa process, Span of Control, Authority, Responsibility and Accountability, Delegation of authority, Decentralizationofauthority.EnhancingManagerialEffectivenessthroughselfandothers,Individ ual Personality&Behaviour,Perception,Attitudes,	10
3	Technology Management: Strategies &their applications in industry, Business specifications versus	10
4	Marketing Management, Marketing sales, advertising, marketing research, supply chain management	10
5	Laws: Company Laws, Factory Laws, Labor Laws and Intellectual Property Rights (IPR)	
6	CommunicationSkills:Communicationprocess,mediachannels,writtenandverbal/presentations kills,	

List of Text Books/ Reference Books

Essentials of Management,Koontz
Innovationand Entrepreneurship,Peter Drucker
Industrial Management–I,JhambL.C.and JhambS.
Essentials of Organizational Behavior,S.Robbins
OrganizationalBehaviour, LuthansF
Principles ofMarketing,Kotler
Research andDevelopment Management,BamfieldP
Industrial Management, Spriegel U.S.

	Wet Processing of Textiles **TXP1013**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**

CO1	Able to explain and use dyeing of cotton with reactive dye and azoics using padding mangle and carry out and examine printing of Cotton, Polyester and its blend with Pigments	3	3	2	2	3	2	2	1	2	2	2	2	2	3
CO2	Able to process and evaluate dyeing of cotton hank by tub liquoring using azoics and choose and apply different styles of printing on Natural and Synthetic fabrics using different dye classes.	2	3	3	3	2	2	1	2	2	2	3	3	2	2
CO3	Able to comprehend basis of special styles of printing like Batik, Tie and Dye and	2	2	2	3	3	2	2	2	3	2	2	3	3	3
CO4	Able to explain and carry out discharge and resist style of printing of cotton	3	2	2	3	3	2	1	2	3	2	3	3	2	2
CO5	Ability to use machinery for dyeing of cotton with reactive dyes on Laboratory Jigger and Winch	2	2	3	3	3	2	2	2	3	2	2	2	2	3
TXP1013		3	3	3	3	3	2	2	2	3	2	2	3	3	3

Course Code: TXP 1013	**Course Title: Wet Processing of Textiles**	**Credits =3**		
		L	**T**	**P**
Semester: VI	**Total contact hours: 30**	**2**	**1**	**0**

List of Prerequisite Courses

All Dyes related courses

Sr.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, 118olubilized 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		

	Wet Processing of Textiles **TXP1013**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	Able to explain and use dyeing of cotton with reactive dye and azoics using padding mangle and carry out and examine printing of Cotton, Polyester and its blend with Pigments	3	3	2	2	3	2	2	1	2	2	2	2	2	3
CO2	Able to process and evaluate dyeing of cotton hank by tub liquoring using azoics and choose and apply different styles of printing on Natural and Synthetic fabrics using different dye classes.	2	3	3	3	2	2	1	2	2	2	3	3	2	2
CO3	Able to comprehend basis of special styles of printing like Batik, Tie and Dye and	2	2	2	3	3	2	2	2	3	2	2	3	3	3
CO4	Able to explain and carry out discharge and resist style of printing of cotton	3	2	2	3	3	2	1	2	3	2	3	3	2	2
CO5	Ability to use machinery for dyeing of cotton with reactive dyes on Laboratory Jigger and Winch	2	2	3	3	3	2	2	2	3	2	2	2	2	3

TXP1013		3	3	3	3	3	2	2	2	3	2	2	3	3	3

Semester VII

	Course Code: CEP1714	Course Title: Chemical Engineering Laboratory	Credits = 2		
			L	T	P
	Semester: VII	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

Process Calculations (CET1507), Transport Phenomena (CET1105), Chemical Engineering Operations (CET1401), Chemical Reaction Engineering (CET1212)

List of Courses where this course will be prerequisite

Other B. Tech. courses in this and the last semester

Description of relevance of this course in the B. Tech. Program

This course provides students the first-hand experience of verifying various theoretical concepts learnt in theory courses. It also exposes them to practical versions of typical chemical engineering equipments and servers as a bridge between theory and practice. This particular lab focuses on fluid dynamics, distillation, filtration, drying and sedimentation.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	4 - 6 Experiments on fluid dynamics and heat transfer	24
2	3 - 5 Experiments on Chemical Engineering Operations	16
3	2 – 4 Experiments on Reaction Engineering	12
4	1 – 3 Experiments on process dynamics and control	8
	Total	**60**

List of Text Books/ Reference Books

1	McCabe W.L., Smith J.C., and Harriott P. Unit Operations in Chemical Engineering, 2014
2	Bird R.B., Stewart W.E., and Lightfoot, E.N. Transport Phenomena, 2007

3	Coulson J.M., Richardson J.F., and Sinnott, R.K. Coulson & Richardson's Chemical Engineering: Chemical engineering design, 1996.
4	Green D. and Perry R. Perry's Chemical Engineers' Handbook, Eighth Edition, 2007.
Course Outcomes (students will be able to…..)	
CO1	Learn how to experimentally verify various theoretical principles (K3)
CO2	Visualize practical implementation of chemical engineering equipment (K4)
CO3	Develop experimental skills (K4)
CO4	Ability to document scientific and technical data
CO5	Ability to demonstrate project management skill in performing the experiments

Semester VII	Chemical Engineering Laboratory **CEP1714**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	Learn how to experimentally verify various theoretical principles (K3)	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	Visualize practical implementation of chemical engineering equipment (K4)	3	3	2	1	2	3	3	0	3	3	3	2	2	3
CO3	Develop experimental skills (K4)	3	3	2	3	2	2	3	3	3	3	2	2	3	2
CO4	Ability to document scientific and technical data	2	2	2	2	2	2	2	3	3	2	3	2	3	2
CO5	Ability to demonstrate project management skill in performing the experiments	2	3	2	2	2	3	3	2	2	3	2	2	2	2
CEP1714		3	3	2	3	2	3	3	3	3	3	3	2	3	3

	Course Code:	**Course Title:**	**Credits = 3**		
	CET1703	**Chemical Process Control**	**L**	**T**	**P**
	Semester: VII	**Total Contact Hours: 45**	**2**	**1**	**0**
List of Prerequisite Courses					
Material and Energy Balance Calculations, Applied Mathematics, Chemical Engineering Operations, Chemical Reaction Engineering					
List of Courses where this course will be prerequisite					

