Syllabus for Bachelor of Technology

(B.Tech. in Dyestuff Technology)

(Under the New Education Policy-NEP 2020)

in

(2023-2024)

INSTITUTE OF CHEMICAL TECHNOLOGY

(University Under Section-3 of UGC Act, 1956)

Elite Status and Center for Excellence

Government of Maharashtra

Nathalal Parekh Marg, Matunga, Mumbai 400 019 (INDIA)

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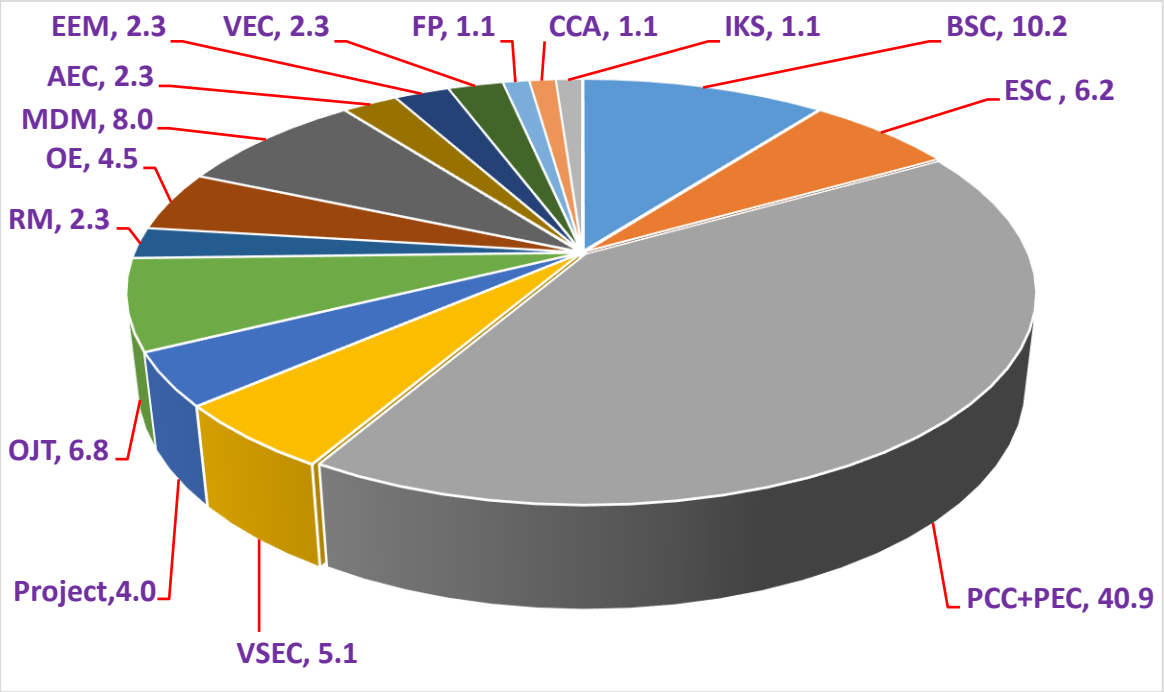
Department of Speciality Chemicals Technology

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 2023 as per NEP 2020. The 176 credit programme each has following Credit Distribution



This does not include Honors courses of 18 credits.

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.

Graduate Attributes

1. Problem analysis and solving skills
2. Familiar with usage of modern tools, techniques
3. Communication Skills
4. Capacity to analyze new concepts
5. Capacity to analyze and interpret experimental data Capacity to analyze business trends
6. Capacity to design, optimize and operate equipment and plants safely, economically and effectively
7. Design and Development of solutions to industrial and societal needs
8. Skills related to Project Management and Economics
9. Skills to analyze scientific literature including patents
10. Ethics

Syllabus Structure for B. Tech (Dyestuff Technology) Course

SEMESTER- I										
Course Code	**Subjects**	**Course Type**	**Credits**	**Hrs/Week**			**Marks for various Exams**			
				L	**T**	**P**	**C.A.**	**M.S.**	**E.S.**	**Total**
CHT1405	Physical Chemistry	BSC	3	2	1	0				
CHT1406	Analytical Chemistry	BSC	3	2	1	0				
MAT1205	Engineering Mathematics	ESC	3	2	1	0				
PYT1205	Applied Physics	BSC	2	1	1	0				
GET1305	Engineering Graphics and Computer Aided Drawing	VSEC	3	1	0	4				
DYT1011	**SPL-1:** A Primer on Technology of Intermediates and Dyestuffs	ESC	2	1	1	0				
PYP1101	Physics Laboratory	BSC	2	0	0	4				
HUT1110B	Communication Skills(English)	AEC	2	0	0	4				
	OPEN Activity - Sports/ Fine arts/Yoga/ Music/NSS**	CCA	2	0	0	4				
	TOTAL:		**22**	**9**	**5**	**16**				

SEMESTER- II										
Subject Code	**Subjects**	**Course Type**	**Credits**	**Hrs/week**			**Marks for various Exams**			
				L	**T**	**P**	**C.A.**	**M.S.**	**E.S.**	**Total**
CHT1407	Organic Chemistry	BSC	3	2	1	0				
CHT1408	Industrial Chemistry	BSC	3	2	1	0				
DYT1021	**SPL-2**: Physical and Chemical Constitution of Colorants	PCC	2	1	1	0				
GET1306	Basic Mechanical Engineering	ESC	2	1	1	0				
GET1125	Electrical Engineering and Electronics	ESC	2	1	1	0				
CEP1720	Process Calculations	ESC	2	0	0	4				
CHP1343	Physical and Analytical Chemistry Laboratory	BSC	2	0	0	4				
CHP1132	Organic Chemistry Laboratory	VSEC	2	0	0	4				
	OPEN Activity- Sports/ Fine Arts/Yoga/ Music/NSS**	CCA	2	0	0	4				

	MOOC- Indian Knowledge System (NPTEL - Introduction to Ancient Indian Technology)	IKS	2	0	0	4				
	TOTAL:		**22**	**7**	**5**	**20**				

Note: Universal Human Values (UHV) an audit course to be taken in inter-semester break after Semester-II to be taken as MOOC course.

** Students will undertake these co-curricular activities such as sports / Fine Arts / Yoga / Music / Literature etc administered through various clubs under Technological Association approved by Dean, Students Affairs.

	SEMESTER- III									
Subject Code	**Subjects**	**Course Type**	**Credits**	**Hrs /week**			**Marks for various Exams**			
				L	**T**	**P**	**C.A.**	**M.S.**	**E.S.**	**Total**
DYT1031	**SPL-3:** Technology of Benzenoid Intermediates	PCC	4	3	1	0				
DYT1041	**SPL-4:** Quinonoid Intermediates - Chemistry and Technology	PCC	2	1	1	0				
OE	From Basic Sciences (Chemistry/ Physics/Biology / Maths / Humanities)	OE	4	3	1	0				
	Communication Skills – (Marathi / Hindi or Any other language will be chosen using MOOCS)	AEC	2	1	1	0				
HUT1205	Basic Economics and Finance	EEM	2	1	1	0				
	Digital Computation in Emerging Areas **(NPTEL course: Introduction To Industry 4.0 And Industrial Internet Of Things)**	VEC	2	0	0	4				
	MDM-I: From Sciences and/or any other Engineering / Humanities Discipline	MDM	2	1	1	0				
DYP1111	**Pr 1**: Lab-1: Analysis of Inorganic Raw Materials used in Colorants Industries	PCC	2	0	0	4				
DYP1121	**Pr 2**: Lab 2: Chromatographic Methods and Analysis	PCC	2	0	0	4				
	TOTAL:		**22**	**11**	**7**	**8**				

	SEMESTER- IV									
Subject Code	**Subjects**	**Course Type**	**Credits**	**Hrs/week**			**Marks for various Exams**			
				L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
CET1105	Transport Phenomena	PCC	4	3	1	0				
DYT1051	**SPL-5:** Technology of Naphthalene Intermediates	PCC	3	2	1	0				
DYT1061	**SPL-6**: Technology of Ionic Dyes - 1	PCC	3	2	1	0				
OE	From Basic Sciences (Chemistry/ Physics/ Biology / Maths) or Humanities Discipline	OE	2	1	1	0				
CET1805	Chemical Process Economics	EEM	2	1	1	0				

HUT1206	Environmental Sciences and Technology	VEC	2	1	1	0				
	MDM II: From Sciences and/or any other Engineering /Humanities	MDM	2	1	1	0				
	Community Projects#	CEP/FP	2	0	0	4				
DYP1131	**Pr 3**: Lab-3: Preparation of Intermediates	VSEC	2	0	0	4				
	TOTAL:		**22**	**11**	**7**	**8**				

Students will undertake community projects as individual or group related to study of societal technological activities through various organization such as Lions club, Teach India, Marathi Vidnyan Parishad, CSR projects outsourced by various industries, ISR activities administered through Technological Association approved by the Dean, Student Affairs.

	SEMESTER- V									
Subject Code	**Subjects**	**Course Type**	**Credits**	**Hrs /week**			**Marks for various Exams**			
				L	**T**	**P**	**C. A.**	**M.S.**	**E. S.**	**Total**
CET1806	Chemical Reaction Engineering	PCC	2	1	1	0				
CET1807	Chemical Engineering Operations	PCC	2	1	1	0				
DYT1071	**SPL-7**: Technology of Non-ionic Dyes - 1	PCC	4	3	1	0				
DYT1081	Offered by the department/MOOCs (one of the electives can be DYT1081) **SPL-8**:Computational Color Chemistry	PEC	4	3	1	0				
OE	From Basic Sciences (Chemistry/ Physics/ Biology / Maths) or Humanities Discipline	OE	2	1	1	0				
DYT1091	Honors Course-I (Metal Complex Colorants)	PCC	4	3	1	0				
	MDM III: From Sciences and/or any other Engineering / Humanities Discipline	MDM	4	2	0	4				
DYP1141	**Pr 4**: Lab 4: Analysis of Colorants and Fibers	PCC	2	0	0	4				
DYP1151	**Pr 5**: Lab 5: Preparation of Ionic Dyes	PCC	2	0	0	4				
	TOTAL:		**26**	**14**	**6**	**12**				

	SEMESTER- VI									
Subject Code	**Subjects**	**Course Type**	**Credits**	**Hrs/week**			**Marks for various Exams**			
				L	**T**	**P**	**C.A.**	**M.S.**	**E. S.**	**Total**
DYT1101	**SPL-9**: Technology of Ionic Dyes - 2	PCC	3	2	1	0				
DYT1111	**SPL-10**: Structural Elucidation of Dyes	PCC	3	2	1	0				
DYT1121	Offered by the department/MOOCs (one of the electives can be DYT1121) **SPL-11**: High Performance Pigments	PEC	4	3	1	0				

DYT1131	**SPL-12**: Technology of Non-ionic Dyes - 2	PCC	4	3	1	0				
DYT1141	Honors Course-II (Near IR Absorbing Dyes)	PCC	4	3	1	0				
	MDM IV: From Sciences and/or any other Engineering / Humanities Discipline	MDM	2	1	1	0				
CEP1714	Chemical Engineering Laboratory	VSEC	2	0	0	4				
DYP1161	**Pr 6**: Lab-6: Preparation of Non-ionic Dyes	PCC	2	0	0	4				
DYP1171	**Pr 7**: Lab -7: Application of Colorants	PEC	2	0	0	4				
	TOTAL:		**26**	**14**	**6**	**12**				

SEMESTER- VII

Subject Code	Subjects	Course Type	Credits	Hrs/week			Marks for various Exams			
				L	T	P	C. A.	M.S.	E.S.	Total
DYT1151	**SPL-13**: Chemistry and Technology of Pigments	PCC	3	2	1	0				
DYT1161	**SPL-14**: Chemistry and Technology Fluorescent Colorants	PCC	2	1	1	0				
DYT1171	Offered by the department/MOOCs (one of the electives can be DYT1171) Colorants in Organic Electronics	PEC	3	2	1	0				
DYT1181	Offered by the department/MOOCs (one of the electives can be Technology of Biosensors DYT1181/	PEC	2	2	0	0				
DYT1191	Honors-III **(**Case Studies in Colorants Industry**)**	PCC	4	3	1	0				
	MDM V: From Sciences and/or any other Engineering / Humanities Discipline	MDM	2	1	1	0				
DYP1181	Literature Review (Research Methodology - I)	RM-1	2	1	0	2				
DYT1201	Design and Analysis of Experiments (Research Methodology - II)	RM-2	2	1	0	2				
DYP1191	Project -I (Literature search + Expt)	Project	4	0	0	8				
DYP1201	**Pr 8**: Lab-8: Synthesis, Analysis and Applications of Optical Brighteners	PCC	2	0	0	4				
	TOTAL:		**26**	**13**	**5**	**16**				

	SEMESTER- VIII									
Semester-VIII (10 weeks)										
Subject Code	**Subjects**	**Course Type**	**Credits**	**Hrs /week**			**Marks for various Exams**			
				L	**T**	**P**	**C.A.**	**M.S.**	**E. S.**	**Total**
DYT1211	**SPL-15**: Applications of Organic Dyes	PCC	3	5	1	0				
DYT1221	Honors Course-IV (Formulation Technology in Colorants)	PCC	3	5	1	0				
DYT1231	Honors Course-V (Industrial Waste Management in Colorants Industry)	PCC	3	5	1	0				
	MDM VI: From Sciences and/or any other Engineering / Humanities Discipline	MDM	2	2	1	0				
DYP1211	Project-II (Experiments)	PCC	3	0	0	12				
DYP1221	**Pr 9**: Lab-9: Formulation and Functional Applications of Colorants	PEC	2	0	0	6				
Semester-VIII (12-16 weeks)										
DYP1231	Internship with Industry	OJT	12	0	0	0				
	Total		**28**	**17**	**4**	**18**				

Internship

- In the Eighth semester, every student will have to undergo an internship and/or On Job Training. The Internship would be of 12 credits.
- The internship would be assigned to the student by the Departmental Internship Coordinator, with the approval of Head, Chemical Engineering Department.
- The total duration of the internship would be for a period equivalent to 12 Calendar weeks. The internship may be completed in one or more organizations as described below.
- The internship could be of the following forms:
- 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.
- 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 Chemical Engineering Department.
- Students will be assigned a grade based on the written report and a presentation; evaluated by a committee of faculty members.
- Feedback will be taken from Industry mentors and this will used while assigning the grades.

