INSTITUTE OF CHEMICAL TECHNOLOGY
Ordinances, Regulations and Syllabi relating to the Degree of Master of Dyestuff Technology (M.Tech-Dyestuff Technology)

1. Introduction

The Departmental administrative committee and academic program committee periodically proposed the program outcomes having consistency with the graduate attributes available with NBA. The committee critically analysed information obtained from graduated students, employers and immediately passed out students. The program outcomes are as follows:

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

		ethical manner
9	Individual & team work	The graduates should have competence to undertake designated task on individual or team basis as per the requirement.
10	Communication	The graduates will be able to communicate effectively their points of view
11	Lifelong learning	The graduates will acquire attitude for life- long learning
12	Project management & finance	The graduates should actively participate in project and financial management

SR. NO.	PROGRAM SPECIFIC OUTCOMES (PSOs)
Specialization in dye synthesis, analyses, applications and knowledge of dyeing techniques	Our graduates are totally in tune with the current needs of the dyestuff industry and have considerable problem-solving acumen.
Core organic chemistry, technology development and implementation	Our graduates have a strong foundation in chemistry, and thus combined with their engineering skills are independently able to develop new dyestuff and allied chemical industry related technologies and successfully implement them at an industrial scale

Credit system is a systematic way of describing an educational programme by attaching credits to its components. The definition of credits may be based on different parameters, such as student workload, learning outcomes and contact hours. It is a student-centric system based on the **student workload** required to achieve the objectives of a programme. It should facilitate academic recognition of the courses and mobility of the students. Credits assignment is based on the principle that Credits can only be obtained after successful completion of the work required and appropriate assessment of the learning outcomes achieved. As per the AICTE norms 2L/week of lectures are 2 credits, while 2h/week of practical/ /seminar/literature review/research work are 1 credit. This has been taken as the basis during the working of the proposed syllabus.

Student workload consists of the time required to complete all prescribed learning activities such as attendance at lectures/practical, seminars, projects, etc. Credits are allocated to all the educational components of a study programme and indicate the quantity of work each component requires to achieve its specific objectives.

Evaluation is an important component of any teaching-learning process. The Institute gives emphasis on continuous evaluation with considerable freedom to the teacher in deciding the mode of evaluation of the students. The performance of the student is documented by a **grade** at the end of the semester. The grading scale ranks the

students on a statistical basis. Therefore, statistical data on student performance is a prerequisite for applying the grading system.

2. Course Credits

In general a certain quantum of work measured in terms of **credits** is laid down as the requirement for a particular degree. The student acquires credits by passing courses every semester, the amount of credit associated with a course being dependent upon the number of hours of instruction per week in that course.

There are mainly two types of courses in the Institute - lecture courses and laboratory courses. Lecture courses consist of lecture (L) and tutorial (T) hours. Laboratory courses consist of practical (P) hours. The credit (C) for a course is dependent on the number of hours of instruction per week in that course, as given below:

(1) 1h/week of lecture (L) or tutorial (T) = 1 credit
(2) 2h/week of Practicals (P) = 1 credit
(3) Credit (C) for a theory course = No. of hours of lectures per week +No. of hours of tutorials per week = L + T
(4) Credits (C) for a Laboratory course/Seminar/research work = ½ x No. of hours per week

Credits will be assigned to In-plant, Seminar, Projects and other mandatory course requirements also and these will be mentioned in the respective syllabi. There may be some non-credit requirements. A student is required to earn credits as mentioned in the syllabus.

3. Evaluation

3.1 The weightage of different modes of assessments shall be as under.

	In-Semester evaluation		**End-Semester-Exam**	**Components of continuous mode**
	Continuous mode	**Mid Semester-Exam**		
Theory	20%	30%	50%	Quizzes, class tests (open or closed book), home assignments, group assignments, *viva-voce* assignments, discussions
Practical	50%	-	50%	Attendance, *viva -voce*, journal, assignments, project, experiments, tests
Seminar/ Research work			100%	Continuous evaluation not applicable, End semester evaluation will be based on written report evaluation and presentation in front of the external examiner within the Department

3.2. In-Semester Evaluation:

(a) It is expected that the professor would conduct at least two assessments (in any form as quizzes, tests, home work, group work etc) under the continuous mode in a Semester.
(b) The professor will announce at the beginning of the respective course the method of conducting the tests under the continuous mode and the assignment of marks
(c) In-semester performance of all students should be displayed and sent to the academic office by the teacher at least 15 days before the end-semester examination.
(d) For the theory courses, there will be one mid-semester test for each course to be held as per the schedule fixed in the Academic Calendar.
(e) For mid –semester examinations in theory papers, duration of examination will be 1 hour for 3 credit courses and 2 hours for 4 credit courses

3.3. End-Semester examination:

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

b) For end –semester examinations in theory papers, duration of examination will be 1 hour for 3 credit courses and 2 hours for 4 credit courses
c) For the end semester evaluation of seminar/research work, student will be expected to submit a written report and also make a presentation. The evaluation will be based on the quality of the written report and presentation.

3.4 Passes and Fail

(a) The candidates who obtain 40% and more marks of the total marks of a course head shall be deemed to have **passed** the respective course head.

(b) The candidates who obtain marks less than 40% of the total marks of a course head shall be deemed to have **failed** in the respective course head **(Grade FF).**

3.5 Grades:

a) The performance of a student shall be documented by a **Letter grade.** Each letter grade has a **Grade point** associated with it. The Grades and Grade points shall be assigned to each head of passing and both will be indicated in the mark-list of the semester examination.

b) The total marks (in-semester + end-semester) of a candidate in a subject head are converted into a letter grade, based on the relative (and some times the absolute) performance of the student.