Chemical Engineering Laboratory, Projects		
Description of relevance of this course in the B. Tech. Program		
Process control plays a very critical role in the context of actual operation of a process plant. Most of the core chemical engineering courses focus on the steady state operation. In the real-life environment, process is continuously subjected to various disturbances which deviates the operation from the designed steady state. This course specifically prepares students to assess the impact of such disturbances and equip them with the tools available to tackle these situations.		
Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
1	Instrumentation: Principles of measurement; Pressure, Temperature, Level, Flow and composition measuring devices; Introduction to controllers (PLC, digital control, DCS), Introduction to control valves, Types of control valves, Control valve characteristics	9
2	Introduction to system dynamics, Concept of dynamic response, Linear systems, First, second and higher order system, Systems with dead-time, Definition of terms such as transfer function, Time constant, Gain of the process with practical examples Response of processes to standard inputs	9
3	Introduction to Process Control: Set point, disturbance, closed loop and open loop control, Feedback and feed-forward configurations, Poles and zeros of the transfer functions Basic control actions (ON/OFF, P, I and D), Effects of controller action on process response: Offset, closed-loop gain, controller gain effect of controller parameters	6
4	Stability analysis of feedback systems, Notion of stability, Criteria for stability	6
5	Control System Design: Introduction to controller design Identification of controlled, manipulated and disturbance variables, Pairing of inputs and outputs Controller selection for pressure, flow, temperature, level and composition control	9
6	Multiple Loop and Traditional Advanced Control Systems: Cascade control, Ratio control, Feed-forward control, Selective control, Split-range control, Inferential control	6
Total		**45**
List of Text Books/ Reference Books		
1	Chemical Process Control: An Introduction to Theory and Practice, Stephanopolous G.	
2	Process Modeling, Simulation, and Control for Chemical Engineers, Luyben W.L.	

3	Process Dynamics and Control, Seborg, D.E. and Mellichamp, D.A. and Edgar, T.F. and Doyle, F.J.
4	Process Control: Modeling, Design, and Simulation, Bequette, B.W.
5	Process Control Instrumentation Technology, Johnson, C.D.
Course Outcomes (Students will be able to …….)	
1	Specify the required instrumentation and control elements for a particular process (K3)
2	Develop input-output transfer function models for dynamics of processes (K4)
3	Characterize the dynamics and stability of processes based on mathematical analysis (K5)
4	Design and tune process controllers (K6)
5	Specify the required instrumentation and control elements for a particular process (K3)

	Chemical Process Control **CET1713**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	Specify the required instrumentation and control elements for a particular process (K3)	3	3	2	2	2	3	3	0	3	3	3	2	3	3
CO2	Develop input-output transfer function models for dynamics of processes (K4)	3	3	2	0	2	3	3	3	3	3	0	2	3	2
CO3	Characterize the dynamics and stability of processes based on mathematical analysis (K5)	3	2	3	3	1	3	1	3	3	1	3	3	3	3
CO4	Design and tune process controllers (K6)	3	3	1	3	3	2	3	3	2	3	3	1	2	3
CO5	Specify the required instrumentation and control elements for a particular process (K3)	3	1	2	2	2	3	3	3	3	3	3	2	3	3
CET1703		3	3	3	3	3	3	3	3	3	3	3	3	3	3

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

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.

	Technology of cationic and sulfur colorants **DYT1105**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Understand* the constitution of Sulphur dyes. (K2)	1	2	2	2	1	0	1	0	0	0	2	0	2	3
CO2	*Interpret* the structural diversities in cationic dyes. (K2)	2	2	3	3	1	0	1	0	0	0	2	0	2	3
CO3	*Distinguish* the colour changes with different classes of cationic dyes. (K2)	1	3	3	3	1	0	1	0	0	0	2	0	2	3
CO4	*Conceptualize* the process in the manufacture of Sulphur dyes. (K2)	3	3	3	3	3	3	2	2	1	1	3	1	3	2
CO5	*Assess* the technical importance of cationic dyes and their manufacture. (K2)	3	3	3	3	3	3	2	2	1	1	3	2	3	2
DYT1105		3	3	3	3	3	2	2	2	1	1	3	2	3	3

	Course Code: DYT 1206	**Course Title: Structural elucidation of organic molecular spectroscopy (Marks 100)**	**Credits = 4**		
			L	**T**	**P**
	Semester:VII	**Total contact hours: 60**	**3**	**1**	**0**
List of Prerequisite Courses					
	All BTech dyestuff Technology courses				

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 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.	CO1, CO2, CO3, CO4	Chalk and board, Tutorial	09
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

	Structural Elucidation of organic compounds **DYT1206**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Understand* the basic concepts of spectroscopy (K2)	3	3	3	3	2	1	0	1	1	0	3	0	2	3
CO2	*Demonstrate* the knowledge in analyzing the UV and IR spectra (K2)	3	3	3	3	2	1	0	1	1	0	3	0	2	3
CO3	*Analyze* the NMR spectra (K3)	3	3	3	3	2	1	0	1	1	0	3	0	2	3
CO4	*Solve* complicated spectral problems (K4)	3	3	3	3	2	1	0	1	2	2	3	2	3	2
CO5	*Assess* the mass spectroscopic spectra (K4)	3	3	3	3	2	2	0	1	2	2	3	2	3	3
DYT1206		3	3	3	3	2	2	0	1	2	2	3	2	3	3

	Course Code: Elective-II	**Organic Reaction mechanism and reagent chemistry Elective-II**	**Credits = 4**		
			L	**T**	**P**
	Semester:VII	**Total contact hours: 30**	**3**	**1**	**0**
List of Prerequisite Courses					
	All BTech dyestuff Technology courses				
List of Courses where this course will be prerequisite					

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,CO3, 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,CO3, 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,CO3, CO4, CO5	K3, A2	Chalk and board	8
4.	Neighbouring group participation; 1,2 and 1,4 addition to conjugated systems.	CO1,CO2,CO3, 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