BSC: Basic Science Course,
ESC: Engineering Science Course
PCC: Program Core Course, PEC: Program Elective Course
MDM: Multi-disciplinary Minor: Different discipline of engineering or different faculty altogether
OE: Open Elective: To be chosen Compulsorily from faculty other than major discipline
VSEC: Vocational and Skill Enhancement Course: Hands on training corresponding to major/minor
AEC: Ability Enhancement Course: English 2 credit, Modern Indian Language 2 credit
IKS: Indian Knowledge System: Indian Architecture/Maths/Medicine
VEC: Value Education Course: e.g. Understanding India, Environmental Science / Education / Digital and Tech solutions
RM: Research Methodology
CCA: Co-curricular activities: Health and wellness / Yoga / Sports / Cultural activities / NSS/NCC/Applied visual performing arts

EXIT Policy

Based on the National Education Policy guidelines, the students have an option of exiting at each level of their four year program. Student will get certificate after 1st year, diploma after second year and B.Sc (Tech/Engg) after third year.

Sr. No.	Exit Year	Activity	Credits	Duration (No of Weeks)
1	1st Year (After Semester II)	8 credit course workshop/chemistry lab (after semester 2)	8	8 weeks
2	2nd Year (After Semester IV)	Certificate Course in Practice of Chemical Technology (CCPCT)	8	8 weeks
3	3rd Year (After Semester VI)	In-plant training	8	8 weeks

Semester-I

BSC	Course Code: CHT1405	Course Title: Physical Chemistry	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 , other multidisciplinary courses on Chemistry / Chemical Engineering.

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	**Laws of thermodynamics** – a) Enthalpy and heat capacities, application of first law to gases, thermochemistry- Hess law b) 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 c) Third law of thermodynamics, absolute entropies, verification of third law	6
2	**Spontaneous process and equilibrium** –Helmholtz and Gibbs free energy, spontaneity and free energy, Maxwell's relations, effect of T and P on free energy,	3
3	**Multicomponent system –** free energy and entropy of mixing, partial molar quantities and chemical potential, Gibbs Duhem equation	6
4	**Equilibrium in solutions –** ideal and non ideal solutions, Henry's law and Raoult's law, colligative properties, activity and activity coefficients, thermodynamic properties of electrolytes in solution	7
5	**Solubility equilibria** – solubility constant, common ion effect, effect of added salts on solubility pH, weak and strong acids and bases, buffer solutions, ionic solutions **Chemical Equilibria –** le Chaterlier's principle, Effect of temperature, pressure and composition on equilibrium	5
6	**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
7	**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
8	**Homogenous catalysis** – homogeneous acid / base catalysis (specific and general acid catalysis), enzyme catalysis (Michelis Menten kinetics)	6
9	**Reactions at interface –** Adsorption isotherms, kinetics of surface reactions- Hishelwood and Rideal models of surface reactions	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	Elements of Physical Chemistry (7th edition) by P. W. Atkins and J. de Paula, Oxford University Press, 2016.

3	Chemical Kinetics (3rd edition) by Keith J. Laidler, New York : Harper & Row, 1987.
Course Outcomes (Students will be able to…..)	
CO1	*Elements of Physical Chemistry* (7th edition) by P. W. Atkins and J. de Paula, Oxford University Press, 2016.
CO2	*Physical Chemistry* (6th edition) by Ira Levine, McGraw-Hill Education, 2009
CO3	Elucidate the effect of thermodynamic quantities on chemical equilibria and relate it to properties of chemical systems
CO4	Comprehend fundamental knowledge in chemical kinetics with basics of order, molecularity and temperature effect
CO5	Examine kinetics for complex, fast as well as surface reactions and comprehend different theories in kinetics

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

BSC	**Course Code:** CHT1406	**Course Title:** **Analytical Chemistry**	**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 , 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	5
2	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 - Infrared spectroscopy - fluorescence spectroscopy	8
5	**Electrochemical methods:** General principle, instrumentation and applications of - Conductometry - Potentiometry	8
6	**Chromatographic methods:** General principle, instrumentation and applications of - Gas chromatography (GC) - HPLC	10

	Total	45
	List of Textbooks/Reference Books	
1	David Harvey. Modern Analytical Chemistry; McGraw-Hill (1999)	
2	R. A. Day and A. L. Underwood. Quantitative Analysis, Prentice Hall of India (2001)	
3	H. H. Willard, L. L. Merritt, J. A. Dean and F. A. Settle. Instrumental Methods of Analysis, 7th ed.; Wadsworth Publishing, USA (2004)	
4	D. A. Skoog, D. M. West, F. James Holler and S. R. Crouch. Fundamentals of Analytical Chemistry; 9th ed.; Cengage Learning (2013)	
5	D. A. Skoog, F. James Holler and S. R. Crouch. Principles of Instrumental Analysis; 6th ed.; Cengage Learning (2016)	
	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	Understand the principles of chromatographic separations. (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; P, Psychomotor domain

ECS	**Course Code: MAT 1301**	**Course Title: Engineering Mathematics**	**Credits = 3**		
			L	**T**	**P**
	Semester: I	**Total contact hours: 45**	**2**	**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	
This is a basic Mathematics course which will give the students the required foundations of mathematics to understand engineering concepts in the later part of the technology programs in ICT Mumbai. This course will also introduce probability distributions and basic statistics will be helpful to understand various data science studies in different engineering disciplines.	

	Course Contents (Topics and subtopics)	**Required Hours**
1	**Linear Algebra:** Vectors in $\mathbb{R}^n$, notion of linear independence and dependence. $\mathbb{R}^n$ as a vector space, vector subspaces of $\mathbb{R}^n$, basis of a vector subspace, row space, null space, and column space, rank of a matrix. Determinants and rank of matrices. Linear transformations in $\mathbb{R}^n$, 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 square methods, Diagonalization of matrices and its applications to stochastic matrices	15
2	**Differential Calculus:** Higher order differentiation and Leibnitz Rule for the derivative, Taylor's and Maclaurin's theorems, Maxima/Minima, convexity of functions and applications.	15

	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, Method of Lagrange Multipliers, Introduction to double and triple integrals.	
3	**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	**45**

List of Textbooks/ Reference Books	
1	G. Strang, Linear Algebra and its Applications (4th Edition), Thomson (2006).
2	Howard Anton, Elementary Linear Algebra, John Wiley & Sons (2016)
3	Stewart, James, Single Variable Calculus, 6th Edition, Cenage learning (2016)
4	Hughes-Hallett et al., Calculus - Single and Multivariable (3rd Edition), John-Wiley and Sons (2003).
5	E. Kreyszig, Advanced Engineering Mathematics (8th Edition), John Wiley (1999). (Officially prescribed)
6	S. R. K. Iyengar, R. K. Jain, Advanced Engineering Mathematics Narosa, (2020)
7	A First Course in Probability, Sheldon Ross, Pearson Prentice Hall, 9th Edition (2018)
8	W.W. Hines, D. C. Montgomery, D.M. Goldsman, John-Wiely, Probability and Statistics in Engineering, John Wiley & Sons (2008)
9	Alexander M. Mood, Duane C. Boes, and Franklin A. Graybill, Introduction to the Theory of Statistics, Mc GrawHill, (1973)

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.	K2, K3
CO2	Understand the computational and geometrical concepts related to linear transformations, eigenvalues and eigenvectors and apply them to solve computational problems	K1, K2, K3
CO3	Demonstrate understanding of different concepts in linear algebra in solving computational problems related to vectors and matrices and apply them to solve problems arising the Engineering especially in AI and ML.	K2, K3, K5
CO4	Understand the concepts of various probability distributions and apply them to analyze various engineering problems and make inference about the system	K2, K3, K4
CO5	Understand the method of linear and nonlinear least squares method and apply it to choose appropriate mathematical functions for modelling real data sets, arising from engineering disciplines	K3, K4, K5

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

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1												
CO2												
CO3												
CO4												
CO5												

BSC	Course Code: PYT1205	Course Title: Applied Physics	Credits = 2		
			L	T	P
	Semester: I	Total contact hours: 30	2	0	0

Course Outcomes (students will be able to…)	
1	Assign Miller indices to various crystallographic planes and directions in a crystal lattice, thereby understand periodicity in the crystal lattice.
2	Analyze a given x-ray diffraction pattern to deduce the crystal structure of the material and calculate the values of the basic structural parameters.
3	Classify solids, and in turn semiconductors, based on electron occupancy and calculate basic quantities related to charge transport in them.
4	Analyze simple ideal fluid flows by applying the continuity equation and Bernoulli's equation.
5	Describe the basic behaviour of viscous flows and the relationships between various flow parameters.
6	Understand simple models that are used to describe viscoelastic flows.
List of Prerequisite Courses	
1	Standard XI and XII Physics course
2	Standard XII Chemistry course
List of Courses where this course will be prerequisite	
1	Applied Physics Laboratory (Sem-II)
2	Materials Science Minor program courses (Sem-III, IV, V, VI, VII, VIII)
3	Open Elective courses from Physics Department (Sem-II, IV, V)

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

The physics of solids and fluids play a key role in the various areas of chemical technology. The Applied Physics course will provide the students with the necessary fundamentals to develop a broad understanding of various aspects related to solids and fluids, and thereby equip them with the ability to apply it wherever required in their course of study.

	Course Contents (Topics and subtopics)	Reqd. hours
	Solid State Physics	
1	Crystal Structure of Solids: A revision of concepts of a lattice, a basis, unit cell, different crystal systems (SC, BCC, FCC, HCP), co-ordination number and packing fractions. Single crystalline, Polycrystalline, and Amorphous materials.	3
2	Crystallographic planes and directions: concept of Miller indices and its determination, examples; calculation of inter-planar spacing in terms of Miller indices.	3
3	Determination of crystal structure using X-rays: Bragg's law of X-ray diffraction, types of diffractometers, Indexing diffraction peaks and calculation of various lattice parameters and crystallite size	4
4	Energy band in solids and classification of solids, the concept of Fermi level and Fermi distribution function, Intrinsic and extrinsic semiconductors, Transport properties of semiconductors: Conductivity in semiconductors and its dependence of carrier concentration and mobility.	5
	Physics of Fluids	
5	A revision of the basic concepts of hydrostatics and ideal fluid flow: Equation of continuity and Bernoulli's equation.	4
6	The concept of viscosity, Newton's law of viscosity, Reynold's number, Poiseuille's equation for streamline flows	4
6	An introduction to Rheology: Parameters of viscous flows, Newtonian and non-Newtonian behaviour, Variation of viscosity with shear rate, shear time, temperature, and pressure (qualitative ideas with illustrative examples), measuring properties of viscous flows. The concept of viscoelasticity, Maxwell and Kelvin models of relaxation, relaxation spectrum, creep testing.	7
	Total	**30**

List of Textbooks/Reference books	
1	Fundamentals of Physics – Halliday, Resnick, Walker – 6th Edition – John Wiley
2	Sears and Zeemansky's University Physics – Young and Freedman – 12th Edition – Pearson Education
3	A Textbook of Engineering Physics – M N Avadhanulu, P G Kshirsagar, TVS Arun Murthy – 11th Edition – S. Chand Publishers
4	Solid State Physics – S. O. Pillai – 10th Edition – New Age Publishers
5	Solid State Physics – A. J. Dekker – MacMillan India
6	Engineering Physics – V Rajendran – 6th Edition – McGraw Hill Publishers

7	Introduction to Rheology – H. A. Barnes, J. F. Hutton and K. Walters – 4th Edition – Elsevier Science.
8	Viscoelastic Properties of Polymers – J. D. Ferry – 3rd Edition – Wiley

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	Introduced to 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; P, Psychomotor domain

VSEC	**Course Code:** GET1305	**Course Title:** Engineering Graphics and Computer Aided Drawing	**Credits = 3**		
			L	**T**	**P**
	Semester: I	**Total Contact Hours: 75**	**1**	**0**	**4**

List of Prerequisite Courses

Mathematics, Geometry, basic drawing and visualization

List of Courses where this course will be prerequisite

Industrial drawing, Equipment Design, Manufacturing and designing of any component, industrial 3D product modelling etc.

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

Drawing is a language used by engineers and technologists. A student is required to know the various processes and the equipment used to carry out the processes. Some of the elementary areas like product sizing, manufacturing etc., are very common to all the branches of technology. These and many other processes require machines and equipment's. 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 various 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. This course is required in many subjects as well as later in the professional career.