Letter Grade	Grade Point
AA	10
AB	9
BB	8
BC	7
CC	6.5

CD	6
DD	5.5
EE	5

c) For granting class, a grade point of 6.0 and above will be considered equivalent to First class.

d) The grades to be allotted in the case of students who fail or do not appear at the end-semester examination shall be as under.

Letter Grade	Grade Point	Explanation
FF	0	The candidate fails in course head. The candidate will be allowed to take end-semester repeat or subsequent examinations as per rule.
XX		The candidate has not kept term for the course head due to attendance less than requisite. Further see 3.5(g) below. In the above cases, the candidate has to repeat the respective course by paying the fees.
I	0	The candidate has kept term for the course head, has taken all the internal examinations with satisfactory performance, but has failed to take the end-semester examination or repeat examination due to genuine reasons. The candidate will be allowed to take end-semester repeat or subsequent examinations as per rule.
FR	0	The candidate has exhausted all the permissible chances to clear the end-semester examinations. The candidate has to register for the respective semester again for all the subject heads or will be out of the respective degree course as per the rules.
DR	0	(i) The candidate hasn't participated in academic programme. (ii) The candidate has taken a drop for the subject head; - provided he/she intimates the same (i or ii) at least 7 days in advance of the commencement of the end-semester examination for the respective year.

e) Grades **FF** and **I** are place-holders only and do not enter into CPI/SPI calculations directly. These grades get converted to one of the regular grades after the end-semester examination

f) A candidate with an **FR** grade is not eligible for any repeat examination in that course and has to re-register for that semester by paying the appropriate fees.

g) **I** grade will not be continued beyond the permissible number of end-semester/repeat examinations.

h) **'XX' Grade:** The grade **XX** in a course is awarded if – (i) candidate does not maintain the minimum 75% attendance in the Lecture/Tutorial/Practical classes, (ii) candidate receives less than 20% of the combined marks assigned for continuous assessment and mid-semester examination, and (iii) candidate

indulges in a misconduct/uses unfair means in the examination, assignments, etc., of a nature serious enough to invite disciplinary action in the opinion of the teacher.

(**Note:** Award of the **XX** grade in the case of g(iii) above shall be done by Disciplinary Action Committee (DAC)).

i) The names/roll numbers of students to be awarded the **XX** grade should be communicated by the teacher to the Academic office as per academic calendar before the last date of submission of the application for end-semester examination

3.6. Awarding the grades

The grading scale ranks the students on a statistical basis on the basis of the overall performance of the students of a given class in the given course head. Therefore, statistical data on students' performance is a prerequisite for applying the grading system. While assigning grades in a given course head, it is essential to know the **average marks (AM)** obtained by the students *who have passed the subject head* and the **highest marks (HM)** obtained in the *same subject head*.

3.6.1. If the **average marks (AM)** obtained by the students *who have passed the subject head* is <60%, the interval AM shall be awarded grade CC and the other grades shall be decided as follows:

i. AA, AB, BB, and BC grades shall be decided between the AM and HM by dividing the range in equal intervals.

ii. CD, DD and EE grades shall be decided between the AM and minimum marks required for passing the head (i.e. 40%) by dividing the range in equal intervals.

3.6.2. If the **average marks (AM)** obtained by the students *who have passed the subject head* is such that **60% ≤ AM < 70%,** the interval AM shall be awarded grade BC and the other grades shall be decided as follows:

(i) AA, AB, BB grades shall be decided between the AM and HM by dividing the range in equal intervals.
(ii) CC, CD, DD and EE grades shall be decided between the AM and minimum marks required for passing the head (i.e. 40%) by dividing the range in equal intervals.

3.6.3. If the **average marks (AM)** obtained by the students *who have passed the subject head* is **≥ 70%,** the interval AM shall be awarded grade BB and the other grades shall be decided as follows:

(i) AA and AB grades shall be decided between the AM and HM by dividing the range in equal intervals.

(ii) BC CC, CD, DD and EE grades shall be decided between the AM and minimum marks required for passing the head (i.e. 40%) by dividing the range in equal intervals.

4. SPI and CPI

a) **Semester Performance Index (SPI):** The performance of a student in a semester is indicated by **Semester Performance Index (SPI),** which is a weighted average of the grade points obtained in all the courses taken by the student in the semester and scaled to a maximum of 10. (SPI is to be calculated upto two decimal places.)

A Semester Grade Point Average (SGPA) will be computed for each semester as follows:

$$SGPA = \frac{\left(\sum_{i=1}^{n} c_i g_i\right)}{\left(\sum_{i=1}^{n} c_i\right)}$$

Where

'n' is the number of courses for the semester,

'c_i' is the number of credits allotted to a particular course, and

'g_i' is the grade-points awarded to the student for the course based on his performance as per the above table.

SGPA will be rounded off to the second place of decimal and recorded as such.

b) **Cumulative Performance Index (CPI):** An up to date assessment of the overall performance of a student from the time he entered the Institute is obtained by calculating **Cumulative Performance Index (CPI)** of a student. The CPI is weighted average of the grade points obtained in all the courses registered by the student since he entered the Institute. CPI is also calculated at the end of every semester (upto two decimal places).