	Organic Reaction mechanism and reagent chemistry **Elective-II**														
CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	*Identify* the classes of organic molecular structure. (K2)	3	3	3	3	0	0	1	0	0	0	2	3	2	2
CO2	*Design* synthetic route of different organic molecules. (K3)	3	3	3	3	1	1	1	1	1	1	3	3	2	3
CO3	*Propose* the retrosynthetic pathway of different organic molecules. (K3)	3	3	3	3	1	1	1	1	1	1	2	3	2	3
CO4	*Analyse* the reaction mechanism (K4)	3	3	3	3	2	2	1	2	1	1	2	3	2	3
CO5	*Assess* the best possible route for the synthesis (K3)	3	3	3	3	2	2	1	2	2	2	3	3	2	3
Elective-II		3	3	3	3	2	2	1	2	2	2	3	3	2	3

	Course Code:	**Course Title:**	**Credits = 4**		
	HUT1105	**Industrial Management**	**L**	**T**	**P**
	Semester: VII	**Total Contact Hours: 60**	**3**	**1**	**0**

List of Prerequisite Courses

None

List of Courses where this course will be prerequisite

None

Description of relevance of this course in the B. Tech. Program

This course is required for effective and holistic functioning of students in their professional career.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	Greiner's Model of Organization Life Cycle Organic and mechanistic structures	3

2	Marketing Management Introduction, Porter's value chain, Porter's five forces, Porter's generic strategies	7
3	Introduction to the 4Ps of Marketing Product, Price, Place, Promotion	11
4	Production and Operations Management Concept of productivity, World class manufacturing, Business process reengineering, Kanban, JIT, Poka Yoke system, Maintenance practices	10
5	Quality Management The concept of quality, Quality control ,acceptance sampling and SQC Deing's 14 points, TQM, Insights into ISO-9000, ISO -14000,ISO-50000	6
6	Financial Management Accounting system, Balance-sheet evaluation, Fund-flow analysis, financial ratios an insight, Costing	15
7	Materials Management Value analysis, Purchasing and vendor development, Warehousing and inventory control methods	4
8	Maintenance Management Classifications, Equipment and plant reliability and availability, Management of shut downs and turnarounds	4
	Total	**60**
List of Textbooks/Reference Books		
1	Industrial Management–I, Jhamb L. C. and Jhamb S.	
2	Industrial Management, Spriegel U.S.	
3	Operations Management for Competitive Advantage, Richard B. Chase, F. Robert Jacobs, Nicholas Acquilano	
4	World Class Manufacturing - A strategic Perspective, B.S. Sahay, K.B.C. Saxena, Ashish Kumar	
5	Management Finance, Varanasay Murthy	
6	Essentials of Management,Koontz	
7	Principles of Marketing, Kotler	
8	Quality Planning and Analysis, Juran	

9	Financial Management, Prasanna Chandra
10	Financial Management, R. M. Srivastava
11	Select HBR cases and articles for review

	Industrial Management 2 **HUT1105**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	explain the fundamental concepts of Marketing management and the various aspects therein (K2)	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	describe the fundamental concepts of Finance and analyse the balance sheet (K4)	3	3	2	3	1	1	3	3	3	3	3	2	3	3
CO3	explain various productivity techniques that when combined with engineering knowledge can be applied successfully in the industry (K2)	3	2	0	2	1	3	3	2	3	3	0	1	3	2
CO4	study real life practical problems, constraints and will be able to think in terms of various alternative solutions (K3)	3	3	2	0	1	3	3	3	3	3	3	2	2	3
CO5	Ability to solve the real-life chemical industry problems through financial, marketing and project management	3	3	2	2	1	2	2	2	2	2	2	2	2	2
HUT1105		3	3	2	3	1	3	3	2	2	2	2	3	3	3

	Course Code:	**Course Title:**	**Credits = 4**		
	MAT1106	**Design and Analysis of Experiments**	**L**	**T**	**P**
	Semester: VII	**Total Contact Hours: 60**	**2**	**2**	**0**
List of Prerequisite Courses					
HSC Standard Mathematics, Applied Mathematics – I (MAT1101), Computer Applications Laboratory (MAP1201)					
List of Courses where this course will be prerequisite					
All subsequent technology and science courses					
Description of relevance of this course in the B. Tech. Program					
This course is required for graduating technocrats to function effectively and efficiently in Industry, Academia and other Professional Spheres.					
Sr. No.	**Course Contents (Topics and subtopics)**		**Required Hours**		

	Module I (Statistical Theory of Design of Experiments)	
1	**Fundamental Principles of Classical Design of Experiments:** Strategy of Experimentation, Typical applications of experimental design, Basic principles, Guidelines for designing experiments	2
2	**Review of Probability and Basic Statistical Inference:** Concepts of random variable, Probability, Density function cumulative distribution function, Sample and population, Measure of central tendency, Mean, median and mode, Measures of variability, Concept of confidence level, Statistical Distributions: Normal, Log Normal & Weibull distributions, Hypothesis testing	4
3	**Experiments with a Single Factor: Analysis of Variance -** Fixed effect model and Random effect model, Model adequacy checking, Contrasts, Orthogonal contrasts, Regression Models and ANOVA, Violation of normality assumption: Kruskal-Wallis test Randomized block designs, Latin square designs, Balanced incomplete block designs	8
4	**Factorial Designs:** Definition, Estimating model parameters, Fitting response curves and surfaces	4
	Module II (Data Analysis using Software (R/Python))	
5	The 2^k Factorial design, Blocking and confounding in the 2^k Factorial design, Focus of 2^2 and 2^3 designs, Blocking and confounding in the 2k Factorial Design	8
6	Plackett Burman methods, Central Composite Design (CCD)	4
7	Descriptive Statistics, Probability Distribution and Testing of Hypothesis using R	6
8	Regression techniques, Diagnostic checks, ANOVA using R and implementation of contrasts	6
9	Construction of Balanced Incomplete Block Designs and data analysis using R	6
10	Analysis of factorial designs using R, Understanding output and interpretation	6
11	Factorial designs, Data analysis and interpretation.	6
	Total	**60**
	List of Textbooks/ Reference Books	
1	Montgomery, Douglas C. Design and Analysis of Experiments; 9th Ed.; John Wiley & Sons, Inc. (2017)	
2	Box, G. E.; Hunter, J. S.; Hunter, W. G. Statistics for Experimenters: Design, Innovation, and Discovery; 2nd Ed.; Wiley (2005)	
3	Lawson, John. Design and Analysis of Experiments with R; 1st Ed.; CRC Press (2015)	
4	Rasch, D.; Pilz, J.; Verdooren, R.; Gebhardt, A. Optimal Experimental Design with R; 1st Ed.; CRC Press (2011)	