	Course Contents (Topics and Subtopics)	**Required Hours**
1	**Orthographic projections**: Introduction, Principles of Projection, Methods of Projection, Planes of projection, Quadrants, First-angle method of projection, Third-angle method of projection, and concept of orthographic projections.	20
2	**Sectional Projections and Missing Views**: Need for the drawing sectional views, concept of sectioning and section lines, Sectional drawings of different solids and machine components, Auxiliary planes, and views. **Missing Views**: Concept of recognizing missing views and their interpretation, drawing of missing views from given orthographic drawings.	15
3	**Isometric projections**: Concept of isometric views, isometric projections and isometric scale, Iso metric projections of different solids and machine components	15
4	**Computer Aided Drafting and Assembly drawing**: Basic introduction to CAD softwares, Design and Development of new products, Application of CAD, 2D, 3D part modelling on softwares, drawing modification and dimensioning, modelling of different machine components. Basics of Assembly drawing, preparation of 2D, 3D components and assembling on CAD software, conversions, labelling and table creation for bill of materials.	25
	Total	**75**

List of Textbooks/Reference Books	
1	Engineering Drawing by N.D.Bhat
2	Engineering Drawing by N.H.Dubey
3	CAD/CAM: Theory and Practice by Ibrahim Zeid and R Sivasubramanian
Course Outcomes (Students will be able to…..)	
CO1	Draw Orthographic and Sectional Orthographic Views from Pictorial View 2 Draw isometric view when Front View and either top view or side view is given. 3 Understand basics of Assembly Drawing 4 Understand basics of CAD and Prepare 2D,3D drawings using CAD.
CO2	Draw Orthographic and Sectional Orthographic Views from Pictorial View 2 Draw isometric view when Front View and either top view or side view is given. 3 Understand basics of Assembly Drawing 4 Understand basics of CAD and Prepare 2D,3D drawings using CAD.
CO3	Draw Orthographic and Sectional Orthographic Views from Pictorial View 2 Draw isometric view when Front View and either top view or side view is given. 3 Understand basics of Assembly Drawing 4 Understand basics of CAD and Prepare 2D,3D drawings using CAD.
CO4	Draw Orthographic and Sectional Orthographic Views from Pictorial View 2 Draw isometric view when Front View and either top view or side view is given. 3 Understand basics of Assembly Drawing 4 Understand basics of CAD and Prepare 2D,3D drawings using CAD.

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
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; P, Psychomotor domain

ESC	**Course Code:**	**Course Title:**	**Credits = 2**		
	DYT1011	**SPL1: A Primer on Technology of Intermediates and Dyestuffs**	**L**	**T**	**P**
	Semester: I	**Total Contact Hours: 30**	**1**	**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	05
2	Chemistry of Benzenoid intermediates- **a.** Electrophilic aromatic substitution reaction **b.** Orientation in aromatic substitutions	05
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	05

	(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	05
5	**Chemistry: Naphthalene intermediates** **a.** Synthesis of naphthalene **b.** Substitution pattern **c.** Reactions possible and criterion for the same	05
6	Technology and Reactions of naphthalene **a.** Nitration **b.** Sulphonation **c.** Halogenation **d.** Reduction (Key points are similar to benzene)	05
	Total	**30**

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**	**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
CO5	K3	3	2	2	0	2	3	3	3	1	3	0	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; P, Psychomotor domain

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

List of Prerequisite Courses

Applied Physics

List of Courses where this course will be prerequisite

Independently set up, handle, and use basic setups to measure and obtain various physical quantities. Use basic instruments like vernier-caliper, screw-gauge, travelling microscope, thermometer, etc. to make accurate measurements. Correlate and use directly measured quantities to obtain the relevant parameters through appropriate formulae, calculations, and/or graphical plotting, thereby understand the measurement principle involved in the experimental setups. Preliminarily treat the obtained datasets statistically to obtain errors in the experiments.

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

The hands-on experience gained by the students in the Applied Physics laboratory course will equip them with basic experimental skills related to measurement of various important physical quantities. These skills will act as a useful foundation for other laboratory and theory courses in their area of specialization.

Sr. No.	**Course Contents (Topics and Subtopics)**	**Required Hours**
1	Determination of Co-efficient of Viscosity by Poiseuille's method	5
2	Thermistor characteristics: Determination of Bandgap of a semiconductor	6
3	Determination of compressibility of liquids using an Ultrasonic Interferometer	5
4	Measurement of thermal conductivity of a solid: Lee's disc method	6
5	Photoelectric effect: Determination of h/e	5
6	Hall effect: Determination of carrier type and concentration in a semiconductor	6
7	Newton's rings: Determination of wavelength of light	5
8	Laser Diffraction: Determination of particle size	8
9	Determination of Co-efficient of Viscosity by Poiseuille's method	8
10	Thermistor characteristics: Determination of Bandgap of a semiconductor	6
Total		**60**

List of Text Books/ Reference Books

1	Fundamentals of Physics - Halliday, Resnick, Walker - 6th Edition - John Wiley
2	Sears and Zeemansky's University Physics - Young and Freedman - 12th Edition - Pearson Education
3	A Textbook of Engineering Physics - M N Avadhanulu, P G Kshirsagar, TVS Arun Murthy - 11th Edition - S. Chand Publishers
4	Engineering Physics - V Rajendran - 6th Edition - McGraw Hill Publishers
5	Concepts of Modern Physics - A. Beiser, McGraw-Hill.
6	Ultrasonics: Methods and Applications - J. Blitz, Butterworth.
7	Optics - Ajoy Ghatak - 7th Edition - McGraw Hill
8	Fundamentals of Optics - F. Jenkins and H. White - 4th Edition McGraw Hill
9	ICT Physics Laboratory Manual (supplied to students)

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

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

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

AEC	**Course Code: HUT1110B**	**Course Title: Communication Skills-English**	**Credits = 2**		
			L	**T**	**P**
	Semester: I	**Total Contact Hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses

Standard XIIth English

List of Courses where this course will be prerequisite

All courses in this and subsequent semesters

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 Technologist. 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; 0, No Contribution

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

Semester-II

BSC	Course Code: CHT1407	Course Title: Organic Chemistry	Credits = 3		
			L	T	P
	Semester: II	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, Biochemistry and several Special Subjects of Chemical Technology 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	**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**
2	**Aromatic Substitution Reactions** **A) Electrophilic 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. **B) Nucleophilic Substitution Reactions** Addition and elimination mechanism, Benzyne mechanism, Sandmeyer reaction.	**10**
3	**Heteroaromatic Compounds** IUPAC nomenclature, structures and common names, comparison with benzenoid compounds, reactivity and synthesis – pyrroles, furans, thiophenes and pyridines	**8**
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	**10**
6	**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**
	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	be well versed with aromatic chemistry and interpret the outcome of general transformations (K3).
CO3	Understand the importance of heterocycles, learn the properties and synthetic routes, interpret the 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).
CO5	Appreciate the stereo-chemical implications of organic compounds and visualize and appreciate the chirality concept (K2).
CO6	Understand organic chemistry reactions related to aliphatic as well as aromatic compounds as well as decipher the outcome of a given organic transformation (K3).
CO7	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	0	2	1	3	3	2	3	3	3	1	3	2
CO2	K2	3	2	0	1	0	3	3	1	2	3	2	0	3	2
CO3	K3	3	3	1	2	2	3	1	3	3	2	3	2	3	3
CO4	K4	3	3	1	3	2	3	2	3	2	3	3	2	3	3
CO5	K4	3	3	1	3	2	3	2	3	2	3	3	2	3	3
CO6	K4	3	3	1	3	2	3	2	3	2	3	3	2	3	3
CO7	K4	3	3	1	3	2	3	2	3	2	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; P, Psychomotor domain

BSC	Course Code: CHT1408	Course Title: Industrial Chemistry	Credits = 3		
			L	T	P
	Semester: II	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, Environment Science and Technology

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 Chemical Industry: Bulk chemicals, fine chemicals, intermediates, active pharmaceutical ingredients (API), etc.	**3**
2	Petrochemical Industry: operations and processes in manufacture of ethers, hydrocarbons, aromatic compounds, etc.	**6**
3	PRIMARY INORGANIC MATERIALS: Water, Hydrogen, Hydrogen Peroxide and Inorganic Peroxo Compounds, Nitrogen and Nitrogen Compounds, Phosphorus and its Compounds, Sulfur and Sulfur Compounds, Halogens and Halogen Compounds,	**8**
4	MINERAL FERTILIZERS: Phosphorus-Containing Fertilizers, Nitrogen-Containing Fertilizers, Potassium-Containing Fertilizers	**4**
5	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	8
6	ORGANIC BULK CHEMICALS: Manufacture of methanol, acetic acid, ethanol, ethylene, propylene, butadiene, acetaldehyde, acetylene, BTX, alkyl benzenes, acetone, phenol, styrene, esters, ethylene oxide, phthalic acid, Vinyl-Halogen and Vinyl-Oxygen Compounds, azo dyes, Polyamides, Propene Conversion Products, Aromatics - Production and Oxidation Products of Xylene and Naphthalene	**8**
7	Important pharmaceutically active ingredients, agrochemicals, insecticides, pesticides, perfumery chemicals.	**8**
	Total	**45**

List of Text Books/ Reference Books

1	Industrial Organic Chemistry, 3rd, Completely Revised Edition, Klaus Weissermel, Hans-Jürgen Arpe ISBN: 978-3-527-61459-2 July 2008.
2	Industrial Inorganic Chemistry, 2nd Completely Revised Edition, Karl Heinz Buchel, Hans-Heinrich Moretto, Dietmar Werner, ISBN: 978-3-527-61333-5, 667 pages, November 2008, Wiley-VCH.
3	Inorganic Chemistry – an industrial and environmental perspective, T.W. Swaddle, ISBN 0-12- 678550-3 , 482 pages, Academic Press

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

CO1	Understand the important of chemical principles applied to various industrial processes
CO2	Describe the fundamental processes underlying manufacture of important organic and inorganic chemicals
CO3	Review and assess the impact of the chemical factors on the efficiency of industries and feedstock manufacturing

CO4	Modify existing applications for improving the efficiencies in terms of yields, energy requirement and environmental impact

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; P, Psychomotor domain

PCC	**Course Code:** **DYT1021**	**Course Title:** **SPL2: Physical and Chemical Constitution of Colorants**	**Credits = 2**		
			L	**T**	**P**
	Semester: II	**Total Contact Hours: 30**	**1**	**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.	02
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	02
3	Resonance theory of color, failures of resonance theory. Steric effects in electronic absorption spectra – some general considerations.	02
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	02
5	Simple donor-acceptor chromogens: general characteristics – donor group, unsaturated bridge, acceptor group. The carbonyl acceptor – merocyanine types of compounds.	02

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	02
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.	02
8	Di- and triaryl methane colorants, heterocyclic analogues of di- and triaryl methane colorants. Simple color and constitution relationships.	02
9	Essentials of computational colour chemistry – brief introduction to one particle system. Schrodinger equation. Particle in a box.	02
10	Two particle system, Many particle systems – HartreeFock theory. Basis sets.	02
11	Electronic Structure theory. Molecular orbitals and light absorption. Semiempirical methods,	02
12	Limitations of HartreeFock method, Computational complexities in post HartreeFock (wavefunction based methods).	02
13	Introduction to Density Functional Theory and its application in colour chemistry	02
14	Excited State calculations, Configuration Interaction Singles.	02
15	Time Dependent Density Functional Theory.	02
	Total	**30**

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	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	2	2	0	3	3	3	3	3	3	2	3	3

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

ESC	**Course Code:** **GET1306**	**Course Title:** **Basic Mechanical Engineering**	**Credits = 2**		
			L	**T**	**P**
	Semester: II	**Total Contact Hours: 30**	**1**	**1**	**0**

List of Prerequisite Courses

Physics, Basic Mathematics

List of Courses where this course will be Prerequisite

Energy Engineering, Unit Operations, Mechanical design of chemical equipments

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

Students will be able to understand various equipments like steam turbine, gas turbine, pumps, compressors, and power transmission system.

Sr. No.	**Course Contents (Topics and subtopics)**	**Required Hours**
1	**Introduction- Concept of Stress**: Condition of Equilibrium for concurrent coplanar and non-concurrent coplanar forces. Deformation in solids- Hooke's law, stress and strain- tension, compression and shear stresses, Stress Strain Diagram, elastic constants and their relations volumetric, linear and shear strains.	6
2	**Introduction to Thermodynamics**: First Law of Thermodynamics, Steady-flow energy equation, Second Law of Thermodynamics	4
3	**Basics of Power Station** -Steam Generators Fire tube and Water tube boiler, Low pressure, and high-pressure boilers, Mountings and accessories, Boiler efficiency -Steam Turbines Working principle of steam, gas and water turbines, Concept of impulse and reaction steam turbines. -Compressors/Pumps Different Types of Compressors and their applications, Different Types of Pumps, and their applications	8
4	**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 numerical)	4
5	**Refrigeration and Air-conditioning** Vapour compression refrigeration cycle, Vapour absorption refrigeration systems, Properties of air such as DBT, WBT, DPT, relative humidity, Psychometric chart.	4
6	**Renewable Energy** Role and importance of non-conventional and alternate energy sources such as solar, wind, ocean, bio-mass and geothermal, hydrogen energy	4
	Total	**30**

List of Text Books/ Reference Books

1	Strength of Materials by S. Ramamrutham, Dhanpat Rai Pvt. Ltd
2	Thermodynamics by P.K. Nag
3	Power plant by Morse
4	Heat Engines by P.L. Balani
5	Hydraulic Machines by Jagdish Lal
6	Renewable Energy resources by Tiwari and ghosal, Narosa publication.
7	Non-conventional energy sources, Khanna publications
8	Refrigeration and air conditioning by C.P. Arora
9	Theory of Machines by Rattan. S.S
10	Gas turbine theory by HiH Saravanamutoo

Course Outcomes (Students will be able to…..)	
CO1	Understand different types of stresses and their effects on bodies. (K2)
CO2	Describe the working of steam boilers, mountings, and accessories. (K2)
CO3	Explain the working principles of power developing systems such as steam turbines, gas turbines and internal combustion engines. (K2)
CO4	Describe the working principle of vapour compression and vapour absorption refrigeration systems. (K2)
CO5	Discuss different types of power transmission systems and their typical applications. (K2)
CO6	Explain the working principles of power absorbing devices such as pumps and compressors. (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
CO5	K2	3	2	1	2	0	3	3	2	3	3	3	1	3	2
CO6	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; 0, No Contribution

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

ESC	Course Code: GET1125	Course Title: Electrical Engineering and Electronics	Credits = 2		
			L	T	P
	Semester: II	Total Contact Hours: 30	1	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 the basics of electricity, selection of different types of drives for a given application process. They will get basic knowledge as regards to Power supplies, instrumentation amplifiers and thyristor application in industries.