Starting from the first semester at the end of each semester (S), a Cumulative Grade Point Average (CGPA) will be computed as follows:

$$CGPA = \frac{\left(\sum_{i=1}^{m} c_i g_i\right)}{\left(\sum_{i=1}^{m} c_i\right)}$$

Where

'm' is the total number of courses from the first semester onwards up to and including the semester S,

'c_i' is the number of credits allotted to a particular course, and

'g_i' is the grade-points awarded to the student for the course based on his performance as per the above table.

CGPA will be rounded off to the second place of decimal and recorded as such.

c) The CGPA, SGPA and the grades obtained in all the subjects in a semester will be communicated to every student at the end of every semester / beginning of the next semester.

d) **When** a student gets the grade 'FF', or I' in any subject head during a semester, the SGPA and CGPA from that semester onwards will be tentatively calculated, taking only 'zero' grade point for each such 'FF' or 'I' grade. When the 'FF' grade(s) has / have been substituted by better grades after the repeat examination or subsequent semester examination, the SGPA and CGPA will be recomputed and recorded.

5. Repeat End-Semester Examination

5.1. For those candidates who fail in a subject head or are eligible for appearing at the repeat examination, **Repeat End-Semester Examination** will be conducted within one month from the declaration of the results of regular end-semester examination, as per **Regulation R.14**.

5.2. The marks obtained by candidates in the in-semester examinations (continuous assessment and Mid-Semester Examination) will be carried forward in such cases.

5.3. Grading the performance in the Repeat Examination: The grades will be assigned as per 3.5 and 3.6 above. However, for a candidate taking any repeat examination or subsequent regular semester examination or performance improvement examination shall be awarded **one grade lower** than that decided on the basis of the actual marks obtained; provided 'EE' grade obtained in such an examination shall remain 'EE'. For reference see the table below.

Grade obtained in repeat or subsequent end-semester examination	Grade to be assigned	Grade point
AA	AB	9.0
AB	BB	8.0
BB	BC	7.0
BC	CC	6.5
CC	CD	6.0
CD	DD	5.5
DD	EE	5.0
EE	EE	5.0

5.4. Revaluation of end-semester and repeat examination: Candidate's performance in these examinations will be displayed on proper notice board and after 3 days of such display the marks will be sent to the Academic Office. No revaluation of these examinations will be allowed.

6. Passing of a Semester examination

A candidate shall be declared as **'PASSED'** any semester examination if he/she has

a) Cleared all heads of passing by securing grades EE or higher in all the heads;
b) Passed all the heads of passing such as project, seminar, training, etc as per the rules;
c) Satisfactorily completed all the mandatory requirements of the course;
d) paid all the Institute dues;
e) No case of indiscipline pending against him/her.

7. Eligibility for the Award of a Degree

A candidate shall be declared eligible for the award of a degree, if he/she has cleared all the semester examinations as given in (6) above.

8. Allowed to keep terms (ATKT)

8.1 A candidate who has I grade in one or more heads of passing of an odd semester of an academic year shall be allowed to keep terms for the respective even semester.

8.2. A candidate shall be allowed to keep terms for the subsequent academic year if he/she has FF or I grades in not more than two heads of passing from all the heads of passing of the two terms of the previous academic year taken together. Such a candidate shall be declared as **FAILED, ATKT**.

9. Repeating a course

9.1 A student is required to repeat the course under the following situations:

(a) A student who gets an **XX, FR, or DR** grade in a course; or

(b) A student has exhausted all permissible chances to clear the course.

9.2 A candidate from first year who remains absent for the regular end-semester examination of a semester and the corresponding repeat examination for **ALL SUBJECTS** shall have to take fresh admission for the corresponding year; unless the candidate has dropped out / terminated from the course.

9.3 If a candidate at the Second, fails to pass any semester examination in not more than 4 consecutive examinations, including the repeat examinations, from the date of registering for the respective year, the candidate shall have to take readmission for the corresponding year again in which the failure has occurred, provided the course is not changed.

10. Improvement of performance

A candidate will be allowed to appear at the **entire examination** after the regular end-semester examination as per the respective rules to improve the performance. In such a case if the result of the examination repeated –

1) Is better than the previous one, the previous result shall be declared null and void; and
2) Is worse than the previous one, the result of the subsequent examination shall not be declared.
3) However, awarding of final grade will be made under the provision of sub clause 5.3 above.

11. Exit rules for poorly performing students

A candidate shall be excluded from a course under the following conditions:

(a) If he/she fails to pass any semester examination of the any year of the course in not more than four consecutive attempts (Examination conducted by Institute) from the date of joining the course.

(b) If he/she does not keep two consecutive terms without giving any reasonable justification (as prescribed by the institute) for doing so.

(c) If a candidate fails to fulfil all the requirements of his/her respective degree within the prescribed period from the date of taking admission to the course, the candidate shall be excluded from the course.

12. Miscellaneous

(a) Although CPI will be given in the Semester grade report, the final degree certificate will not mention any **Class** whatsoever.

(b) Not withstanding anything said above if a course is revised /restructured then transient provisions applicable at the time of revision /restructuring shall be applicable.