5	Unpingco, J. Python for Probability, Statistics, and Machine Learning; 2nd Ed.; Springer (2019)
6	Anderson-Cook, Christine M.; Montgomery, Douglas C.; Myers, Raymond H. Response Surface Methodology: Process and Product Optimization using Designed Experiments; 4th Ed.; Wiley (2016)
7	Montgomery, Douglas C. Introduction to Statistical Quality Control; 7th Ed.; Wiley (2009)
8	Lazić, Živorad R. Design of Experiments in Chemical Engineering: A Practical Guide; 1st Ed.; Wiley-VCH (2005)

	Design and Analysis of Experiments **MAT1106**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	Explain the basic principles of design of experiments (K2)	3	2	1	2	0	3	3	3	3	3	1	1	3	2
CO2	perform statistical analysis of single experiments and do post hoc analysis (K3)	3	3	2	2	2	3	3	3	0	3	3	2	3	3
CO3	conduct experiment and analyse the data using statistical methods (K4)	3	2	2	3	2	3	1	3	3	2	3	2	2	3
CO4	choose an appropriate design given the research problem (K5)	3	3	3	3	3	3	3	3	3	3	0	3	3	3
CO5	perform statistical analysis of different designs using R and interpret the results (K5)	3	1	3	3	3	3	3	2	3	3	3	3	0	3
MAT1106		3	3	3	3	3	3	3	3	3	3	3	3	3	3

	Course Code: DYP 1007	**Course Title: Project -I**	**Credits = 2**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 60**	**0**	**1**	**4**
List of Prerequisite Courses					
Seminar (**DYP 1006**)					
List of Courses where this course will be Prerequisite					
Project II (**DYP 1008**)					

Description of relevance of this course in the B. Tech. (Dyestuff Technology) Programme		
1. Develop a skill to solve a research problem related to dyestuff technology 2. Develop skills for presenting a research work effectively. The course presents an opportunity to the students for fine-tuning their scientific communication skills, oral as well as written.		
Sr. No.	**Course Contents (Topics and subtopics)**	**Required Hours**
1	Teachers will communicate various research project topics to all the students based on interest and facilities available and relevance to the area of Dyestuff Technology. - Each student based on his/her interest and merit selects the research topic and is allotted a supervisor. - Review of literature, formulation of research project, hypothesis, objectives, methodology, possible expected outcomes, planning for experimentation, experimental trials, data generation and analysis. - Oral presentation & written report of the seminar will be evaluated.	**60**
	Total	**60**
List of Textbooks/Reference Books		
1	Relevant research articles, patents, review articles, conference proceeding, book chapters and books	

	Project-I **DYP1007**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Develop* critical thinking to identify the research gap for the project (K5)	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	*Formulate* a scientific question and approach to solve it (K6)	3	3	3	3	3	3	3	3	3	3	2	3	3	1
CO3	*Plan* the experimental methodology for the project (K5)	3	2	3	3	3	3	3	1	3	3	3	3	3	3
CO4	*Develop* skills to communicate the research plan effectively (K6)	3	3	3	3	3	2	3	3	3	0	3	3	2	3
CO5	*Develop* skills for writing a scientific document on the research work (K6)	3	3	3	3	3	3	3	3	3	3	3	3	3	3
DYP1007		3	3	3	3	3	3	3	3	3	3	3	3	3	3

	Course Code: DYP 1006	Course Title: Seminar	Credits = 3		
			L	T	P
	Semester: VII	Total Contact Hours: 60	0	0	4

List of Prerequisite Courses

All the previous dyestuff technology courses

List of Courses where this course will be prerequisite

All the B.Tech (dyestuff technology) courses in this semester and the subsequent semesters.

Description of relevance of this course in the B. Tech. Program

The course is intended to develop student's ability to read, understand any given topic related to dyestuff technology, collect literature, write a scientific report on that topic based on the provided guidelines and present the scientific merits and demerits of the matter. Students shall prepare critical reviews of selected topics in Chemical Technology and allied subjects and submit in the form of standard typed reports. Students shall also make oral presentations of the reviews.

	Course Contents (Topics and Subtopics)	Required Hours
1	Any topic related to dyestuff technology.	60
	Total	**60**

List of Textbooks/Reference Books

1	nil

	Seminar **DYP1006**														
CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	Develop a protocol for literature survey about a certain topic (K4)	3	3	1	3	2	3	3	3	3	3	3	2	3	3
CO2	Evaluate the literatures and interpret the scientific content (K5)	3	2	3	3	3	0	3	3	3	3	2	3	3	3
CO3	Apply the concept of dyestuff technology on a selected topic (K3)	3	3	2	2	2	3	3	2	3	3	3	1	3	3
CO4	Develop skills for presenting a scientific topic in dyestuff technology (K6)	3	1	3	3	0	3	3	3	1	3	0	3	3	3
CO5	Develop skills for writing a scientific document (K6)	3	3	3	3	3	3	3	3	3	3	3	3	3	3
DYP1006		3	3	3	3	3	3	3	3	3	3	3	3	3	3

	Course Code: DYP 1012	Course Title: In-plant Training	Credits = 6		
			L	T	P
	Semester: VII	Total duration: 12 weeks	0	0	0

List of Prerequisite Courses

	None

List of Courses where this course will be Prerequisite

	Project I (FDP 1027), Project II (FDP 1024)

Description of relevance of this course in the B. Tech. (Food Engg. & Tech.) Programme

The course is designed to – 1. develop a systematic thinking about an industrial problem; 2. develop skills for communication, networking, personal grooming & amp; professional conduct within an industrial environment, and 3. develop the attitude for individual and teamwork.