Sr. No.	Course Contents (Topics and Subtopics)	Required Hours
1	**Fundamentals of DC Circuits** Voltage and Current Sources, Basic Laws, Network Theorems, Superposition Theorem and Thevenin's Theorem,	4
2	**AC Fundamentals:** A.C. through resistance, inductance and capacitance, simple RL, RC and RLC circuits. Power, power factor	4
3	**Three Phase Systems**: Three phase system of emfs and currents, Star and Delta connections, three phase power	5
4	**Single phase transformers**: Principle of working, Efficiency, regulation.	5
5	**Electrical drives**: Basic concepts of different types of Electrical motors as drives, Their suitability for various applications.	5
6	**Regulated power supplies**, Diodes as rectifiers, Half wave and Full wave rectifier, Filters and Regulators	5
7	**Bipolar junction transistors**: Different configurations, Characteristics, Concept of basic amplifier circuits, Amplifier gain, Transistor as switch	3
8	**Introduction to Integrated circuits:** Basic concepts of ICs	2
9	**Introduction to data acquisition and signal conditioning,** Basic concept and Block diagram, Concept of conversion of physical quantity to electrical signal, signal conditioning, Introduction to A/D and D/A converters	3
10	**Introduction to instrumentation amplifiers and their applications** Operational Amplifier – Notation, Pin diagram, Differential and common mode gain, CMRR, Introduction to various applications such as Non-inverting, inverting amplifiers, adder,subtractor, integrator, differentiator,	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 Technology by B.L.Theraja, A.K.Theraja vol I,II,IV

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

CO1	understand the basic concepts of D.C circuits. Solve basic electrical circuit problems.(K3)
CO2	understand the basic concepts of single phase and three phase AC supply and circuits.(K2)
CO3	understand the basic concepts of transformers and motors used as various industrial drives.(K2)
CO4	understand 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

ESC	**Course Code: CEP1720**	**Course Title: Process Calculations**	**Credits = 2**		
			L	**T**	**P**
	Semester: II	**Total contact hours: 60**	**0**	**0**	**4**
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.				
Description of relevance of this course in the B. Tech. Program					
This is a basic course. This knowledge will be required in almost all subjects later. 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					

Sr. No.	**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	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		
	Elementary Principles of Chemical Processes, Felder, R.M. and Rousseau,	
	Chemical Process Principles, Hougen O.A., Watson K. M.	
	Basic Principles and Calculations in Chemical Engineering, Himmelblau,	

	Stoichiometry, Bhatt B.I. and Vora S.M.	
Course Outcomes (students will be able to…..)		
1	Students will be able to convert units of simple quantities from one set of units to another set of units	
2	Students will be able to calculate quantities and /or compositions, energy usages, etc. in various processes and process equipment such as reactors, filters, dryers, etc.	

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
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; P, Psychomotor domain

BSC	**Course Code:** **CHP1343**	**Course Title:** **Physical and Analytical Chemistry Laboratory**	**Credits = 2**		
			L	**T**	**P**
	Semester: II	**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	(8 to 10 experiments will be conducted from following list) **1.** To determine the total hardness of given water sample **2.** To determine the dissociation constants of a polybasic acid using pH meter **3.** To determine pKa of the given weak acid by potentiometric titration **4.** To determine the critical micelle concentration (CMC) of the given surfactant by surface tension measurement using a stalagmometer **5.** To determine the normality and volume of weak acid and strong acid in the given mixture using conductometric titration **6.** To determine the rate constant of hydrolysis of an ester catalyzed by an acid **7.** To study the kinetics of the reaction between K2S2O8 and KI and hence, determine rate of the reaction **8.** To verify Beer – Lambert's Law **9.** To determine the equivalent conductance of strong electrolyte at infinite dilution and verify Ostwald's law of dilution, for dissociation of weak electrolyte **10.** To determine the molecular weight of the given polymer by viscosity measurements **11.** To determine the vitamin C concentration from the given tablet sample by titration **12.** Demo of Gas chromatography and FT-IR.	4h per practical
	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 reaction rate parameters
CO2	List simple methods of chemical analysis
CO3	Determination of physic chemical parameters using simple laboratory tools

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
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

VSEC	**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; P, Psychomotor domain

Semester-III

PCC	Course Code DYT1031	**Course Title:** **SPL3: Technology of Benzenoid Intermediates**		Credits = 4		
				L	T	P
	Semester - III	Total Contacts hours = 60		3	1	0
	Description of Relevance To make the students understand chemistry various intermediates used for the chemical industry in general and the 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 methods and choose accordingly the further processes to make intermediates. • To develop in them capacity to understand proper selection of chemical processes based on economic and ecological aspects					
		Statement	Level	Method	Hours	
	Chemistry of Benzenoid intermediates **a.** Electrophilic aromatic substitution reaction **b.** Orientation in aromatic substitutions	C1, C5	K1, K2	Marker and Board	04	
	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	C2, C3, C5	K4, K5	Marker and Board, Projector	16	

	(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				
	Unit Processes: a. Friedel Craft's Reaction b. Oxidation c. Ammonolysis d. Hydrolysis e. Diazotization and coupling				30
	Active Methylene compounds				6
	Technology and safety aspects				2
	Separation techniques and agitation system				2

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	2	2	2	3	3	3	3	1	3	2	3	3
CO2	K4	3	2	2	3	3	2	3	3	2	3	2	2	3	2
CO3	K4	3	1	0	2	1	3	2	2	3	3	3	1	2	3
CO4	K3	3	3	2	1	1	2	3	3	3	2	0	2	1	2
CO5	K2	3	2	2	3	2	3	3	2	2	3	3	2	3	3
Course	K3	3	3	3	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; P, Psychomotor domain

PCC	Course Code: DYT1041	Course Title: SPL4: Quinonoid Intermediates - Chemistry and Technology	Credits = 2		
			L	T	P
	Semester: III	Total Contact Hours: 30	1	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	10
2	Synthesis of Anthraquinone and anthraquinone derivatives	10
3	Reactions of Anthraquinone: Sulphonation, Nitration, Halogenation, Bucherer Reaction	10
	Total	**30**

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

EEM	**Course Code: HUT1205**	**Course Title:** **Basic Economics and Finance**	**Credits = 2**		
			L	**T**	**P**
	Semester: III	**Total Contact Hours: 30**	**2**	**0**	**0**
List of Prerequisite Courses					
Course Outcomes (students will be able to…..)					
1	Students will be able to know and apply accounting and finance theory.				
2	Students will be able to understand the mechanics of preparation of financial statements, their analysis and interpretation				
3	Students will be able to explain basic economic terms, concepts, and theories				
4	Students will be able to identify key macroeconomic indicators				
List of Prerequisite Courses					
	MATHS-1 AND MATHS -2 OF FIRST YEAR COURSEWORK				
List of Courses where this course will be prerequisite					
	PROJECT ECONOMICS **FUNDAMENTALS OF MARKETING MANAGEMENT AND MARKET RESEARCH**				
Description of relevance of this course in the BACHELOR'S Program					
	Course Contents (Topics and subtopics)		**Reqd. hours**		
1	INTRODUCTION Explaining the Economy		3		

	The Supply and Demand Model Using the Supply and Demand Model	
2	THE COMPETITIVE EQUILIBRIUM MODEL Deriving Demand Deriving Supply Market Equilibrium and Efficiency	5
3	DEVIATIONS FROM COMPETITION Monopoly and Market Power Between Monopoly and Competition Antitrust Policy and Regulation	5
4	MACRO FACTS AND MEASURES Getting Started with Macroeconomic Ideas Measuring Production, Income and Spending of Nations	5
5	ACCOUNTING TRANSACTIONS Journal entries Debit credit rules Compound journal entry Journal and ledger Rules of posting entries Trial balance	5
6	CAPITAL AND REVENUE Income and expenditure Expired costs and income Final accounts Manufacturing accounts Trading accounts Profit and Loss account Suspense account Balance sheet	5
7	CONCEPT OF DEPRECIATION	2
List of Textbooks		
	Finance and Accounting for Nonfinancial Managers: All the Basics You Need to Know -William G. Droms and Jay O. Wright	

	Microeconomics: Basic Principles and Applications- A A Temu, D W Ndyetabula, et al PRINCIPLES OF ECONOMICS(12e)- E. Case Karl, C. Fair Ray, et al	
List of Additional Reading Material / Reference Books		
	Basic Finance for Nonfinancial Managers: A Guide to Finance and Accounting Principles for Nonfinancial Managers- Kendrick Fernandez Microeconomic Theory: Basic Principles and Extensions- Walter Nicholson and Christopher Snyder Macroeconomics(10e) Part of: Pearson Series in Economics (23 books) - by Froyen	

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
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; P, Psychomotor domain

PCC	Course Code: DYP1111	Course Title: Pr1: Analysis of Inorganic Raw Materials used in Colorant Industries	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

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)														
		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	K4	3	2	1	2	0	3	3	3	3	3	3	1	3	2
CO2	K4	3	2	1	3	1	3	3	2	2	1	3	0	3	3
CO3	K4	3	3	3	2	1	2	3	0	3	2	3	2	2	3
CO4	K3	3	2	1	2	0	3	3	3	3	3	2	1	3	2
Course	K4	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; P, Psychomotor domain

PCC	**Course Code:** DYP1121	**Course Title:** Pr2: Chromatographic Methods and Analysis	**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
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	K4	3	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K4	3	2	0	3	1	3	3	1	2	3	2	1	3	3
CO3	K4	3	3	3	2	2	1	3	3	3	2	3	2	2	2
CO4	K3	3	2	1	2	1	3	3	3	3	0	2	1	3	2
Course	K4	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; P, Psychomotor domain

Semester-IV

PCC	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, and fluid moving machinery such as pumps.	10
3	Particle Dynamics, Flow through Fixed and Fluidised 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 transfercoefficient.	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	Students should be able to calculate friction factor, pressure drop, power requirements of singe phase flow in a circular pipe
CO2	Students will be able to calculate flow and power required for pumps
CO3	Students should be able to calculate heat transfer coefficients and do basicsizing of double pipe and shell and tube heat exchangers
CO4	Students should be able to calculate mass transfer coefficients and estimatemass transfer rates in simple situations

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

PCC	Course Code DYT1051	**Course Title:** **SPL5: TECHNOLOGY OF NAPHTHALENE INTERMEDIATES**		Credits = 4		
				L	T	P
	Semester - IV	Total Contacts hours = 60		3	1	0
	Description of Relevance To make the students understand chemistry various intermediates used for the chemical industry in general and the 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 methods and choose accordingly the further processes to make intermediates. • To develop in them capacity to understand proper selection of chemical processes based on economic and ecological aspects					
		Statement	Level	Method	Hours	
1	Chemistry of Naphthalene **a.** Synthesis of naphthalene **b** Raw materials **c**. Mechanism	C1, C2	K1, K2	Marker and Board	04	
2	Introduction of Functional groups into Naphthalene and relevant 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 Naphthalene and substituted Naphthalene** (v) Plant and process flow (vi) Safety and process control parameters **C. Nitration:**	C2, C3, C5	K4, K5	Marker and Board, Projector	16	

	(i) Reaction phenomenon and conditions (ii) Nitrating agents and solvents (iii) Work up and Material of construction (iv) Substitution in **Naphthalene** and substituted **Naphthalene** (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 **Naphthalene** and Substituent **Naphthalene** (iv) Process and workup (v) Safety aspect **E. Halogenation** (i) Basic nucleophilic and Electrophilic substitution (ii) Reaction and MOC				
3	Unit Processes: a. Friedel Craft's Reaction b. Oxidation c. Ammonolysis d. Hydrolysis e. Diazotization and coupling f. Bucherer Reaction, Reverse 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				30

	(ii) Radical Reaction (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				
4	Synthesis of naphthol, naphthylamine sulphonic acids, Bon acid and its derivatives	C2, C4	K4, K5	Marker and Board, Projector	8
5	Case studies Commercially important bulk and specialty intermediates synthesis	C1, C4	K2, K3	Marker and Board, Ball and stick model	08
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,	C4, C5	K4	Marker and Board, Projector	04

	separation techniques: (a) Physical method (b) Chemical method				

Course Outcomes (students will be able…..)