Syllabus Structure -Master's courses
Dyestuff Technology

Semester I										
Content	Subject Code	Subjects	Credits	Hrs/Week			Marks for various Exams			
				L	T	P	Continuous Assessment	Mid-semester Examination	Final Examination	Total
Core I	**DYT2101**	Advances in Chemistry and Technology of Colorants	3	2	1	0	10	15	25	50
Core II	**DYT2102**	Specialty chemicals Chemistry and Technology	3	2	1	0	10	15	25	50
Core III	**DYT2103**	Unit process and operations in specialty chemicals industry	3	2	1	0	10	15	25	50
Elective I		-	3	2	1	0	10	15	25	50
Elective II		-	3	2	1	0	10	15	25	50
Seminar and Critical Review	**DYP2004**		3	0	0	6	Seminar -35 (Report-20 Presentation-15) Critical Review-15 (Report-10 Presentation-5)			50
Practical I	**DYP2001**	Advanced Unit Process and Formulations Laboratory	3	0	0	6	25	-	25	50
Research I	**DYP2003**		6	-	-	12	-	-	-60 (Report) 40 (Presentation)	100
TOTAL			27	10	5	24	-	-	-	450

Semester II										
Content	**Subject Code**	**Subjects**	**Credits**	**Hrs/Week**			**Marks for various Exams**			
				L	**T**	**P**	**Continuous Assessment**	**Mid-semester Examination**	**Final Examination**	**Total**
Core I	**DYT2106**	Crop Protection Chemicals	3	2	1	0	10	15	25	50
Core II	**DYT2109**	Organic Materials for Electronics	3	2	1	0	10	15	25	50
Core III	**DYT2108**	Formulations in fine chemicals industry	3	2	1	0	10	15	25	50
Elective III	**DYT2110**	Elective-I Biosensors	3	2	1	0	10	15	25	50
Elective IV	**DYT2017**	Elective-II Mechanisms of Organic Reaction	3	2	1	0	10	15	25	50
Practical II	**DYP2002**	Chemical Business Design	3	0	0	6	25	-	25	50
Research II	**DYP2005**		9	-	-	18	-	-	90 (Report) 60 (Presentation)	150
TOTAL			27	10	5	24	-	-	-	450

Semester III										
Content	**Subject Code**	**Subjects**	**Credits**	**Hrs/Week**			**Marks for various Exams**			
				L	**T**	**P**	**Continuous Assessment**	**Mid-semester Examination**	**End-semester Examination**	**Total**
Core I	**DYP2006**	In plant training (15 Weeks to 6 months)	30			40			450	450

Semester IV					
				Hrs/Week	**Marks for various Exams**

Content	Subject Code	Subjects	Credits	L	T	P	Continuous Assessment	Mid-semester Examination	End-semester Examination	Total
Core I	**DYP2007**	Research, Thesis and Open defense	30			40			450	450

Subject: Advances in Chemistry and Technology of Colorants
DYT 2101

Type of course: Dyestuff Technology Subject
Prerequisite: Basic knowledge of organic chemistry and dyes
Rationale: To introduce various advance concepts of colorants and functional dyes.
Teaching and Examination Scheme:

Marks	**50**
Number of Hours per Week	**3**
Credits	**3**
Class	**M.Tech Dyes**
Semester	**1**

Detailed Syllabus:

Sr. No.	Topic	Hrs
1	**Colorants: History and Advancement:** History of dyestuff industry, Important breakthroughs, commercialization and growth	3
2	**Colorants for Textile Applications:** Origin of colour, Classification of different classes of dyes, Dye classes for principle applications in textile dyeing (acid dyes, direct dyes, reactive dye, disperse dye, vat dye, sulfur dye, basic dye and solvent dye), Principles of dyeing, Modern methods of dyeing, Food colorants, fluorescent brighteners and optical whitening agents, Environmental issues, Waste water treatment and dye removal from waste water.	10
3	**Pigments in the colorant industry**, Classification of organic pigments-Azo, Anthraquinone pigments, DPP pigment, Phthalocyanin pigment, Quinacridone pigment etc. Properties of pigments and pigment dispersion.	5
4	**Functional colorants**: Interactions of functional dyes, Colorants for electronics, Colorants for reprographics (electrophotography, ink jet printing), Colorants for biomedical applications, Laser dyes, Thermochromic dyes, Photochromic dyes, Electrochromic dyes, Piezochromic dyes, Dyes for molecular recognition-fluorescent probes, Hair dyes, Leather dyes,	10
5	**Structural colors**: Nano-optics in the biological world	2

Course Outcome

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

- **CO1:** *Understand the* different terminologies related to dye industry
- **CO2:** *Describe* and *explain* the general requirements for dye design, their synthetic techniques, application procedures and fastness properties
- **CO3:** *Classify and differentiate* dyes and pigments based on application and chemical constitution
- **CO4:** *Outline* the synthesis of various commercially important dyes and pigments
- **CO5:** *Knowledge* about the recent advances in the science and technology of colorants

Sl. No.	Course Content	CO Statement	Knowledge level	Delivery method	No. Of Hours to be handled
1		CO1, CO2, CO3	K1, K2, K3	Chalk board	5
2		CO1, CO2, CO3	K1, K2, K3	Chalk board	5
3		CO4	K1, K2, K3, K4	Chalk board	10
4		CO5	K1, K2, K3, S3	Presentation, Assignments and Chalk board	3
5		CO3	K1, K2 and K3	Chalk board	5
6		CO5	K1, K2 , K3 and S3	Presentation, Assignments and Chalk board	2

Assessment:

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

References:

1. Industrial Dyes: Chemistry, Properties and Applications by Klaus Hunger, Wiley-VCH
2. Handbook of Textile and Industrial Dyeing by Matthew Clarke, Woodhead Publishing Limited, 2011
3. Colorants for non-textile applications by H. S. Freeman and A. T Peters, Elsevier
4. High Technology Application of Organic Colorants by Peter Gregory, Springer, US