Sr. No.	Course Contents (Topics and subtopics)	Required weeks
1	Each Student will be involved in R & D/ manufacturing (QA / QC / Plant Engineering /Stores and Purchase)/ marketing / finance/ consultancy/ Technical services/ Engineering / Projects, etc. Oral presentation & written report of the in-plant training will be evaluated along with industry feedback.	**12**
	Total	**12**

	In-Plant Training **DYP1012**															

CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	*Apply* the concept of project & production management in further planning (K3)	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	*Develop* critical thinking regarding the various operations involved in dyestuff technology and allied industry (K4)	3	3	2	3	2	3	3	3	3	3	3	2	3	2
CO3	*Solve* certain industrial challenges in dyestuff technology and allied field (K6)	3	3	3	3	3	3	2	3	1	3	2	3	3	3
CO4	*Present* and communicate an industrial problem effectively (K6)	3	3	2	3	3	3	3	0	3	3	3	3	2	3
CO5	*Write* a scientific report on the training (K6)	3	3	3	3	1	3	3	3	3	2	3	3	3	3
DYP1012		3	3	3	3	3	3	3	3	3	3	3	3	3	3

Semester VIII

Code & Title of the Course: DYP1009		**Preparation, Analysis and Application of Dyes, Intermediates, Optical Brighteners and Functional Colorants** DYP1009	
Marks		100	
Number of Hours per Week		8	
Credits		4	
Class		Final Year B Tech (Dyes)	
Semester		VIII	
Sl. No.	Detailed Syllabus	List of Experiments	Hours
1	Preparation, analysis and application **Detailed Syllabus**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* • *Diaminostilbenedisolphonic 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 Azocoumarin 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:

1. Viva
2. Assignment
3. Practical

Recommended books:

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

	Preparation, Analysis and Applications of Dyes, Intermediates, Optical Brightners **DYP1009**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Design* the synthetic route for the preparation of dyes and intermediates (K3)	3	3	3	3	1	3	3	1	3	1	3	2	2	3
CO2	*Conduct* experiments in the lab independently for the synthesis of dyes, intermediates and optical brighteners (K3)	3	3	3	3	3	3	2	0	3	1	3	2	3	2
CO3	*Execute* the process with utmost efficiency and precession (K3)	3	3	3	3	3	3	2	0	3	1	3	3	2	3

CO4	*Evaluate* the purity, and characterize the products via instrumental methods (K5)	3	2	2	3	3	2	1	2	3	1	3	1	2	2
CO5	*Apply* of the synthesized products for diverse uses (K4)	3	3	3	3	3	3	3	1	3	1	3	2	3	3
DYP1009		3	3	3	3	3	3	3	2	3	1	3	3	3	3

	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					
	All BTech dyestuff Technology courses				
	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-CO5	45		

List of Text Books/ Reference Books

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

	Case Studies in Dyestuff Industry **DYT1106**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Correlate* industry-oriented situations for synthesis or isolation of intermediates (K2)	3	3	2	3	3	2	3	2	0	1	2	0	3	3
CO2	*Understand* practical aspects of selection of suitable methods and isolation techniques (K2)	3	3	3	3	3	2	3	2	0	1	2	0	3	3
CO3	*Realize* the utility of the theoretical concepts in the practical situations (K2)	2	3	3	3	3	3	3	2	2	1	2	2	3	3
CO4	*Formulate* strategies to solve the practical problem (K4)	3	3	3	3	3	3	3	2	2	3	3	3	3	3

CO5	Assess the problem component and come up with a rational solution (K5)	3	3	3	3	3	3	3	2	2	3	3	3	3	3
DYT1106		3	3	3	3	3	3	3	2	2	3	3	3	3	3

Subject Code: 1107				Subject: **Technology of pigments**			Total Marks: 100
L	T	Test	C	Theory Marks		Continuous Assessment	
				Mid Sem	End Sem		
4	2	0	3	30	20	15	100

Sl.No.	Contents	Hrs.
1	Introduction to pigments, colour and physical constitution, optical properties of pigments, crystalline modifications and other basic properties	5
2	Chemistry – Lake pigments, condensation pigments, arylide pigments, copper phthalocyanine, benzimidazolone pigments, vat pigments, quinacridone pigments. Technology – manufacture of some of the above pigments	5
3	High performance pigments, dioxazine pigments, diketopyrrolopyrrole pigments, perylene pigments and other condensed heterocyclic pigments, quinophthalone pigments, azamethine pigments, thiazine pigments	15
4	Heterocyclic analogues of conventional pigments, luminescent pigments	5
5	Pigment finishing and standardisation. Newer Technologies of pigment processing. Latent Pigment Technology. Pigment Flush.	2
6	Pigments in organo electronics and other modern applications. Pigments for printing inks, ink jet printing and other applications.	3
7	Introduction to inorganic pigment;Theirclassification,Fundamental aspects of their chemical and physical properties;Introduction to general method of determination of inorganic pigment.	5

8	White Pigments based on Titanium Oxide, Zinc oxide, and Zinc Sulfide; properties, production, raw materials, application in commercial products, and toxicology	5
9	Various colored pigments on metal oxides and hydroxides; synthesis, properties, uses and economic aspects	5
10	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	5
11	Inorganic pigments with special properties for examples Magnetic pigment, Luminescent pigments, Transparent pigments, Electroluminescent pigments, Special effect pigments, etc.	5

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.

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

	Technology of Pigments **DYT1107**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Conceptualize* the basic pigmentary properties like hue, tinctorial strength, blooming, bleeding, stability, optical properties, polymorphism, etc.	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**0**	**1**	**1**	**1**	**1**	**2**	**2**
CO2	*Classify* the pigments based on chemical constitution and color	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**1**	**1**	**1**	**2**	**1**	**2**	**1**
CO3	*Correlate* and predict various application properties of pigments	**3**	**3**	**2**	**2**	**3**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**3**	**2**
CO4	*Describe* and *apply* the standardization and after treatment methods of pigments	**3**	**3**	**3**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**2**	**1**	**3**	**2**

CO5	*Propose* synthetic routes for different pigments	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**1**	**3**	**1**	**3**	**3**
DYT1107		3	3	3	3	3	3	2	1	1	1	3	1	3	3

	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 Courses					
	All BTech dyestuff Technology Courses					
	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