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

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

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	K4	3	2	1	2	1	3	1	3	3	1	3	1	3	2
CO2	K3	3	3	2	2	2	1	3	3	3	3	2	2	3	3
CO3	K4	3	3	1	3	2	2	3	2	0	3	3	0	3	3
CO4	K4	3	0	3	3	3	3	2	3	3	2	3	3	2	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; P, Psychomotor domain

PCC	Course Code: DYT1061	Course Title: SPL6: Technology of Ionic Dyes - I	Credits = 3		
			L	T	P
	Semester: IV	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

All dyestuff technology courses from Sem I to Sem III

Basic knowledge of organic chemistry

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	Course Outcomes (Students will be able to…..) CO 1 *Explain* the and define the classes of dyes, substrates (K2) CO 2 *Understand* the variety and chemistry of dyes and their application (K2) CO 3 *Overview* of recent trends in the field of dyes containing azo groups (K2) CO 4 *Differentiate* the Techniques of diazotization and variations available (K2) CO 5 *Design* the synthesis of novel azo based dyes (K3)	05
2	Chemistry & Technology of Acid Dyes	10
3	Manufacture of Acid Dyes	10
4	Chemistry & Technology of Acid Dyes	10
5	Manufacture of Direct Dyes	5
6	**Drawbacks of Ionic Dyes**	5
	Total	**45**

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

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	2	1	2	3	3	3	3	3	3	2	1	3
CO2	K2	3	2	2	3	0	3	1	3	2	3	1	2	3	2
CO3	K3	3	1	0	2	1	2	2	2	3	3	3	0	3	3
CO4	K4	3	3	2	2	2	1	3	3	1	2	2	2	2	2
CO5	K2	3	2	1	3	2	3	3	3	2	3	3	2	3	3
Course	K3	3	3	3	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: HUT1206	Course Title: Environmental Sciences	Credits = 2		
			L	T	P
	Semester: IV	Total contact hours: 30	2	0	0

	Course Outcomes (students will be able to…..)	
1	Describe the methods of industrial effluent treatment	
2	apply the learning for selection and implementation of appropriate waste management technique for sustainable development	
	List of Prerequisite Courses	
	Course Contents (Topics and subtopics)	**Reqd. hours**
1	(a) Concept of circular economy, EHS management (b) Environment management systems in the chemical industry (c) Legal provisions for environmental management: EP Act 1986; Air Act, 1981; Water Act, 1974; Hazardous waste management Rules, 2019	6
2	Importance of ecology, effluent treatment and discharging norms for treated water	6
3	SPCB consent parameters, monitoring and analysis	4
4	External monitoring of ambient air, noise, stacks, etc	4
5	Air pollutants, sources and effects on human health and environment, monitoring and analysis	6
6	Life cycle analysis, environmental impact assessment	4
	List of Text Books	
1	Introduction to Environmental Engineering and Science by Gilbert M Masters and Wendell P Ela	
2	Environmental Pollution Control Engineering, C. S. Rao	
3	Principles of Instrumental Analysis by D. A. Skoog, F. James Holler and S. R. Crouch, Cengage Learning, 2007	
	List of Additional Reading Material / Reference Books	

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; P, Psychomotor domain

EEM	Course Code: CET1805	Course Title: Chemical Process Economics	Credits=2		
			L	T	P
	Semester: IV	Total contact hours: 30	2	0	0
	List of Prerequisite Courses				
	Material and Energy Balance Calculations, Equip Design and Drawing I, Energy Engineering, Ind Eng Chem.				
	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					

	Course Contents (Topics and subtopics)	Reqd.
2		5
4		5
5		5
6		2
7		5
9		4
	Total	**30**
	List of Text Books/ Reference Books	
1	Chemical Project Economics, Mahajani V.V. and Mokashi SM.	
2	Plant Design and Economics for Chemical Engineers,Peters M.S.,Timmerhaus K.D.	
3	Process Plant and Equipment Cost Estimation, Kharbanda O.P.	
	Course Outcomes (students will be able to…..)	
1	Calculate working capital requirement for a given project	
2	Calculate cost of equipment used in a plant total project cost	
3	Calculate cashflow from a given project	
4	Select a site for the project from given alternatives	
5	List out various mile stones related to project concept to commissioning	

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; P, Psychomotor domain

VSEC	Course Code: DYP1131	Course Title: Pr3: Preparation of Intermediates	Credits = 2		
			L	T	P
	Semester: IV	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)

		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	3	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	0	3	3	1	3	3	3	3	3	3
CO3	K5	3	3	3	1	3	3	3	3	3	2	0	1	3	3
CO4	K3	3	3	3	3	3	1	3	3	3	1	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; P, Psychomotor domain

Semester-V

PCC	Course Code: CET1806	Course Title: Chemical Reaction Engineering	Credits = 2		
			L	T	P
	Semester: V	Total contact hours: 30	1	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

Chemical Reaction Engineering 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

	Course Contents (Topics and subtopics)	Reqd. hours
1	Kinetics of homogeneous reactions, Interpretation of batch reactor data, Single ideal reactors including design aspects	8
2	Multiple reactions, Temperature, and pressure effects	3
3	Introduction to Non ideal flow, RTD measurements, Models to predict conversions	2
4	Homogeneous and Heterogeneous Catalysis, Kinetics of Solid Catalyzed Reactions. Design of gas – solid catalytic reactors	8
5	Introduction to Multiphase reactors	4
6	Mass transfer with chemical Reactions: Regimes of operation and Model contactors	5
	Total	**30**
	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…..)	
1	Describe and discuss principles of various types of reactors	
2	Calculate rates of reactions based on given reaction scheme	
3	Design various components of reactors used in industrial practice	
4	Compare various reactors and select an appropriate reactor for a given situation	
5	Describe and discuss principles of various types of reactors	

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; P, Psychomotor domain

PCC	Course Code: CET1807	Course Title: Chemical Engineering Operations	Credits = 2		
			L	T	P
	Semester: V	Total contact hours:30	1	1	0

List of Prerequisite Courses		
	Process Calculations, Transport Phenomena	
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. Program		
This is a basic Chem Engg. course. The principles learnt in this course are required in almost all the courses and throughout the professional career of student		
	Course Contents (Topics and subtopics)	**Reqd. hours**
1	Distillation: Fundamentals of flash, batch and continuous distillation, distillation columns internals, steam and azeotropic distillation	10
2	Liquid-Liquid Extraction: Solvent selection, construction of ternary diagrams, staged calculations, types of extraction equipment.	5
3	Crystallization: Phase diagram (temp/solubility relationship), evaporative 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 and types of dryers	5
	Total	**30**
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…..)		
1	Do basic sizing of continuous and batch distillation columns	
2	Analyze filtration data and select systems based on requirements, estimate filtration area for given requirements, understand filter aids and their usage	
3	Describe few industrial crystallization, filtration and drying equipment	
4	Describe the need and importance of other separation processes like adsorption, ion exchange and membrane	
5	Gain a practical perspective of unit operation in chemical industries	

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; P, Psychomotor domain

PCC	Course Code: DYT-1071	Course Title: SPL7: Technology of Non-ionic Dyes - I	Credits = 4		
			L	T	P
	Semester: V	Total Contact Hours: 60	2	1	0

List of Prerequisite Courses

All dyestuff technology courses

Basic knowledge of organic chemistry

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	Course Outcomes (Students will be able to…..) CO 1 *Explain* the and define the classes of dyes, substrates (K2) CO 2 *Understand* the variety and chemistry of dyes and their application (K2) CO 3 *Overview* of recent trends in the field of dyes containing azo groups (K2) CO 4 *Differentiate* the Techniques of diazotization and variations available (K2) CO 5 *Design* the synthesis of (K3)	10
2	Chemistry & Technology of Disperse Dyes	10
3	Chemistry & Technology of Azoic dyes	10
4	Chemistry & Technology of Oxidation colorants	10
5	Manufacture of Disperse, Azoic & Oxidation colorants	10
6	**Drawbacks of non-ionic dyes**	10
	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

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	1	3	3	0	1	3	2
CO2	K2	3	3	2	2	0	2	3	3	3	2	3	2	2	3

CO3	K3	3	2	2	3	3	2	1	3	3	3	2	2	3	3
CO4	K4	3	3	1	3	2	3	0	3	2	3	3	3	2	3
Course	K4	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; P, Psychomotor domain

PEC	Course Code: DYT1081	Course Title: SPL8: Computational Colour Chemistry	Credits = 4		
			L	T	P
	Semester: V	Total Contact Hours: 60	3	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.	07
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)

Course Outcomes (Students will be able to…..)	
CO1	comprehend fundamental knowledge of catalysis and its characterization.(K4)
CO2	appreciate the role of biocatalytic processes and issues concerned with APIs.(K3)
CO3	design synthetic pathways for heterocycles by logical disconnection route.(K5)
CO4	map organic molecules with respect to functional group clusters, building-block identification.(K4)
CO5	logical disconnection of molecules at strategic bonds and identification of synthons with known chemistry and Logical design of synthesis of drug and biological molecules.(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+S	K3	K4
CO1	K4	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	2	2	2	0	3	2	2	3	3	1	3	3
CO3	K5	3	2	3	3	3	3	2	3	3	0	2	3	3	2
CO4	K4	3	3	2	1	2	3	3	2	1	3	1	2	2	3
CO5	K5	3	3	2	3	2	3	3	2	3	3	2	2	3	3
Course	K6	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

PCC	Course Code: DYT1091	Course Title: **Honors Course1: METAL COMPLEX COLORANTS**	Credits = 4		
			L	T	P
	Semester: V	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

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 about METAL COMPLEX COLORANTS

	Course Contents (Topics and Subtopics)	Required Hours
1	Types of metal complex dyes – premealllized, afterchrome and metachrome dyes. Nuclear, and peripheral metal complexes. 1:1 and 1:2 metal complexes	4
2	Nature of colored ligands and their occurrence in colorants. Techniques of metal complexation – oxidative, demethylative and hydrolytic metal complexation	4
3	Modification properties on metal complexation	4
4	Absorption characteristics of metal complex dyes	4
5	Typical intermediates and their synthesis	6
6	Mordant dyes	**4**
7	Acid mordant dyes	**4**
8	Azomethine colorants	**4**
9	Azo metal complexes	**12**
10	Copper phthalocyanine and derivatives	**6**
11	Metal complex reactive dyes	**4**
12	Metal complexes as sensitizers in DSSC	**4**
		45

List of Textbooks/Reference Books

1	The Chemistry of Synthetic Dyes – Vol I, Venkataraman K., Academic Press
2	The Chemistry of Synthetic Dyes – Vol II, Venkataraman K., Academic Press
3	The Chemistry of Synthetic Dyes – Vol III, Venkataraman K., Academic Press

4	The Chemistry of Synthetic Dyes and Pigments, Lubs H. A., Robert E. Krieger Publishing Co
Course Outcomes (Students will be able to…..)	
CO1	
CO2	
CO3	
CO4	

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
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; P, Psychomotor domain

PCC	**Course Code:**	**Course Title:**	**Credits = 2**		
	DYP1141	**Pr4: Analysis of Colorants and Fibers**	**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 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	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	0	3	3	1	3	3	3	3	3	3
CO3	K5	3	3	3	1	3	3	3	3	3	2	0	1	3	3
CO4	K3	3	3	3	3	3	1	3	3	3	1	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; P, Psychomotor domain

PCC	**Course Code:** **DYP1151**	**Course Title:** **Pr5: Preparation of Ionic Dyes**	**Credits =** 2		
			L	**T**	**P**
	Semester: V	**Total contact hours:** 60	0	0	4

	Course Outcomes (students will be able to…..)	
1	Execute the synthesis of different classes of ionic dyes (K3)	
2	Able to purify and isolate the ionic dyes (K3)	
3	Differentiate the methods of synthesis of different classes of ionic dyes (K3)	
4	Design the synthesis of ionic dyes (K4)	
5	Develop practical skills in the synthesis, separation and isolation of the ionic dyes (K4)	
	List of Prerequisite Courses	
1	HSC (Science)	
2	All previous dyestuff technology courses	
	Course Contents (Topics and subtopics)	**Reqd. hours**
1	Preparation of several ionic dyes by various techniques	10
2	Preparation of several ionic dyes with different components – acidic and alkaline coupling	10
3	Preparation of some Acid, Direct, Reactive, & Basic Dyes	10
4	Synthesis of any 10 of the ionic dyes listed below: a.	30
	List of Text Books	
1	Fundamental Processes Of Dye Chemistry by Hans Eduard Fierz-David And Louis Blangey	
2	Chemistry and applications of dyes by Warring and Hallas	
	List of Additional Reading Material / Reference Books	
1	Chemistry of Synthetic Dyes – Vol II, Venkataraman, K., Academic Press, 1952	
2	Chemistry of Synthetic Dyes – Vol IV, Venkataraman, K., Academic Press, 1972	
	Color Chemistry –Synthesis, Properties and Applications of Dyes and Pigments, Zollinger H., 2nd ed., Weinheim – VCH, 1991	

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	K4	3	2	1	2	1	3	1	1	3	3	3	1	3	2
CO2	K5	3	3	2	2	1	3	3	3	3	3	3	3	3	1
CO3	K5	3	3	2	0	2	3	3	2	3	3	3	2	2	3
CO4	K4	3	3	3	2	3	3	0	3	3	2	2	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; P, Psychomotor domain

Semester-VI

PCC	Course Code: DYT1101	Course Title: SPL9: Technology of Ionic Dyes - II	Credits = 3		
			L	T	P
	Semester: VI	Total Contact Hours: 45	2	1	0

List of Prerequisite Courses

All dyestuff technology courses from Sem I to Sem III

Basic knowledge of organic chemistry

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	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)	05
2	Chemistry & Technology of Reactive Dyes	10
3	Manufacture of Reactive Dyes	10
4	Chemistry & Technology of Basic Dyes	10
5	Manufacture of Basic Dyes	5
6	**Drawbacks of Ionic dyes - II**	5
	Total	**45**

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

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

CO5	K4	3	2	2	3	2	3	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; P, Psychomotor domain

PCC	Course Code: DYT1111	Course Title: SPL10: Structural Elucidation of Dyes	Credits = 3		
			L	T	P
	Semester: VI	Total contact hours: 45	2	1	0

	Course Outcomes (students will be able to…..)	
CO1	Understand the basic concepts of spectroscopy (K2)	
CO2	Demonstrate 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)	
	List of Prerequisite Courses	
	All the Dyes Special Courses	
	Course Contents (Topics and subtopics)	**Reqd. hours**
1	Introduction to spectral methods of analysis. UV-Visible spectroscopy.	05
2	NMR spectroscopy of synthetic dyes: Principles, some basic terms. Shielding and de-shielding, chemical shift in 1H-NMR spectroscopy, Magnetic Anisotropy, Spin-Spin coupling and splitting in 1NMR spectroscopy, Coupling constant, analysis of 1H-NMR spectrum. Details of water-insoluble azo, disperse anthraquinone, cationic and acid dyes.	10
3	IR-Spectroscopy of synthetic dyes: Basic theory, fingerprint region, treatment to identify functional groups, structure elucidation.	10
4	Mass spectroscopy of synthetic dyes: Basic terms and nitrogen rule. Mass Spectral Data, Representation of fragmentation process, factors governing fragmentation process, examples of common types of fragmentation. Details of anthraquinone, azo, cationic, acid and methine dyes.	05
5	Combined use of IR, NMR and Mass spectroscopy for dyes structures elucidation.	10
6	Utility of all chromatographic techniques like GC, HPLC and HPTLC in organic chemistry. Some other advanced techniques like GC-MS and LC-MS for self study. X-RAY diffraction and scanning and similar techniques.	05
	List of Text Books	
1	The Analytical Chemistry of Synthetic Dyes by K. Venkatraman	
2	Introduction to Spectroscopy by Donald L.Pavia, Gary M. Lampman, George S.Kriz, James R.Vyvyan	
	List of Additional Reading Material / Reference Books	
1	Spectroscopic identification of Organic Compounds by Robert M.Silverstein, Francis X.Webster, David Kiemle	