Course Title: Specialty chemicals Chemistry and Technology
Course Code: DYT2102

Type of course: Dyestuff Technology Subject

Prerequisite: HSC (Science)

Rationale: Students will be able to understand the basics characteristic of specialty chemicals for their applications

Teaching and Examination Scheme:

Marks	**50**
Number of Hours per Week	**3**
Credits	**3**
Class	**M.Tech Dyes**
Semester	**1**

Content:

Sr. No.	Topic	Teaching Hours
1.	Brief discussion on handling of solvents, solvent recovery, IPR issues.	3
2.	Chemistry of some advanced dyestuff intermediates, agrochemical, pharmaceutical intermediates, perfumery and flavor intermediates, chiral chemistry and their Retrosynthesis.	15
3.	Discussion on manufacture and application of some specialty chemicals.	12

Course Outcome

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

- **CO1** *Define* and *state* different terminologies related to specialty chemicals. (K2, A2)
- **CO2** *Describe* and *explain* the general requirements for specialty chemicals and their techniques
- **CO3** Outline the synthesis of various specialty chemicals. (K2, A1)
- **CO4** *Classify and differentiate* chemicals based on application and chemical constitution. (K4,

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	3
2	Chemistry of advanced intermediates	CO1, CO2, CO3, CO4	Board, Marker, presentation	15

3	Manufacture and application of some speciality chemicals	CO1, CO2, CO3, CO4	Board, Marker, presentation	12

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:

1 Fine Chemicals manufacture – Technology & Engineering, Cybulski A., Moulijn J. A., Sharma M. I Sheldon R. A., Elsevier.
2 Catalysis of Organic Reactions, Ford M. E. (Ed), Marcel Dekker Inc.
3 Organic Synthesis Engineering, Doraiswamy L. K., Oxford University Press.
4 Handbook of Chemical Process Development, Chandalia S. B., Multi-Tech Publishing Co.
5 Solvent Recovery Handbook, Smallwood I., Blackwell Publishing. Industrial Organic Chemistry, Arpe H.J.VCH, Weinheim, Weissermal K.1993

Subject: Unit Process and Operations in Specialty Chemical Industry
DYT 2103

Type of course: Dyestuff Technology Subject
Prerequisite: Industry visits for unit process and unit operation study
Rationale: To introduce various existing processes and technology of Specialty chemicals field to students.

Teaching and Examination Scheme:

Marks	**50**
Number of Hours per Week	**2 + 1**
Credits	**3**
Class	**M.Tech Dyes**
Semester	**1**

Content:

Sr. No.	Topic	Teaching Hours
1.	Feedstock for chemical industry- Basic Raw materials: Fossil feedstock, Petroleum and coal based raw materials, history and development	02

2.	Introduction of Functional groups into benzene, naphthalene and Anthracene technology involved **Basic Unit processes**: Sulphonation, Nitration, Reduction, Halogenation, amination etc, Reaction phenomenon and conditions, Reaction agents and solvents, Work up and Material of construction, Plant and process flow, Safety and process control parameters	15
3.	**Basic Unit Operations:** Importance of agitation in batch reactors, consequences of poor agitation, axial and radial flow, kinds of stirrers used, power number etc Distillation, Filtration, Crystallization – solubility, saturation, super saturation, particle size and distribution, equipment Heat transfer in jacketed batch and semi reaction vessels, effect of scale-up, exothermic reactions, cooling fluids employed, runaway reactions – case studies and prevention, cooling towers and boilers	06
4.	Chemistry and Technology of some advanced dyestuff intermediates, agrochemical and other specialty chemicals Case studies of commercial dyes, pigments, **Specialty chemicals like**: Flavors, fragrances, agrochemicals, pharmaceuticals, cosmetics etc.	05
5.	Brief discussion on fine chemical industry with examples of some global fine chemical companies	02

Course Outcome

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

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

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

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

CO4: Outline the synthesis of various compounds

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

Sl. No.	Course Content	CO Statement	Delivery method	No. Of Hours to be handled
1	History and development, overall background	CO1, CO2, CO3, CO4, CO5	Board, Marker, presentation	02
2	Unit Processes and unit operations	CO1, CO2, CO3, CO4, CO5	Board, Marker, presentation	16
3	Chemistry and technology of	CO1, CO2, CO3, CO4, CO5	Board, Marker, presentation	06

	intermediates and specialty chemicals			
4	Case studies in fine and specialty chemicals	CO1, CO2, CO3, CO4, CO5	Board, Marker, presentation	06

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:

- Industrial organic chemistry, Weissermal K., ArpeH.J.VCH, Weinheim, 1993
- Organic synthesis, Smith M B, Tata McGrow Hill, NY, 2nd Ed, 2004
- Chemistry of Synthetic Dyes, Lubs H. A., NY 1995
- Chemistry of synthetic dyes vol I, Venkatraman K., NY 1952
- Handbook of Chemical Process Development, Chandalia S. B., Multi-Tech Publishing Co.
- BIOS Reports, FIAT Reports
- Organic Synthesis Collective Volumes I-V
- Unit processes in organic syntheses, P.H. Groggins
- Fine Chemicals manufacture – Technology & Engineering, Cybulski A., Moulijn J. A., Sharma M. M., Sheldon R. A., Elsevier
- Catalysis of Organic Reactions, Ford M. E. (Ed), Marcel Dekker Inc.
- Fine Chemicals – The Industry and the Business, Pollak P., Wiley
- Chirality in Industry II – Developments in the Commercial Manufacture and Applications of Optically Active Compounds, Collins A. N., Sheldrake G. N., Crosby J. (Eds), John Wiley & Sons
- Organic Synthesis Engineering, Doraiswamy L. K., Oxford University Press
- Handbook of Chemical Process Development, Chandalia S. B., Multi-Tech Publishing Co.
- Solvent Recovery Handbook, Smallwood I., Blackwell Publishing.
- Industrial Organic Chemistry, Arpe H.J.VCH, Weinheim, Weissermal K.1993