	Functional Application of Colorants **DYT1205**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Grasp* broad idea about functional applications of dyes (K2)	1	2	2	2	1	1	2	0	1	1	3	0	3	2
CO2	*Understand* underlying properties for their application in commercial product (K2)	1	3	2	2	1	1	2	1	1	1	3	0	3	2
CO3	*Know* various colorants based on specific molecule engineering (K2)	2	3	2	2	1	2	2	0	1	1	3	0	2	3
CO4	*Apply* the knowledge in planning the synthesis of functional dyes (K3)	3	3	3	2	2	2	3	1	2	2	3	2	3	3
CO5	*Design* functional dyes based on the specific role (K4)	3	3	3	3	2	2	3	1	2	3	3	3	3	3
DYT1205		3	3	3	3	2	2	3	1	2	3	3	3	3	3

	Course Code: HUT1107	**Course Title: Value Education**	**Credits = 4**		
			L	**T**	**P**
	Semester: VIII	**Total contact hours: 45**	**2**	**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. (Dyestuff Tech.) Programme		
-		
Sr. No.	**Course Contents (Topics and subtopics)**	**Required Hours**
1	Unit –I Education and Human values 1. Education: Etymology, definitions (western, Indian) 2. Relationship between education and Axiology (Ethics, Logic, aesthetics/Satyam, shivam , Sundaram) 3. Evaluation of education: Ancient Indian education :Purusharthas 4. Concept and types of values 5. Functions of holistic education for the development of Personal/individual growth *Social, National Global citizenship.	**15**
2	Unit –II National and International Values for Global Development • Importance for national integration and international understanding. • National values (constitutional Values)- Democracy, socialism ,Secularism ,Equality, Justice, Liberty, freedom and Fraternity • Constitutional provisions for values in Indian constitution –Article 14,15,16,17 & 19 • Social values- Empathy Social responsibility, self- control, Humanity university brotherhood. • Professional values- Religious Tolerance, Wisdom, character formation (Character building) • Aesthetic values- Love and appreciation of literature and fine arts and respect for the same	**15**
3	Unit –III Human Rights 1. Right to information 2. Right when arrested 3. Right to compensation in accidents 4. Rights of consumers 5. Constitutional Rights of women 6. Rights of Wife and Children 7. Offenses relating to marriage 8. Women's rights to protect from domestic violence 9. Rights against Dowry 10. Free Legal services to the poor 11. Workman's right to compensation for accidents and Occupational Diseases 12. Working women's right for Maternity benefits 13. Right of women against Sexual Harassment in workplaces 14. The law on rape	**15**
	Total	**45**

	Project-II **HUT1107**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Perform* experiments & troubleshoot to generate reliable data (K5)	3	3	3	3	3	3	3	3	3	3	3	3	3	3

CO2	*Apply* different statistical tools for scientific data analysis (K4)	3	3	2	3	2	3	3	3	2	3	3	2	3	3
CO3	*Evaluate* critically the experimental data and draw meaningful inferences (K5)	3	3	3	3	3	0	3	3	3	3	3	3	3	3
CO4	*Develop* skills to communicate the research outcome effectively (K6)	3	3	3	3	3	3	1	3	3	3	3	2	3	3
CO5	Develop skills for writing a complete document on the project work (K6)	3	3	3	3	3	3	3	3	3	3	3	3	3	3
DYP1008		3	3	3	3	3	3	3	3	3	3	3	3	3	3

	Course Code: DYP 1008	**Course Title: Project -II**	**Credits = 4**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 120**	**0**	**0**	**8**
List of Prerequisite Courses					
	Project I (**DYP 1007**)				
List of Courses where this course will be Prerequisite					
Relevant courses of Semester VIII					
Description of relevance of this course in the B. Tech. (Dyestuff Tech.) Programme					
1. Develop a skill to execute & solve a research problem in dyestuff technology 2. Develop skills for presenting a research outcome effectively					

Sr. No.	**Course Contents (Topics and subtopics)**	**Required Hours**
1	The topic of the research with defined objectives and hypothesis should be explored by scientifically planned rational experiments. Students should have actual experimental data collected on the chosen research topic.	**80**
2	-Oral presentation of proposed research work with data generated during actual trial targeted towards the objectives -Submission of report of research proposal	**40**
	Total	**120**

	Project-II **DYP1008**														
CO	Statement	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	*Perform* experiments & troubleshoot to generate reliable data (K5)	3	3	3	3	3	3	3	3	3	3	3	3	3	3
CO2	*Apply* different statistical tools for scientific data analysis (K4)	3	3	2	3	2	3	3	3	2	3	3	2	3	3
CO3	*Evaluate* critically the experimental data and draw meaningful inferences (K5)	3	3	3	3	3	0	3	3	3	3	3	3	3	3
CO4	*Develop* skills to communicate the research outcome effectively (K6)	3	3	3	3	3	3	1	3	3	3	3	2	3	3
CO5	Develop skills for writing a complete document on the project work (K6)	3	3	3	3	3	3	3	3	3	3	3	3	3	3
DYP1008		3	3	3	3	3	3	3	3	3	3	3	3	3	3

	Course Code: CET1504	**Course Title: Chemical Project Engg and Economics**		**Credits = 3**	
			L	**T**	**P**
	Semester: VIII	Total contact hours: 45	**2**	**1**	**0**
	List of Prerequisite Courses				
	Material and Energy BalanceCalculations, Equip Desand Dwg I, Energy Engineering,				
	List of Courses where this course will be prerequisite				
	Home Paper I and II				
	Description of relevance of this course in the B Tech. Program				
	This course is required for the future professional career				

Sr. No.	**Topic**	**Teaching Hours**
1.	Introductiontogreenfieldprojectsandglobalnatureofprojects;Impactofcurrencyfluctuations onProject justificationandcashflowsandConceptsof—Quality byDesign‖includingtypical design	6