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	K2	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K3	3	2	3	3	0	3	3	2	2	3	0	3	2	3
CO3	K3	3	3	1	2	3	2	2	3	1	3	3	3	3	3
CO4	K4	3	2	3	3	2	1	3	3	3	2	3	0	3	3
Course	K3	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; P, Psychomotor domain

PEC	**Course Code:** **DYT 1121**	**Course Title:** **SPL11: High Performance Pigments**	**Credits = 4**		
			L	**T**	**P**
	Semester: VI	**Total contact hours:** 45	3	1	0

	Course Outcomes (students will be able to…..)	
1	*Differentiate* between pigments and high-performance pigments (K2)	
2	*Conceptualize* the basic pigmentary features which classify them HPP, etc. (K2)	
3	*Classify* the pigments based on chemical constitution and color (K3)	
4	*Correlate* and predict various application properties of the HPP (K3)	
5	*Design* the synthesis and manufacturing technology of HPP (K3)	
	List of Prerequisite Courses	
1	Technology of Pigments	
2	Basic knowledge of organic chemistry	
	Course Contents (Topics and subtopics)	**Reqd. hours**
1	Introduction to Organic and inorganic high-performance pigments	2
2	Global Market of High-Performance pigments, Chemical and physical characterization of high performance organic pigments, Regulatory aspects of high performance pigments	3
3	Inorganic High-performance pigments: Bismuth vanadates, Cadmium pigments, Cerium pigments, Complex inorganic pigments, Titanate pigments, Special Effect pigments, IR reflecting complex-colored inorganic pigments and their manufacture, applications and properties, chemical and physical properties, dispersibility, fastness properties, and applications	10
4	Azo-High Performance Pigments: Benzimidazolone, Disazo-condensation pigments, their synthesis, manufacturing technology, physical and chemical properties, applications	3
5	Diketopyrrolopyrrole (DPP) pigments, their synthesis, manufacturing technology, physical and chemical properties, applications	3
6	Dioxazine pigments, their synthesis, manufacturing technology, physical and chemical properties, solid state properties, applications	3
7	Isoindoline pigments, their synthesis, manufacturing technology, physical and chemical properties, applications	3
8	Perylene pigments, their synthesis, manufacturing technology, physical and chemical properties, applications	3
9	Phthalocyanine pigments, their synthesis, manufacturing technology, physical and chemical properties, applications	3
10	Quinacridone pigments, their synthesis, manufacturing technology, physical and chemical properties, applications	3
11	Quinophthalone pigments, their synthesis, manufacturing technology, physical and chemical properties, applications	3
12	Imidazolone-annellated triphenedioxazine pigments, their synthesis, manufacturing technology, physical and chemical properties, applications	3
13	Vat pigments and anthraquinone pigments, their synthesis, manufacturing technology, physical and chemical properties, applications	3
	List of Text Books	
1	Chemistry of Synthetic Dyes and Pigments, Lubs H. A., Robert E Krieger Publishing	
2	Industrial Inorganic Pigments Edited by G. Buxbaum and G. Pfaff, Wiley VCH	
3	Chemistry of Synthetic Dyes – Vol II, Venkataraman K., Academic Press, New York, 1952	
4	Industrial Organic Pigments – Production, Properties, Applications, Herbst W. and Hunger K., VCH Verlag, Weinheim, 1997.	
5	High Performance Pigments, Smith H. M.	
	List of Additional Reading Material / Reference Books	
1	The Colour Science of Dyes and Pigments, R. McLaren Bristol, Adam Hilger Ltd., 1983	
2	Color Chemistry –Synthesis, Properties and Applications of Dyes and Pigments, Zollinger H., 2nd ed., Weinheim – VCH, 1991	

		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	2	1	2	1	3	3	3	3	3	3	1	3	2
CO2	K3	3	3	2	2	2	2	3	1	3	3	1	2	2	3
CO3	K4	3	3	0	3	2	3	3	2	3	3	2	3	3	3
CO4	K3	3	3	3	1	3	2	3	3	3	0	3	3	2	3
CO5	K3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Course	K4	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; P, Psychomotor domain

PCC	**Course Code:** **DYT1131**	**Course Title:** **SPL12: Technology of Non-ionic Dyes - II**	**Credits = 4**		
			L	**T**	**P**
	Semester: VI	**Total Contact Hours: 60**	**2**	**1**	**0**

List of Prerequisite Courses

All dyestuff technology courses from Sem I to Sem VI

Basic knowledge of organic chemistry

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	Course Outcomes (Students will be able to…..) CO 1 *Explain* the and define the classes of dyes, substrates (K2) CO 2 *Understand* the variety and chemistry of dyes and their application (K2) CO 3 *Overview* of recent trends in the field of dyes containing azo groups (K2) CO 4 *Differentiate* the Techniques of diazotization and variations available (K2) CO 5 *Design* the synthesis of (K3)	10
2	Chemistry & Technology of Vat Dyes	15
3	Chemistry & Technology of Sulfur Dyes	15
4	Manufacture of Vat & Sulfur Dyes	15
5	**Drawbacks of non-ionic dyes - ii**	5
6		
	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

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	K2	3	3	2	3	2	0	3	2	3	1	3	3	2	3
CO3	K3	3	2	3	1	3	2	3	2	3	3	2	2	3	3
CO4	K4	3	3	2	2	2	3	3	3	3	3	3	0	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; P, Psychomotor domain

PCC	Course Code: DYT1141	Course Title: Honors Course II: NEAR-IR ABSORBING DYES – CHEMISTRY and TECHNOLOGY	Credits = 4		
			L	T	P
	Semester: VI	Total Contact Hours: 60	3	1	0

List of Prerequisite Courses

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 about **NEAR-IR ABSORBING DYES**

	Course Contents (Topics and Subtopics)	Required Hours
1	Creating red shift in absorption of dyes – general design strategies	5
2	Technological importance NIR lights and NIR dyes	4
3	NIR-absorbing and NIR-reflecting colorants	4
4	Cyanines	4
5	NIR-absorbing azo dyes	4
6	Mordant dyes	4
7	NIR absorbing xanthenes	4
8	NIR absorbing coumarins	4
9	BODIPY and aza-BODIPY dyes	4

10	NIR absorbing quinonoid dyes	**4**
11	ESIPT dyes	**4**
		45

List of Textbooks/Reference Books

1	Near InfraRed Absorbing Dyes by Matsuoka
2	
3	
4	

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	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K3	3	3	2	1	2	3	3	2	3	2	0	2	2	3
CO3	K4	3	3	3	3	3	2	3	3	3	3	3	3	3	3
CO4	K3	3	3	0	2	3	3	3	3	3	1	2	3	3	2
Course	K3	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; P, Psychomotor domain

VSEC	**Course Code:** **CEP1714**	**Course Title:** **Chemical Engineering Laboratory**	**Credits = 2**		
			L	**T**	**P**
	Semester: **VI**	**Total contact hours: 60**	**0**	**0**	**4**

List of Prerequisite Courses

	Process Calculations, Transport Phenomena, Chemical Engineering Operations, Chemical Reaction Engineering	

List of Courses where this course will be prerequisite

	Other B. Tech. courses	

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

Chemical Engineering lab provides students the firsthand experience of verifying various theoretical concepts learnt in theory courses. It also exposes them to practical versions of typical chemical engineering equipment's and servers as a bridge between theory and practice. This particular lab focuses on fluid dynamics, distillation, filtration, drying and sedimentation.

	Course Contents (Topics and subtopics)	**Reqd. 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…..)		
1	Learn how to experimentally verify various theoretical principles	
2	Visualize practical implementation of chemical engineering equipment's	
3	Develop experimental skills	

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; P, Psychomotor domain

PCC	**Course Code:** **DYP1161**	**Course Title:** **Pr6: Preparation of Non-ionic Dyes**	**Credits** = 2		
			L	**T**	**P**
	Semester: VI	**Total contact hours:** 60	0	0	4

	Course Outcomes (students will be able to…..)	
1	Execute the synthesis of different class of non-ionic dyes (K3)	
2	Able to purify and isolate the non-ionic dyes (K3)	
3	Differentiate the methods of synthesis of different classes of non-ionic dyes (K3)	
4	Design the synthesis of non-ionic dye (K4)	
5	Develop practical skills in the synthesis, separation and isolation of the non-ionic dye (K4)	
	List of Prerequisite Courses	
1	HSC (Science)	
2	All previous dyestuff technology courses	
	Course Contents (Topics and subtopics)	**Reqd. hours**
1	Preparation of several non-ionic azo dyes by various methods of diazotization techniques	10
2	Preparation of several non-ionic azo dyes with different coupling components – acidic and alkaline coupling	10
3	Preparation of some disperse dyes	10
4	Synthesis of any 10 of the non-ionic dyes listed below: a. Diazotization and coupling of 2,4-dinitro aniline with anisole b. Diazotization and coupling of aniline with N,N-dimethyl aniline c. Diazotization and coupling of aniline with naphthol derivatives and naphthyl amines d. Diazotization and coupling of aniline with acetoacetanilide e. Synthesis of aniline yellow f. Synthesis of butter yellow g. Synthesis of chrysodine G h. Synthesis of bis azo non-ionic dyes	30

	i. Synthesis of Celliton scarlet B j. Synthesis of para red k. Synthesis of Naphthol AS dyes l. Synthesis of indigo m. Synthesis of alizarin orange n. Synthesis of alizarin red o. Synthesis of alizarin blue p. Synthesis of indanthrone blue q. Synthesis of benzanthrone r. Synthesis of dibenzanthrone s. Synthesis of Caledon jade green t. Synthesis of flavanthrone u. Synthesis of pyranthrone v. Synthesis of algol rose R w. Synthesis of Celliton Fast Blue FFG	
List of Text Books		
1	Fundamental Processes Of Dye Chemistry by Hans Eduard Fierz-David And Louis Blangey	
2	Chemistry and applications of dyes by Warring and Hallas	
List of Additional Reading Material / Reference Books		
1	Chemistry of Synthetic Dyes – Vol II, Venkataraman, K., Academic Press, 1952	
2	Chemistry of Synthetic Dyes – Vol IV, Venkataraman, K., Academic Press, 1972	
	Color Chemistry –Synthesis, Properties and Applications of Dyes and Pigments, Zollinger H., 2nd ed., Weinheim – VCH, 1991	

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	1	2	3	3	3	3	3	3	1	3	3
CO2	K4	3	3	2	3	2	3	3	1	3	2	3	2	3	3
CO3	K4	3	3	3	3	3	0	2	3	3	3	2	3	3	3
Course	K4	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; P, Psychomotor domain

PCC	Course Code: DYP1171	Course Title: PR7: APPLICATION OF COLORANTS	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

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	**60**
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+S	K3	K4
CO1	K3	3	1	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	3	2	2	1	2	3	0	3	2	3	3
CO3	K4	3	3	3	0	3	3	2	3	1	3	2	3	2	2
CO4	K5	3	3	2	2	2	3	3	2	2	3	3	1	3	3
Course	K5	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-VII

PCC	**Course Code:** **DYT1151**	**Course Title:** **SPL13:** Chemistry and Technology of Pigments	**Credits =** 3		
			L	**T**	**P**
	Semester: VII	**Total contact hours:** 45	2	1	0
Course Outcomes (students will be able to…..)					
1	*Differentiate* between dyes and pigments (K2)				
2	*Conceptualize* the basic pigmentary properties like hue, tinctorial strength, blooming, bleeding, stability, optical properties, polymorphism, etc. (K2)				
3	*Classify* the pigments based on chemical constitution and color (K3)				
4	*Correlate* and predict various application properties of pigments (K3)				
5	*Design* the synthesis and manufacturing technology of pigments (K3)				
List of Prerequisite Courses					
1	All dyestuff technology courses from Sem I to Sem VI				
2	Basic knowledge of organic chemistry				
	Course Contents (Topics and subtopics)		**Reqd. hours**		
1	Introduction to pigments, Colour and physical constitution, optical properties of Organic and inorganic pigments, Introduction to general method of determination of inorganic pigment.		2		
2	Classification and general discussion about different classes of organic pigments: Azo pigments, Azo pigments, Benzimidazolone pigments, disazo condensation pigments, metal complex pigments, polycyclic pigments, phthalocyanine pigments, Anthraquinone pigments, heterocyclic pigments Classification and general discussion about different classes of inorganic pigments: White Pigments based on Titanium Oxide, Zinc oxide, and Zinc Sulfide, Various colored pigments on metal oxides and hydroxides; Black pigments and Inorganic pigments with special properties for examples Magnetic pigment, Luminescent pigments, Transparent pigments, Electroluminescent pigments, Special effect pigments, etc		2		
3	Chemical and physical characterization of pigments: Hue, Crystal modification and crystal structure, Tinctorial strength, Light fastness and weather fastness, Solvent and migration fastness, specific surface area, Particle size distribution, Polymorphism, and crystallinity		5		
4	Application properties of pigments: Coloristic property, Color depth, Tinctorial strength, Hiding power, Transparency, Fastness properties, Migration properties, Blooming, Bleeding, Over pigmentation		5		
5	Pigment dispersion technology, Pigment dispersion kinetics and thermodynamics, Dispersion and critical pigment volume concentration, Surface modification of pigments		5		
6	Pigment finishing and standardization, Newer Technologies of pigment processing. Latent Pigment Technology, Flush pigments, Pigment evaluation techniques and equipment.		5		
7	Azo pigments: Classification of azo pigments, Starting material synthesis, Important intermediates, Synthesis of azo pigments, Methods of diazotization and coupling, Finishing of azo pigments, Filtration, drying and milling techniques, Production units for azo pigments manufacture, Mono azo yellow and orange pigments, Chemistry and manufacturing technologies of lake pigments, dis azo pigments, Diarylide yellow pigments, bisacetoacetarylide pigments, beta-naphthol pigments, naphthol AS pigments, BONA pigment lakes, Metal complex pigments		12		
8	White Pigments based on Titanium Oxide, Zinc oxide, and Zinc Sulfide; properties, production, raw materials, application in commercial products, and toxicology		3		
9	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		3		
10	Inorganic pigments with special properties for examples Magnetic pigment, Luminescent pigments, Transparent pigments, Electroluminescent pigments, Special effect pigments, etc.		3		
List of Text Books					