Subject: Advanced Unit Process and Formulation Laboratory

DYP 2001

Type of course: Dyestuff Technology Subject
Prerequisite: Industry visits for unit process and formulation study
Rationale: To introduce various existing unit processes and technology of formulations to students.

Teaching and Examination Scheme:

Marks	**50**
Number of Hours per Week	**4**
Credits	**3**
Class	**M.Tech Dyes**
Semester	**1**

Content:

Sr. No.	Topic	Practical Hours
1.	Unit processes (Nitration, sulphonation, reduction, oxidation, etc) for intermediates, plant and block diagram, calculation of e-factor, atom economy, selectivity and yield of the product, PCT for the synthesis and MOC, Cost analysis, literature of best possible greener route/ alternate route for the synthesis of the compound.	24
2.	Synthesis of dyes and intermediates purification techniques, analysis, scale up parameter study	08
3.	Synthesis of dyes, application techniques, color measurements	06
4.	Synthesis of pigments, physical properties, purification	08
5.	Formulation of ink and /or paint using synthesized dyes and pigments, Formulation by use of commercial dyes and pigments for inks, paints	08
6.	Formulation of fragrances, soaps, cosmetics and other specialty chemicals	06

Notes: Maintain a log sheet for the detailed description during the synthesis

Course Outcome

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

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

Sl. No.	Course Content	CO Statement	Delivery method	No. Of Hours to be handled
1	Unit processes (Nitration, sulphonation, reduction, oxidation, etc) for intermediates, plant and block diagram, calculation of e-factor, atom economy, selectivity and yield of the product, PCT for the synthesis and MOC, Cost analysis, literature of best possible greener route/ alternate route for the synthesis of the compound.	CO1, CO2, CO3, CO4, CO5	Laboratory Practical	24
2	Synthesis of dyes and intermediates purification techniques, analysis, scale up parameter study	CO1, CO2, CO3, CO4, CO5	Laboratory Practical	08
3	Synthesis of dyes, application techniques, color measurements	CO1, CO2, CO3, CO4, CO5	Laboratory Practical	06
4	Synthesis of pigments, physical properties, purification	CO1, CO2, CO3, CO4, CO5	Laboratory Practical	08
5	Formulation of ink and /or paint using synthesized dyes and pigments, Formulation by use of commercial dyes and pigments for inks, paints	CO1, CO2, CO3, CO4, CO5	Laboratory Practical	08
6	Formulation of fragrances, soaps, cosmetics and other specialty chemicals	CO1, CO2, CO3, CO4, CO5	Laboratory Practical	06

Assessment methods:

1. Viva
2. Assignment
3. Practical

Recommended 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

6. Unit Processes in Organic Synthesis, Groggins P.H, McGraw Hill, 2001

7. Chemical Process Industry, Joseph A Brink & R N Shrieves, McGraw Hill, 1984

8. Fundamental Processes of Dye Chemistry, Fierz, David, Blangey,Interscience Publishers,1955

9. Color Chemistry: Syntheses, Properties and Applications of Organic Dyes and Pigments, Heinrich Zollinger, Wiley-VCH,2nd Ed, 1991

Subject: Crop Protection Chemicals
DYT 2106

Type of course: Dyestuff Technology Subject
Prerequisite: Basic knowledge of organic chemistry
Rationale: To introduce various concepts of agrochemicals and synthesis of agrochemicals along with their modes of action and application
Teaching and Examination Scheme:

Marks	**50**
Number of Hours per Week	**3**
Credits	**3**
Class	**M.Tech Dyes**
Semester	**2**

Content:

Sr. No.	Topic	Practical Hours

1.	**General Introduction**: Definition, importance & classification of agrochemicals. Classification of pesticides on chemical nature and according to target species, mode of action. Classification of insects and pests-Public health pests/Agricultural pests/Domestic pests/Animal husbandry pests/Plant pests etc. Toxicity (acute and chronic toxicity in mammals, birds, aquatic species etc.). Causes of outbreak of pest growth & development. Insect pest control in agro chemistry- Principle and practices.	3
2.	**Pesticide Formulations, Techniques and Analysis**- General aspects: definition, objectives, process, purpose, product spectrum, classification, formulation codes etc. Equipment used in preparation of formulations. Precautions in the use of pesticides.A brief introduction on methods of analysis of physical properties of formulations- Suspensibility, wettability, Emulsion stability, wet sieve test, acidity, alkalinity, moisture content, Flash Point, Specific gravity, Persistent foaming, water runoff test, dry sieve test etc. Regulations and Quality- Brief introduction on the packaging of pesticide products. Pesticide application techniques and devices used – Dusters and sprayers, types of nozzles etc. Calculation of amount of formulation required for field application.	5
3.	**Pesticides Synthesis and Manufacturing Technology**- Retrosynthesis of Agrochemicals. Following classes of pesticides are to be studied - Hydrocarbons, Halogenated hydrocarbons, carboxylic acids, phenols, amines, amides, aryloxycarboxylic acids, organophosphorous, heteroaromatic pesticides etc. Important reactions namely Michaelis-Arbuzov reaction, Perkow reaction, Thiono-thiolo rearrangement involved in the preparation, properties of important pesticides. Manufacturing processes of some commercially important pesticides.	10
4.	**Pesticides and Environmental Risk Assessment**: Movement, Degradation and Metabolism of Pesticides-Theory Movement and fate of pesticides in environmental components like soil, air, water, flora and fauna, and other non-target organisms. Fate and adverse effects of pesticides on them. Decontamination of pesticides through physical, chemical, photochemical, microbial, enzymatic and biotechnological techniques. Ground water decontamination; Movement in plant, animal and other living systems: Penetration, translocation, excretion etc. Persistence – factors affecting (physical, chemical, biochemical etc.), primary and secondary metabolites in plants and animals with examples. Different methods of pesticide disposal (physical, chemical, incineration and soil treatment). Disposal of industrial effluents and related xenobiotics.	3
5.	**Pesticidal Residue Analysis and analytical Techniques in Pesticide Chemistry**- Application of analytical techniques for residue analysis such as spectrophotometry, chromatography including GC, HPLC, GC-MS, LCMS and ELISA etc.	5
6.	**Recent advances in pest control:** Green Chemistry in pesticides- insect attractants, chemosterilents and repellents, mode of action and Applications. Tactics and strategies of Integrated Pest Management. Management of	2

	insects and diseases in stored agricultural commodities, side effects of applications etc.	

Course Outcome

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

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

Sl. No.	Course Content	CO Statement	Knowledge level	Delivery method	No. Of Hours to be handled
1	General Introduction	CO1, CO2, CO3	K1, K2, K3	Chalk board	5
2	Pesticide Formulations, Techniques and Analysis	CO1, CO2, CO3	K1, K2, K3	Chalk board	5
3	Pesticide Synthesis and Manufacturing Technology	CO4	K1, K2, K3, K4	Chalk board	10
4	Pesticides and Environmental Risk Assessment	CO5	K1, K2, K3, S3	Presentation, Assignments and Chalk board	3
5	Pesticidal Residue Analysis and analytical Techniques in Pesticide Chemistry	CO3	K1, K2 and K3	Chalk board	5
6	Recent advances in pest control	CO5	K1, K2 , K3 and S3	Presentation, Assignments and Chalk board	2

Assessment methods:

4. Viva
5. Assignment
6. Practical

Reference Books:

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

Subject: Organic Materials for Electronics
Course Code: DYT2109

Type of course: Dyestuff Technology Subject
Prerequisite: HSC (Science)
Rationale: Students will be able to understand the basics characteristic of organic materials for the applications in electronics

Teaching and Examination Scheme:

Marks	**50**
Number of Hours per Week	**3**
Credits	**3**
Class	**M.Tech Dyes**
Semester	**2**

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

Subject: Formulations in Fine Chemicals
DYT 2108

Type of course: Dyestuff Technology Subject
Prerequisite: Industry visits for unit process study
Rationale: To introduce various existing processes and technology of Dyes and pigment field to students.

Teaching and Examination Scheme:

Marks	**50**
Number of Hours per Week	**2 + 1**
Credits	**3**
Class	**M.Tech Dyes**
Semester	**2**

Content:

Sr. No.	Topic	Teaching Hours
1.	Introduction to formulations, basics of formulations, types of formulation etc	02
2.	Formulation development and technology in cosmetics like crèmes, lotions, other toiletries	06
3.	Formulation requirement and importance of formulations in pharmaceuticals (Considering food dye and coatings) and agrochemicals	04
4.	Components of formulation, types and basis of formulation for fragrances and flavors	04

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	06

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 basis of formulation for fragrances and flavours	CO1, CO2, CO3, CO4, CO5	Board, Marker, presentation	06

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

Subject: BIOSENSORS (ELECTIVE)
DYT 2110

Type of course: Dyestuff Technology Subject
Prerequisite: Basic knowledge of organic chemistry and dyes
Rationale: To introduce various advance concepts of sensors used for biological system.

Teaching and Examination Scheme:

Marks	**50**
Number of Hours per Week	**3**
Credits	**3**

Class **M.Tech Dyes**
Semester **1**

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

Subject: Mechanism of Organic Reactions
Course Code: DYT2107

Type of course: Dyestuff Technology Subject

Prerequisite: HSC (Science)

Rationale: Students will be able to understand the organic mechanism to synthesis of different classes of organic molecules

Teaching and Examination Scheme:

Marks	**50**
Number of Hours per Week	**3**
Credits	**3**
Class	**M.Tech Dyes**
Semester	**2**

Content:

Sr. No.	Topic	Teaching Hours
1.	Discussion and revision of concepts – elimination reactions, electrophilic aromatic substitution and nucleophilic aromatic and nucleophilic aliphatic substitution reactions, electrophilic addition to alkenes and controlling the geometry of double bonds.	8
2.	Neighboring group participation, conjugate addition of enolates, alkylation of enolates, reactions of enolates with aldehydes and ketones, and acylation at carbon, enamine formation and application.	5
3.	Discussion on mechanism of organic reactions and Retrosynthesis: Rearrangement reactions, cycloaddition reaction, sigmatropic, electrocyclic reactions and organometallic chemistry.	10
4.	Study of intermediates: carbocations, carbanions, carbenes, nitrenes, free radicals their stability, arenium ions and benzynes formation and reactions.	7