	deliverablesandunderstandingconstructability,operabilityandmaintainability duringallstages of project execution.Meaning of Project Engineering, variousstages of project implementation	
2.	Relationshipbetweenpriceofaproductandprojectcostandcostofproduction,EVAanalysis.El ements of cost of production, monitoring of the same in a plant, Meaning of Administrative expenses,sales expenses etc. Introductiontovarious components ofprojectcost andtheirestimation. IntroductiontoconceptofInflation,locationindexandtheiruseinestimatingplantandmachiner y cost. Variouscost indices,Relationshipbetweencost andcapacity.	8
3.	Projectfinancing: debt:Equityratio,Promoters'contribution,Shareholders'contribution,sourceoffinance, time value of money. Concept of interest, time value of money, selection of various alternativeequipmentorsystem basedonthisconcept. Indiannorms,EMIcalculations.Depreciation concept, Indian normsandtheir utilityinestimateofworkingresultsofproject. Workingcapital concept and its relevance to project	7
4.	Estimateofworkingresultsofproposedproject. Capacityutilization,Grossprofit,operatingprofit,profit beforetax,Corporate tax, dividend, Netcashaccruals.Projectevaluation: Cumulativecashflow analysis Break-Even analysis, incremental analysis, various ratios analysis, Discounted cash flow analysis	7
5	Process Selection, Site Selection, Feasibility Report	4
6	Project:ConceptiontoCommissioning:milestones,Projectexecutionasconglomerationoftec hnicaland nontechnical activities, contractual details. Contract:Meaning,contents, Types ofcontract. Lump- sum Turnkey (LSTK),Eng,ProcurementandConstruction(EPC),Eng,ProcurementandConstruction Management (EPCM).Mergersand Acquisitions	6
7	ReadingofBalanceSheetsandevaluationof Techno-commercial ProjectReports	3
8	PERT, CPM,barcharts and network diagrams	4

Reference Books:

Chemical Project Economics,MahajaniV.V. Reference Books andMokashi SM

Plant Designand EconomicsforChemical Engineers,Peters M.S.,TimmerhausK.D.

ProcessPlant and Equipment Cost Estimation, KharbandaO.P.

	Chemical Project Engg and Economics CET1504														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**

CO1	calculate working capital requirement for a given project (K3)	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	calculate cost of equipment used in a plant total project cost (K3)	3	3	2	2	2	3	3	3	3	3	2	2	2	3
CO3	calculate cash-flow from a given project (K3)	3	3	1	0	2	3	1	3	3	3	3	2	3	2
CO4	select a site for the project from given alternatives (K4)	3	3	2	3	2	2	3	3	3	3	3	2	3	3
CO5	list out various milestones related to project concept to commissioning (K2)	3	2	1	2	1	3	3	3	3	0	3	1	3	2
CET1504		3	3	2	3	2	3	3	3	3	3	3	2	3	3

	Course Code: DYT 1812	**Course Title: Introduction to Green Chemistry**		**Credits = 3**	
				L	**T**
	Semester: VIII	Total contact hours: 45		**2**	**1**
	List of Prerequisite Courses				
	All BTech courses				

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 synthesis, dyes industry and Green Chemistry, reduction of energy requirement, reduction of risk and hazard.	8
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

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 inimizationand 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 andrenewable solvents, roomtemperature ionic liquids, applications of supercriticalfluids 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, dyesindustry and Green Chemistry, reduction of energy requirement, reduction of riskand hazard.	CO1, CO3	K1, A1	Chalk and board
4	Catalysis and Green Chemistry, heterogeneous catalysis, homogeneous	CO1, CO2, CO3	K1 and A2	Chalk and board

	catalysis,phase transfer catalysis, biocatalysis, photocatalysis			

	Introduction to Green Chemistry **Elective-III**														
CO	Statement	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	*Understand* the Green aspects of chemistry (K2)	1	3	2	3	2	2	3	3	0	0	3	1	3	2
CO2	*Utilize* and modify the processes to have green and better environmental protective aspect. (K3)	3	3	3	3	3	3	3	2	2	1	2	2	3	2
CO3	*Design* Safer and healthy atmosphere building (K3)	3	3	3	3	3	3	3	3	2	2	2	2	3	3
CO4	*Analyze* energy efficient chemical transformation (K4)	3	3	3	3	3	3	3	3	2	2	3	3	2	3
CO5	*Demonstrate* the sustainable strategies for the chemical synthesis (K5)	3	3	3	3	3	3	3	3	2	2	3	3	2	3
Elective-III		3	3	3	3	3	3	3	3	2	2	3	3	3	3

Sl. No	**Course Code**	**Course Title**	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Total hours**	**Total Credit**
1	**CHP1342**	**BASIC SCIENCE 1:** Physical and Analytical Chemistry Laboratory	0	0	4	4	2
2	**CHT1341**	**BASIC SCIENCE 2:** Physical Chemistry 1	2	1	0	3	3
3	**CHT1401**	**BASIC SCIENCE 3:** Analytical Chemistry	2	1	0	3	3
4	**GEP1101**	**ENGINEERING SCIENCE 1:** Engineering Graphics 1	2	0	6	8	4

5	**HUP1101**	**HUMANITIES 1:** Communications Skills	0	0	4	4	2
6	**MAT1101**	**BASIC SCIENCE 4:** Applied Mathematics **1**	3	1	0	4	4
7	**PYT1101**	**BASIC SCIENCE 5:** Applied Physics 1	3	1	0	4	4
			12	**4**	**14**	**30**	**22**
Semester II							
ID	**Course Code**	**Course Title**	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Total hours**	**Total Credit**
8	**CET1507**	**ENGINEERING SCIENCE 2:** Process Calculations	3	1	0	4	4
9	**CHP1132**	**BASIC SCIENCE 6** Organic Chemistry **Laboratory**	0	0	4	4	2
10	**CHT1132**	**BASIC SCIENCE 7:** Organic Chemistry	3	1	0	4	4
11	**CHT1342**	**BASIC SCIENCE 8:** Physical Chemistry	2	1	0	3	3
12	**MAT1102**	**BASIC SCIENCE 9:** Applied Mathematics **2**	2	2	0	4	4
13	**PYP1101**	**BASIC SCIENCE 10:** Physics Laboratory	0	0	4	4	2
14	**PYT1103**	**BASIC SCIENCE 11:** Applied Physics 2	2	1	0	3	3
			13	**5**	**8**	**26**	**22**
Semester III							
ID	**Course Code**	**Course Title**	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Total hours**	**Total Credit**
15	**CHT1124**	**BASIC SCIENCE 12: Industrial Inorganic Chemistry**	3	1	0	4	4
16	**CHT1136**	**BASIC SCIENCE 13:** Aromatic and Heterocyclic Chemistry	3	1	0	4	4