1	Chemistry of Synthetic Dyes and Pigments, Lubs H. A., Robert E Krieger Publishing	
2	Industrial Inorganic Pigments Edited by G. Buxbaum and G. Pfaff, Wiley VCH	
3	Chemistry of Synthetic Dyes – Vol II, Venkataraman K., Academic Press, New York, 1952	
4	Industrial Organic Pigments – Production, Properties, Applications, Herbst W. and Hunger K., VCH Verlag, Weinheim, 1997.	
5	High Performance Pigments, Smith H. M.	
List of Additional Reading Material / Reference Books		
1	The Colour Science of Dyes and Pigments, R. McLaren Bristol, Adam Hilger Ltd., 1983	
2	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	apply concepts related to preformulation, formulation, evaluation, packaging, large scale manufacturing and facility design of parenteral products.(K3)
CO2	apply the principles of dosage form design to various formulations of different dosage forms, their evaluation and packaging.(K4)
CO3	evaluate importance of facility requirements, stringent testing norms and extreme care during manufacturing to ensure safety and efficacy of the parenteral dosage forms.(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+S	K3	K4
CO1	K3	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	2	3	3	1	3	3	2	3	3	3	1	3	3
CO3	K4	3	3	2	3	3	2	0	3	3	1	0	3	2	3
Course	K4	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; P, Psychomotor domain

PCC	**Course Code: DYT1161**	**Course Title:** Chemistry and Technology Fluorescent Colorants	**Credits = 2**		
			L	**T**	**P**
	Semester: VII	**Total Contact Hours: 30**	**2**	**0**	**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.	06

	Energy Level diagrams. Singlet and triplet states.Franck-Condon principle, Kasha's rule. Quantum mechanically allowed transitions. Charge transfer mediated effects	
2	Stilbene based optical whiteners and fluorescent dyes	06
3	Coumarin and carbostyryl based optical whiteners and fluorescent dyes	06
4	Pyrazoline, naphthaliminde, benzanthrone, and azabenzanthrone based fluorophores	06
5	Water soluble fluorescent dyes, Cyanine dyes, xanthenes, oxazines, and similar dyes. BODIPY and their Aza analogues	06
	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+S	K3	K4
CO1	K2	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	0	3	3	3	3	3	3	3	1	3	3
CO3	K3	3	3	3	3	3	3	2	0	3	3	2	3	2	3
CO4	K2	3	3	1	3	2	2	3	3	2	1	3	3	3	2
CO5	K4	3	2	3	3	3	3	3	3	3	3	3	2	3	3
Course	K4	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; P, Psychomotor domain

DYT1171 SPL-15: (Elective): Colorants in Organic Electronics

Prerequisite: HSC (Science)

Rationale: Students will be able to understand the basics characteristic of colorants for the applications in organic electronics

Teaching and Examination Scheme:

Credits	**3**
Semester	**VII**
	LTP
	210

Content:

Sr. No.	Topic	Teaching Hours
1.	Materials' Foundations: Introduction	1
2.	Electronic Structure: Atomic Structure, Elections in Atom, Filling of Orbitals, The periodic table	2
3.	Chemical Bonding: Bonding Principles, Ionic Bond, Covalent Bond, Metallic Bond, Va der Waals Bonding, Hydrogen Bonding	3
4.	Bonding in Organic Compounds: Hybridized Orbitals, Isomers, Double and Triple Bonds	3
5	Crystalline and Noncrystalline Materials: States of Matter, Phase Changes and Thermodynamic Equilibrium, Crystal Lattice, Crystal Systems, Miller Indices, Distance Between Crystal Planes, Defects, Amorphous Solids	3
6	Polymers: Molecular Weight, Polymer Structure, Polymer Crystallinity	3
7	Soft Matter: Emulsions, Foams, Gels and Diffusion	1
7	Electrical Conductivity: Classical Theory, Electrical Conductivity, Charge Carrier Mobility, Fermi Energy Bands in Solids, Conductors, Semiconductors and Insulators, Electrons and Holes, Intrinsic and Extrinsic Conduction, Organic Compounds, Band Structure , Doping, Solitons, Polarons and Bipolarons	3
9	Electroactive Organic Compounds: Moles and Molecules, Acids and Bases, Ions, Solvents, Functional Groups, Aromatic Compounds, Conductive Polymers, Charge-Transfer Complexes, Buckyball's and Nanotubes, Fullerenes, Carbon Nanotubes, Piezoelectricity, Pyroelectricity and Ferroelectricity, Magnetic Materials, Basic Principles, Organic Magnets	6
10	Tools for Molecular Electronics: Direct Imaging, X-ray Reflection, Electron Diffraction, Raman Scattering Surface Analytical Techniques, Scanning Probe Microscopies, Film Thickness Measurements, Infrared Spectroscopy, NMR Spectroscopy, Mass Spectroscopy	10
11	Applications: Dye sensitized solar cell, Organic light emitting diode, Organic transistor, Flexible Electronics, etc.	10

Course Outcome

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

- **CO1** Ability to understand the fundamental knowledge on basics organic molecules. (K2, A2)
- **CO2** Ability to understand and explain the physical and chemical properties of organic
- **CO3** Ability to understand the correlation organic molecules and electronic applications. (K2,
- **CO4** Ability to understand and analyze the role of organic materials and it's application,

Sl. No.	Course Content	CO Statement	Delivery method	No. Of Hours to be handled
1	Discussion and revision of concepts	CO1, CO2, CO3, CO4	Board, Marker, presentation	5
2	Advanced concepts	CO1, CO2, CO3, CO4	Board, Marker, presentation	5

3	Tools for Molecular electronics	CO1, CO2, CO3, CO4	Board, Marker, presentation	10
4	Applications	CO1, CO2, CO3, CO4	Board, Marker, presentation	10

List of assignments and Open-Ended Projects:

1. Assignments and presentations:
- Design based small project **or**
- Study report based on latest scientific development **or**
- Technology study report

These can be done in a group containing maximum **three** students in each.
2. Evaluation based on assignments and short presentations and discussions

Reference Books:

Molecular Electronics from principles to practice, Michael C. Petty, John Wiley & Sons Ltd., 2007
Organic Electronics materials, manufacturing , and applications, Hagen Klauk, Whiley-VCH, 2006

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	K2	3	3	2	2	2	3	3	3	3	3	3	2	3	3
CO2	K4	3	3	2	0	3	3	3	3	3	3	3	1	3	3
CO3	K3	3	3	3	3	3	3	2	0	3	3	2	3	2	3
CO4	K2	3	3	1	3	2	2	3	3	2	1	3	3	3	2
CO5	K4	3	2	3	3	3	3	3	3	3	3	3	2	3	3
Course	K4	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; P, Psychomotor domain

DYT1181 SPL-16: (Elective): Technology of Biosensors

Prerequisite: Basic knowledge of organic chemistry and dyes

Rationale: To introduce various advance concepts of sensors used for biological system.

Teaching and Examination Scheme:

Credits	**2**
Semester	**VII**
	LTP
	200

Detailed Syllabus:

Sr. No.	Topic	Hrs
1	General concept sensing and elements of biosensing	6
2	Antibodies and other recognition elements	6

3	Modes of recognition	6
4	Fluorescence based sensing	6
5	Fluorescent dyes in biosensing	6

Course Outcome

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

- **CO1:** Comprehend biosensing as a useful domain in bio-analytical techniques
- **CO2:** Comprehend the components of a biosensor
- **CO3:** Learn the recognition elements – antibodies, diabodies, affibodies, affinity proteins, aptamers
- **CO4:** Able to design a biosensor
- **CO5:** Propose a biosensot design for any specific analyte

Sl. No.	Course Content	CO Statement	Knowledge level	Delivery method	No. Of Hours to be handled
1	Chemosensing and biosensing	CO1	K1	lectures	6
2	Antibodies and other recognition elements	CO2	K1, K2	Lectures, presentation by students	6
3	Antibodies and other recognition elements	CO2	K1, K2	Lectures, presentation by students	6
4	Integration of fluorophores in sensing	CO2, CO3	K1, K2, K3	Lectures, presentation by students	6
5	Fluorescent Dyes	CO4, CO5	K2, K3,K4	Lectures, presentation by students	6

Assessment Types:

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

References:

1. Biosensors and Biodetection – Ed - Avraham Rasooly and Keith E. Herold, Humana Press 2008
2. Biosensors for medical applications – Edited by Seamus Higson, Woodhead Publishing Limited, 2012
3. Molecular Biosensor, Bernard Valeur, Wiley VCH, 2002

		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	1	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K3	3	3	2	0	2	3	3	3	2	3	3	2	3	3
CO3	K3	3	3	3	3	3	2	2	3	3	1	3	2	0	3
CO4	K2	3	3	2	3	3	2	3	3	3	3	2	3	3	3
CO5	K3	3	3	3	3	1	3	3	3	0	3	3	3	2	3
Course	K3	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; P, Psychomotor domain

PCC	Course Code: DYT1191	Course Title: Honors Course III: Case Studies in Colorants Industry	Credits = 4		
			L	T	P
	Semester: VII	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.	10

	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.	
	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)	

Course Outcomes (Students will be able to…..)	
CO1	appreciate organic chemical reaction types that play a role in enzymatic transformations, biosynthesis and synthesis (K3)
CO2	understand biosynthetic pathways leading to natural products and the enzymes involved therein .(K2)
CO3	know characteristic features and typical biological activity with respect to structural features and synthetic routes.(K3)
CO4	evaluate the potential of natural products for therapeutic applications.(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	3	2	3	2	3	3
CO2	K2	3	2	0	2	1	3	3	3	2	3	3	1	2	2
CO3	K3	3	1	1	3	1	2	2	3	2	3	2	1	3	2
CO4	K4	3	2	1	2	0	3	3	2	3	3	3	0	3	2
Course	K4	3	3	2	2	2	3	3	3	2	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

RM	Course Code: DYP1181	Course Title: Literature Review (Research Methodology – I)	Credits = 2		
			L	T	P
	Semester: VII	Total contact hours: 45	1	0	2

Course Outcomes (students will be able to…..)	
List of Prerequisite Courses	
1	NA
List of Courses where this course will be prerequisite	
1	NA

Description of relevance of this course in the B. Chem. Engg. Program

The formal exposure to various elements of research methods such as problem formulation, literature search, planning of various activities, documentation, budgeting, purchase, report/thesis compilation, manuscript writing, patent drafting, is critical for polishing the naïve research attitude and aptitude in the PG students of the programme. The course is designed to formally introduce various concepts of research methodology in stepwise manner to the students

	Course Contents (Topics and subtopics)	Reqd. hours
1	Introduction of Course Academic Honesty Practices General philosophy of science & Arguing About Knowledge Case studies in science history	3
2	Motivation and Background Motivation/Demotivation for Research, Building Background for Research and How to read research papers	3
3	Time Management (Academic and Non-academic time), Effort Management, Plan execution, Energy Management Issue, Role and expectation of research supervisor and student	4
4	Finding and Solving Research Problems What is Research, How to start?, Approaches to find research problems and psychological experiments Literature survey, Textbooks, Review and research papers How to ask Questions What is worthwhile research problem, Analytical and synthetic research approach	4
5	Finding and Solving Research Problems What is Research, How to start?, Approaches to find research problems and psychological experiments Literature survey, Textbooks, Review and research papers, critical review of research papers, how to write literature survey report, How to ask Questions, formulating research questions,	4

6	What is worthwhile research problem, Analytical and synthetic research approaches How to solve research problems, designing work plan, importance of objectives, activity and strategizing research work. Design of timeline for work plan (Gnatt Chart etc), Grant Writing Guidelines	4
7	Experimental Research Inventory Management, Material Management Learning required skills for research, Documentation and lab notebook guidelines, Safety aspects in chemical/biological research	4
8	Methods and Tools used in Research: Qualitative studies; Quantitative studies; Simple data organization; Descriptive data analysis; Limitations and sources of error; Inquiries in form of Questionnaire, Opinionnaire or by interview; Statistical analysis of data including Variance, Standard deviation, Students 't' test and Analysis of variance (ANOVA), Correlation data and its interpretation, Computer data analysis	6
9	Scientific Writing Skeleton of research paper, author guidelines, good writing skills, importance of discussion, Macro-level discussion. Structure of the documents. General issues of presentability. Micro-level discussion. Stylistic issues. Examples of bad and good writings.	6
10	Publishing and Reviewing Publication process, How to publish papers, where to submit, Review process and reacting to a review report Reviewing scientific papers	4
11	Scientific Norms and Conventions Authorship. Plagiarism. Simultaneous submissions. Reviewing norms. Referring to other papers. Use of data. Collaborative Research Work	3
List of Textbooks		
	Menzel, D.; Writing a Technical Paper; McGraw-Hill, United States (1961).	
	Best, J. W., Kahn, J. V., Jha, A. K.; Research in Education; 10th ed.; Pearson, New Delhi, India (2005)	
List of Additional Reading Material / Reference Books		

Course Outcomes (Students will be able to…..)	
CO1	Understand the basic concepts of research and the components therein, formally (K2)
CO2	Understand and appreciate the significance of statistics in Chemical Technology, Pharmacy and Chemical Engineering (K2)
CO3	Understand and apply importance of literature survey in research design (K3)
CO4	Understand an in-depth knowledge on the documentation in research(K2)
CO5	Evaluate importance of various parts of a research report/paper/thesis in presentation of research results(K4)
CO6	**Prepare and Deliver a model research presentation (K5)**
CO7	Understand the significance of various types of IPRs in research(K1)
CO8	Create a model research project(K6)

RM	Course Coe: DYT1201	Course Title: Design and Analysis of Experiments (Research Methodology – II)	Credits =2		
			L	T	P
	Semester: VII	Total contact hours: 45	1	-	2
List of Prerequisite Courses					
	Applied Mathematics I				
List of Courses where this course will be prerequisite					
	This course is required for graduating engineers to function effectively in Industry, Academia and other professional spheres. This course is in Semester VIII				

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

Modern day manufacturing activities and R&D activites need decisions taken with a scientific rigour and should be well-supported by 'statistics'. Chemical Technologist graduates who will serve industry as well as postgraduate research students who will serve industry, R&D organisations, or academic research should have a reasonably good background of statistical decision making. This also involves extraction of meaningful data from well-designed minimal number of experiments at the lowest possible material costs. This course will also help the students in all domains of their life by imparting them a vision for critical appraisal and analysis of data.