Course Outcome

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

- **CO1** Ability to identify the classes of organic molecular structure. (K2, A2)
- **CO2** Ability to design synthetic route of different organic molecules. (K3, A2)
- **CO3** Ability to propose the retrosynthetic pathway of different organic molecules. (K2, A1)
- **CO4** Ability to understand the reactivity of different reagents. (K4, A3, S1)
- **CO5** Ability to assess the technical importance of organic mechanism. (K4, A2, S1)

Sl. No.	Course Content	CO Statement	Delivery method	No. Of Hours to be handled
1	Discussion and revision of concepts	CO1, CO2, CO3, CO4, CO5	Board, Marker, presentation	8
2	Advanced concepts	CO1, CO2, CO3, CO4, CO5	Board, Marker, presentation	5
3	Retrosynthesis analysis	CO1, CO2, CO3, CO4, CO5	Board, Marker, presentation	10
4	Study of intermediates	CO1, CO2, CO3, CO4, CO5	Board, Marker, presentation	7

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:

Organic Chemistry, Morrison R. T. and Boyd R. N.
Mechanism and Theory in Organic Chemistry, Lowry T. H. and Richardson K. S., Harper and Row
The Art of Writing Reasonable Organic Reaction Mechanisms, Grossman R. B., Springer

Subject: Chemical Business Design
DYP 2002

Type of course: Dyestuff Technology Subject
Prerequisite: Industry visits for unit process study
Rationale: To introduce various existing processes and technology of Dyes and Pigment field to students.
Teaching and Examination Scheme:

Marks	**50**
Number of Hours per Week	**4**
Credits	**3**
Class	**M.Tech Dyes**
Semester	**2**

Content:

Sr. No.	Topic	Practical Hours
1.	Development of the idea for the synthesis of any intermediate, product or specialty chemical, Selection of process for the synthesized product and laboratory scale development, retro synthesis	12
2.	Market survey, applications of the designed product, area of utility like FMCG or B2B marketing	08
3.	Literature survey to study the existing routes for the selected product, DOE for the selected process, modification in the existing process	10
4.	Raw material analysis, costing, process development, Block and plant diagram, utility study, plant designing	08
5.	Scale up study, study of effluents, ETP, safety norms, IPR	12
6.	Project economics, Cost analysis, Product marketing, innovative ideas to expand the business and establishment	10

Course Outcome

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

- **CO1***: Comprehend* the fundamental knowledge of chemical industry and business
- **CO2:** *Conduct* experiments in the lab independently for the synthesis of intermediates specialty chemicals and *analyse* the products
- **CO3:** *Execute* the process with utmost efficiency and precession
- **CO4:** *Construct* the experimental setup for the unit process according to the procedure

- **CO5:** *Complete* the product marketing analysis and costing

Sl. No.	Course Content	CO Statement	Delivery method	No. Of Hours to be handled
1	Development of the idea for the synthesis of any intermediate, product or specialty chemical	CO1, CO2, CO3,	Laboratory Practical, Library, literature survey from information portals and sources	12
2	Market survey, applications of the designed product, area of utility like FMCG or B2B marketing	CO1, CO3, CO4, CO5	Laboratory Practical, literature survey from information portals and sources	08
3	Literature survey to study the existing routes for the selected product, DOE for the selected process, modification in the existing process	CO1, CO2, CO3, CO4,	Laboratory Practical, literature survey from information portals and sources	10
4	Raw material analysis, costing, process development, Block and plant diagram, utility study, plant designing	CO1, CO2, CO3, CO4, CO5	Laboratory Practical, literature survey from information portals and sources	08
5	Scale up study, study of effluents, ETP, safety norms, IPR	CO1, CO2, CO3, CO4,	Case study of industries, product analysis and marketing	12
6	Project economics, Cost analysis, Product marketing, innovative ideas to expand the business and establishment	CO1, CO2, CO3, CO4, CO5	Survey of chemical market and available resources, marketing strategy development	10

Assessment methods:

7. Viva
8. Assignment
9. Practical

Recommended books:

1. Fine Chemicals manufacture – Technology & Engineering, Cybulski A., Moulijn J. A., Sharma M. M., Sheldon R. A., Elsevier.

2. Catalysis of Organic Reactions, Ford M. E. (Ed), Marcel Dekker Inc.
3. Fine Chemicals – The Industry and the Business, Pollak P., Wiley
4. Organic Synthesis Engineering, Doraiswamy L. K., Oxford University Press.
5. Handbook of Chemical Process Development, Chandalia S. B., Multi-Tech Publishing Co.
6. Solvent Recovery Handbook, Smallwood I., Blackwell Publishing. Industrial Organic Chemistry, Arpe H.J.VCH, Weinheim, Weissermal K.1993
7. Organic synthesis, Smith M B, Tata McGrow Hill, NY, 2nd Ed, 2004
8. Chemistry of Synthetic Dyes, Lubs H. A., NY 1995
9. Handbook of Chemical Process Development, Chandalia S. B., Multi-Tech Publishing Co.
10. *BIOS Reports*, *FIAT Reports*
11. Chemical Project Economics, Mahajani V. V. and Mokashi S M.
12. Plant Design and Economics for Chemical Engineers, Peters M.S., Timmerhaus K.D.
13. Process Plant and Equipment Cost Estimation, Kharbanda O.P.