17	DYP1001	**PROGRAMME CORE 1:** Analysis of Inorganic Raw Materials used in Dyestuff industries	0	0	4	4	2
18	DYT1101	**PROGRAMME CORE 2:** Technology of Intermediates 1	3	1	0	4	4
19	DYT1202	**PROGRAMME CORE 3:** Chemical and Physical Constitution of Colourants	2	1	0	3	3
20	MAP1202	**ENGINEERING SCIENCE 3:** Engineering Applications of Computers	0	0	4	4	2
21	OLT1102	**PROGRAMME CORE 4:** Chemistry of Oleochemicals and Surfactants	3	1	0	4	4
			14	**5**	**8**	**-**	**23**
Semester IV							
ID	**Course Code**	**Course Title**	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Total hours**	**Total Credit**
22	CET1105	**ENGINEERING SCIENCE 4:** Transport Phenomena	3	1	0	4	4
23	DYT1102	**PROGRAMME CORE 5:** Technology of Intermediates 2	3	1	0	4	4
24	GEP1106	**ENGINEERING SCIENCE 5**: Electrical Engineering and Electronics Lab	0	0	4	4	2
25	GET1109	**ENGINEERING SCIENCE 6:** Electrical Engineering And Electronics	2	1	0	3	3
26	GET1301	**ENGINEERING SCIENCE 7:** Engineering Mechanics and Strength of Materials	3	1	0	4	4
27	PYP1103	**BASIC SCIENCE 14:** Colour Physics Laboratory	0	0	4	4	2
28	PYT1202	**BASIC SCIENCE 15:** Colour Physics and Colour Harmony	2	1	0	3	3
			13	**5**	**8**	**-**	**22**
Semester V							

ID	Course Code	Course Title	Lecture (L)	Tutorial (T)	Practical (P)	Total hours	Total Credit
29	**CET1212**	**ENGINEERING SCIENCE 8:** Chemical Reaction Engineering 1	2	1	0	3	3
30	**CET1401**	**ENGINEERING SCIENCE 9:** Chemical Engineering Operations	2	1	0	3	3
31	**DYP1002**	**PROGRAMME CORE 6:** Analysis of Intermediates, Dyes and Fibers	0	0	8	8	4
32	**DYP1003**	**PROGRAMME CORE 7:** Experimental dyeing	0	0	4	4	2
33	**DYT1103**	**PROGRAMME CORE 8:** Technology of azo colorants	3	1	0	4	4
34	**DYT1104**	**PROGRAMME CORE 9:** Technology of Quinonoid colorants	3	1	0	4	4
35	**TXT1215**	**PROGRAMME CORE 10:** Technology of dyeing and printing (including substrates)	3	1	0	4	4
			13	**5**	**12**	**-**	**24**
Semester VI							
ID	**Course Code**	**Course Title**	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Total hours**	**Total Credit**
36	**DYP1004**	**PROGRAMME CORE 11:** Chromatographic Techniques and Preparation of Intermediates of Dyes	0	0	8	8	4
37	**DYP1005**	**PROGRAMME CORE 12:** Process and Plant Design	0	0	4	4	2
38	**DYT1203**	**PROGRAMME CORE 13:** Flourescent Colourants	3	1	0	4	4
39	**DYT1204**	**PROGRAMME CORE 14:** Heterocyclic Intermediates ad colorants	2	1	0	3	3
40	**Elec_DYE_TYBT**	**OPEN ELECTIVE 1:** Technology of Organic Processes	2	1	0	3	3

41	**HUT1103**	**HUMANITIES 2:** Industrial Psychology and Human Resource Management (VF)	2	1	0	3	3
42	**HUT1104**	**HUMANITIES 3:** Industrial Management 1 (VF)	2	1	0	3	3
43	**HUT1106**	**HUMANITIES 4:** Environmental Science and Technology (VF)	2	1	0	3	3
44	**TXP1013**	**PROGRAMME CORE 15:** Wet Processing of Textiles	0	0	4	4	2
			13	**6**	**16**	**-**	**27**
Semester VII							
ID	**Course Code**	**Course Title**	**Lecture (L)**	**Tutorial (T)**	**Practical (P)**	**Total hours**	**Total Credit**
45	**CEP1714**	**ENGINEERING 10:** Chemical Engineering Laboratory	0	0	4	4	2
46	**CET1713**	**ENGINEERING 11:** Instrumentation and Process Control	2	1	0	3	3
47	**DYT1105**	**PROGRAMME CORE 16:** Technology of cationic and sulfur colorants	2	1	0	0	3
48	**DYT1206**	**PROGRAMME CORE 17**: Structural Elucidation of organic compounds	2	1	0	3	3
49	**DYT1721**	**OPEN ELECTIVE 2:** Reaction Mechanism and reagent chemistry	2	1	0	3	3
50	**HUT1105**	**HUMANITIES 5:** Industrial Management 2	2	1	0	3	3
51	**MAT1106**	**BASIC SCIENCE 16:** Design and Analysis of Experiments	2	1	0	3	3
52	**DYP1006**	**SEMINAR 1:** Seminar	0	0	4	4	2
53	**DYP1007**	**PROJECT 1:** Project 1	0	0	8	8	4
54	**DYP1012**	In plant training	-	-	-	-	3
			12	**6**	**16**		**29**

Semester VIII							
ID	Course Code	Course Title	Lecture (L)	Tutorial (T)	Practical (P)	Total hours	Total Credit
55	**CET1504**	**ENGINEERING 12:** Chemical Project Engineering Economics	2	1	0	3	3
56	**DYP1009**	**PROGRAMME CORE 18:** Preparation, analysis and application of dyes, optical brighteners, and functional colourants	0	0	8	8	4
57	**DYT1106**	**PROGRAMME CORE 19:** Case Studies in Dyestuff Industry	3	1	0	4	3
58	**DYT1107**	**PROGRAMME CORE 20:** Technology of Pigments	3	1	0	4	4
59	**DYT1205**	**PROGRAMME CORE 21:** Functional Applications of Organic Colourants	2	1	0	3	3
60	**DYT1812**	**OPEN ELECTIVE 3:** Elective 3 Introduction to Green Chemistry	2	1	0	3	3
61	**HUT1107**	**HUMANITIES 6:** Value Education	2	1	0	3	3
62	**DYP1008**	**PROJECT 2:** Project 2	0	0	8	8	4
			14	**6**	**16**	**-**	**27**