	Course Contents (Topics and subtopics)	Reqd. hours
1	Fundamental principles of classical design of experiments Strategy of Experimentation, Typical applications of Experimental design, Basic Principles, Guidelines for Designing Experiments.	4
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.	3
3	Experiments with a Single Factor: The 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	6
4	Factorial designs: Definition, Estimating model parameters, Fitting response curves and surfaces.	3
5	The 2^k Factorial Design, Blocking and Confounding in the 2k Factorial Design; Focus of 2^2 and 2^3 designs, Blocking and Confounding in the 2^k Factorial Design.	6
6	Plackett Burman methods, Central Composite Design (CCD)	3
7	Descriptive Statistics, Probability Distribution and testing of Hypothesis using R	4
8	Regression techniques, diagnostic checks, ANOVA using R and implementation of contrasts.	4
9	Construction of Balanced Incomplete Block Designs and data analysis using R	4
10	Analysis of factorial designs using R, understanding output and interpretation.	4
11	Factorial designs, Data analysis and interpretation.	4

List of Text Books / Reference Books

1	Douglas C. Montgomery, Design and Analysis of Experiments, 8th Edition, John Wiley & Sons, Inc. 2013
2	Box, G. E., Hunter, W.G., Hunter, J.S., Hunter, W.G., Statistics for Experimenters: Design, Innovation, and Discovery, 2nd Edition, Wiley, 2005.
3	John Lawson, Design and Analysis of Experiments with R, CRC Press, 2015
4	Dieter Rasch, Jürgen Pilz, Rob Verdooren, Albrecht GebhardtOptimal Experimental Designs with R. CRC Press, 2011.
5	José Unpingco, Python for Probability, Statistics, and Machine Learning, Springer, 2019
6	Response Surface Methodology: Process and Product Optimization using Designed Experiments: R. H. Myers, D. C. Montgomery.
7	Introduction to Statistical Quality Control: D. C. Montgomery.
8	Design of Experiments in Chemical Engineering: Živorad R. Lazić.

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

1	Students should be able to understand basic principles of design of experiments.
2	Students should be able to perform statistical analysis of single experiments and do post hoc analysis.

3	Students should be able to conduct experiment and analyse the data using statistical methods.	
4	Students should be able to choose an appropriate design given the research problem.	
5	Students should be able to perform statistical analysis of different designs using R and interpret the results.	

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
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; P, Psychomotor domain

	Course Code: DYP1191	**Course Title: Project -I**	**Credits = 4**		
			L	**T**	**P**
	Semester: VII	**Total contact hours: 120**	**0**	**0**	**4**

List of Prerequisite Courses

Seminar

List of Courses where this course will be Prerequisite

Project II

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

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; P, Psychomotor domain

n

PCC	Course Code: DYP1201	Course Title: Pr8: Synthesis, Analysis and Applications of Optical Brighteners	Credits = 2		
			L	T	P
	Semester: VII	Total Contact Hours: 120	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 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)

		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	0	3	3	3	3	3	3	3	3	3	3	3	3
CO2	K4	3	3	3	3	2	3	3	3	3	1	2	3	2	2
CO3	K4	3	3	3	1	3	3	2	3	0	3	3	0	3	3
CO4	K3	3	3	2	3	3	3	1	3	3	3	3	2	3	3
Course	K4	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; P, Psychomotor domain

Semester-VIII

PCC	Course Code: DYT1211	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

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)

Course Outcomes (Students will be able to…..)	
CO1	draw and understand the 2D and 3D structures of small-molecule drugs and write their IUPAC names.(K2)
CO2	understand and explain the molecular mechanism of action of drugs and biologics, with particular emphasis on the emerging trends and newer targets for varied therapeutic indications.(K3)
CO3	decipher the structure-activity relationship (SAR), metabolism, therapeutic indications, drug-drug interactions, adverse effects of drugs and/or biologics.(K3)
CO4	evaluate the logic behind the design of synthetic routes for small-molecule drugs and related compounds such as metabolites, impurities and prodrugs.(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	3	3	3	0	3	3	3	3	3	3
CO2	K3	3	3	2	3	3	1	3	3	3	2	3	2	3	2
CO3	K3	3	3	3	2	2	3	3	3	3	3	3	1	2	3
CO4	K4	3	3	3	2	3	3	3	3	3	2	2	3	3	2
Course	K3	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; P, Psychomotor domain

SPL-15: Applications of Organic Dyes
Honors Course-IV **()**
Honors Course-V **()**
MDM VI: From Sciences and/or any other Engineering / Humanities Discipline
Project-II (Experiments)
Pr 9: Lab-9:

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Honors Course – IV

DYT1221 SPL-17: Formulation Technology in Colorants

Prerequisite: Industry visits for unit process study

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

Teaching and Examination Scheme:

Marks	**100**
Number of Hours per Week	**2 + 1**
Credits	**3**
Semester	**VIII**

Content:

Sr.	**Topic**	**Teaching**

No.		Hours
1.	Introduction to formulations, basics of formulations, types of formulation etc	07
2.	Formulation development and technology in cosmetics like crèmes, lotions, other toiletries	07
3.	Formulation requirement and importance of formulations in pharmaceuticals (Considering food dye and coatings) and agrochemicals	07
4.	Components of formulation, types and basis of formulation for fragrances and flavors	08
5.	Ingredients and parameters used for the formulation in inks, paints, other high tech applications of colorants including inkjet printing ink, CD-DVDs, security colorants etc.	08
6.	Formulation study for textile and non textile applications of colorants	08

List of assignments and Open-Ended Projects:

1. Assignments and presentations:
- Design based small project **or**
- Study report based on latest scientific development **or**
- Technology study report

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

2. Evaluation based on assignments and short presentations and discussions

Course Outcome

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

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

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

CO3: *Classify and differentiate* formulations based on application and importance

CO4: Outline the importance of formulation in various compounds

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

Sl. No.	Course Content	CO Statement	Delivery method	No. Of Hours to be handled
1	Formulation basics, understanding	CO1, CO2, CO3, CO4, CO5	Board, Marker, presentation	06
2	Role of components in homogenous formulation in fine chemicals	CO1, CO2, CO3, CO4, CO5	Board, Marker, presentation	06
3	Fine chemicals and formulation inter relationship Components of formulation, types and	CO1, CO2, CO3, CO4, CO5	Board, Marker, presentation	06

	basis of formulation for fragrances and flavours				
4	Ingredients and parameters used for the formulation in inks, paints, other high tech applications of colorants including inkjet printing ink, CD-DVDs, security colorants etc.	CO1, CO2, CO3, CO4, CO5	Board, Marker, presentation	08	
5	Case study for formulation positive approach and solutions for problems	CO1, CO2, CO3	Group discussions	04	

Reference Books:

1. Coatings Formulation, An international textbook, Bodo Müller, Ulrich Poth; European Coatings Tech Files
2. Printing Ink Formulations, Ernest W. Flick, Noyes Publications, 1985
3. Chemical Formulation: An Overview of Surfactant Based Chemical Preparations Used in Everyday Life, Author: Anthony E Hargreaves
4. Basics of Paint Technology part I and II, V. C. Malshe
5. Perfumes and Flavours Technology Handbook, H. Panda
6. Textbook of cosmetic formulations, Gaurav kumar Sharma
7. The Theory and Practice of Industrial Pharmacy, by Leon Lachman, 1 December 2009
8. Experimental Dyeing by Giles, SDC
9. Textile Dyeing, V A Shenai
10. Textile Printing, V A Shenoi

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

CO1	understand the principles of process design along with presentation and selection of different routes.(K2)
CO2	follow the impact of regulatory statutes on process development.(K3)
CO3	analyze the importance of process variables and their influence in scale-up.(K4)
CO4	acquire the knowledge of Green Chemistry, hazards, effluents and statistical methods.(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	3	3	3	3	3	3	1	3	3	3
CO2	K3	3	3	2	1	2	3	3	2	3	2	3	3	3	3
CO3	K4	3	1	3	3	3	3	3	2	3	3	3	2	2	3
CO4	K3	3	3	3	2	3	0	3	3	3	3	2	0	3	3
Course	K3	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; P, Psychomotor domain

DYT1231 Honors Course – V Industrial Waste Management in Colorants Industry

Prerequisite: Concept of wastes generated from industries and the problems of waste accumulation

Rationale: To introduce various existing processes and technology of waste management concepts.

Teaching and Examination Scheme:

Marks	**100**
Number of Hours per Week	**3**
Credits	**3**
Semester	**VIII**

Detailed Syllabus:

Sr. No.	Topic	Hrs
1	Waste – Characteristics, Types and Generation	09
2	Solid Waste Management – Creation of Resource. Recent Trends in Composting. Handling gaseous and particulate effluents.	09
3	Recycling and Reuse – Plastics, Metals and Other Useful Materials Waste-to-Energy – The Recent Advances	09
4	Transition from Wastewater Treatment Plant (WWTP) to Water Resource Recovery Facility (WRRF)	09
5	Sustainability of Waste-to-Wealth Technologies Application of the Principles of Circular Economy	09

Course Outcome

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

- **CO1:** Identify the source of waste generation and identify them
- **CO2:** Strategize the waste management
- **CO3:** Choose waste treatment methodologies
- **CO4:** Able to evolve methods to reduce waste at source
- **CO5:** Give a layout of Effluent Treatment Plant

Sl. No.	Course Content	CO Statement	Knowledge level	Delivery method	No. Of Hours to be handled
1	Waste – Characteristics, Types and Generation	CO1	K1	lectures	09
2	Solid Waste Management – Creation of Resource. Recent Trends in Composting. Handling gaseous and particulate effluents.	CO2	K1, K2	Lectures, presentation by students	09

3	Recycling and Reuse – Plastics, Metals and Other Useful Materials Waste-to-Energy – The Recent Advances	CO2	K1, K2	Lectures, presentation by students	09
4	Transition from Wastewater Treatment Plant (WWTP) to Water Resource Recovery Facility (WRRF)	CO2, CO3	K1, K2, K3	Lectures, presentation by students	09
5	Sustainability of Waste-to-Wealth Technologies Application of the Principles of Circular Economy	CO4, CO5	K2, K3,K4	Lectures, presentation by students	09

Assessment Types:

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

References:

4. Industrial Waste Water Treatment Paperback – 2008 by Patwardhan A.D
5. Industrial Wastewater Treatment, Recycling and Reuse 1st Edition - Authors: Vivek Ranade Vinay Bhandari
6. A Handbook of Effluent Treatment Plants - Author: Mehjabin Shaikh
7. Fundamentals of Biological Wastewater Treatment - Author(s): Prof. Dr.-Ing. Udo Wiesmann Dr.-Ing. In Su Choi Prof. Dr.-Ing. Eva-Maria Dombrowski
8. Industrial Wastewater Treatment 1st Edition - J.D. Edwards

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
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; P, Psychomotor domain

PCC	Course Code: DYP1211----	Course Title: Project -II	Credits = 3		
			L	T	P
	Semester: VIII	Total contact hours: 90	0	0	6

List of Prerequisite Courses

Seminar

List of Courses where this course will be Prerequisite

Project I

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

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; P, Psychomotor domain

PEC	Course Code: DYP1221	Course Title: Formulation and Functional Applications of Colorants	Credits = 2		
			L	T	P
	Semester: VIII	Total Contact Hours: 120	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 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 of some granular colorants	40
2	Preparation & analysis of some liquid colorants	40
3	Preparation & analysis of some microencapsulated colorants	40
	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)															
		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	2	1	2	1	3	3	3	3	3	3	2	3	3
CO2	K4	3	2	0	2	1	3	3	3	1	3	3	1	3	3
CO3	K2	3	1	1	2	1	3	2	3	3	3	3	0	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; P, Psychomotor domain

OJT	Course Code: DYP1241	Course Title: Internship with Industry	Credits = 12		
			L	T	P
	Semester: VIII	Total Contact Weeks: 12-16	0	0	0
List of Prerequisite Courses					
None					
List of Courses where this course will be prerequisite					
Project – I (PHP1074), Project – II (PHP1075)					
Description of relevance of this course in the B. Tech. Program					
The course is designed to – 1. develop a systematic thinking about an industrial problem; 2. develop skills for communication, networking, personal grooming & professional conduct within an industrial					

environment, and 3. develop the attitude for individual and teamwork.		
	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., as deemed necessary by the assigned/chosen industry. Oral presentation & written report of the in-plant training will be evaluated along with industry feedback.	12
	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; P, Psychomotor domain