

Program Name : Diploma in Textile Technology
Program Code : TC
Semester : Fifth
Course Title : Dyeing of Synthetic Fibres
Course Code : 22575

1. RATIONALE

In textile industry, various processes such as dyeing, printing, and finishing are used to manufacture quality textile. These major processes improve the aesthetic as well as the market value of the textile. Dyeing is an important process of colouring synthetic textile substrate such as polyester, nylon, acrylic and their blends throughout their length and width. The knowledge and skills related to dyeing of synthetic fibres is essential for the diploma engineer to create quality textile. This course is developed in such a way that basic concepts and principles of dyeing of synthetic fibres, their blends and application methods will help the diploma engineer to get quality dyed yarn and fabrics. This will further help them to solve broad based problems in the textile colouration processes.

2. COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:

- Use relevant dyes, chemicals and dyeing equipment for synthetic fibres and fabrics.

3. COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following industry oriented COs associated with the above mentioned competency:

- Select relevant pretreatment process and dyeing machine for dyeing of synthetic fibres and their blends.
- Use relevant dyeing method for polyester substrate with disperse and cationic dyes.
- Use relevant dyes to dye nylon substrate.
- Use relevant dyes to dye acrylic substrate.
- Use relevant method to dye blended fabrics with relevant dyes.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme												
L	T	P		Theory						Practical						
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	4	7	3	70	28	30*	00	100	40	50#	20	50	20	100	40

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit
 ESE - End Semester Examination; PA - Progressive Assessment



5. COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.

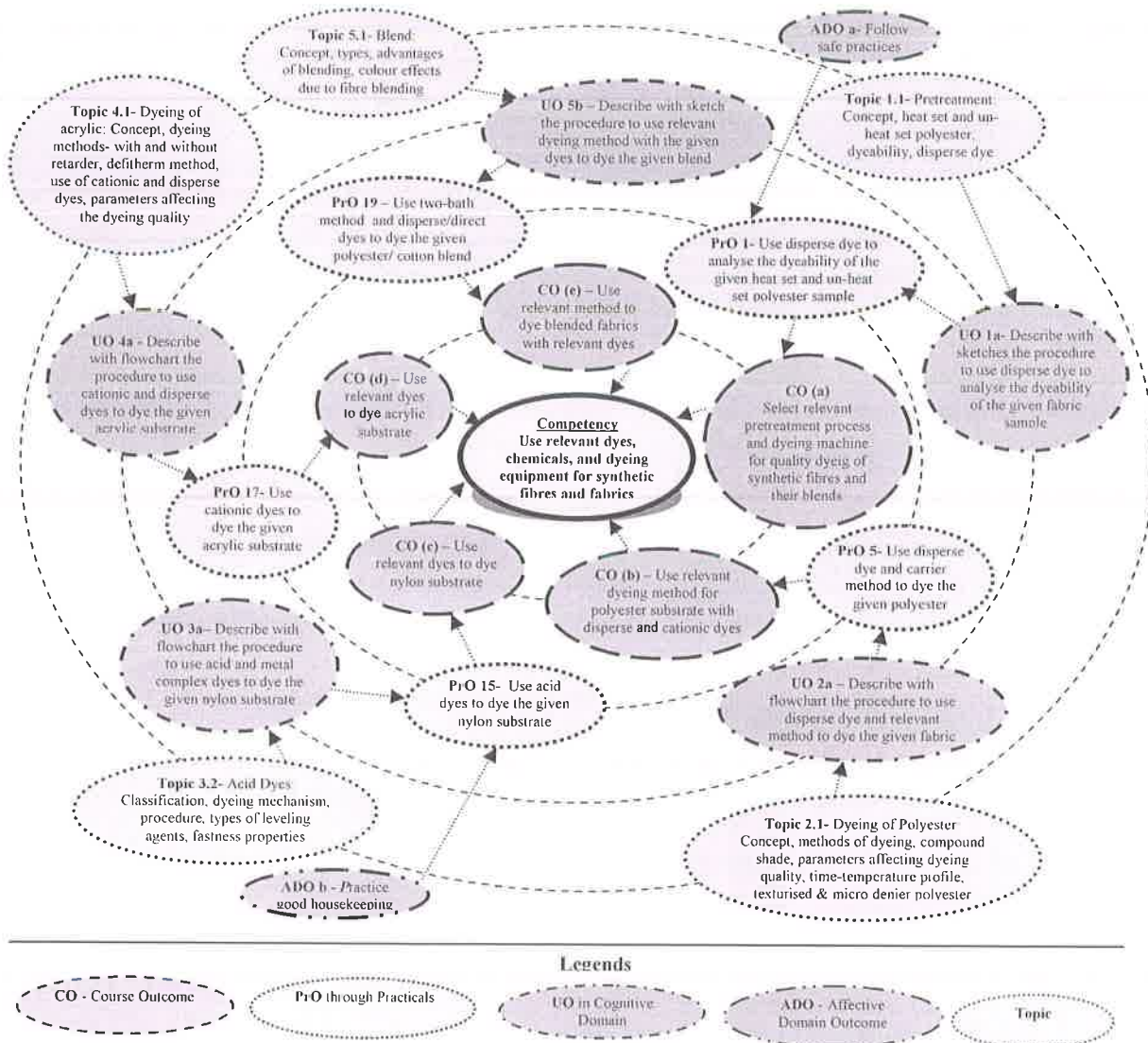


Figure 1 - Course Map

6. SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency:

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1.	Use disperse-dye to analyse the dyeability of the given heat set and un-heat set polyester sample. (Part 1)	I	02*
2.	Use disperse-dye to analyse the dyeability of the given heat set and un-heat set polyester sample. (Part 2)	I	02*
3.	Identify various parts and their functions of package dyeing and beam dyeing machines.	I	02*
4.	Identify various parts and their functions of jet dyeing and continuous dyeing machines.	I	02*



S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
5.	Use disperse-dye and carrier method to dye the given polyester. (Part 1)	II	02
6.	Use disperse-dye and carrier method to dye the given polyester. (Part 2)	II	02
7.	Use disperse-dye and high temperature high pressure method to dye the given polyester. (Part 1)	II	02*
8.	Use disperse-dye and high temperature high pressure method to dye the given polyester. (Part 2)	II	02*
9.	Use disperse-dye and thermosol method to dye the given polyester. (Part 1)	II	02
10.	Use disperse-dye and thermosol method to dye the given polyester. (Part 2)	II	02
11.	Use disperse-dye and carrier dyeing method to develop compound shade on the given polyester. (Part 1)	II	02
12.	Use disperse-dye and carrier dyeing method to develop compound shade on the given polyester. (Part 2)	II	02
13.	Use disperse-dye and high temperature high pressure dyeing method to develop compound shade on the given polyester. (Part1)	II	02*
14.	Use disperse-dye and high temperature high pressure dyeing method to develop compound shade on the given polyester. (Part2)	II	02*
15.	Use acid dyes to dye the given nylon substrate.	III	02*
16.	Use metal complex dyes to dye the given nylon substrate.	III	02*
17.	Use cationic dyes to dye the given acrylic substrate.	IV	02*
18.	Use disperse-dyes to dye the given acrylic substrate.	IV	02*
19.	Use two-bath method and disperse/direct dyes to dye the given polyester/ cotton blend. (Part 1)	V	02*
20.	Use two-bath method and disperse/direct dyes to dye the given polyester/ cotton blend. (Part 2)	V	02*
21.	Use one-bath method and disperse/direct dyes to dye the given polyester/ cotton blend. (Part 1)	V	02*
22.	Use one-bath method and disperse/direct dyes to dye the given polyester/ cotton blend. (Part 2)	V	02*
23.	Use continuous dyeing method with disperse/ reactive dyes to dye the given polyester/ cotton blend. (Part 1)	V	02
24.	Use continuous dyeing method with disperse/ reactive dyes to dye the given polyester/ cotton blend. (Part 2)	V	02
25.	Use two-bath method with disperse/ reactive dyes to dye the given polyester/ cotton blends. (Part 1)	V	02*
26.	Use two-bath method with disperse/ reactive dyes to dye the given polyester/ cotton blends. (Part 2)	V	02*
27.	Use one-bath method with disperse/ direct dyes to dye the given nylon/ cotton blends. (Part 1)	V	02
28.	Use one-bath method with disperse/ direct dyes to dye the given nylon/ cotton blends. (Part 2)	V	02
29.	Use two-bath method with disperse / reactive dyes to dye the given nylon/ cotton blend. (Part 1)	V	02
30.	Use two-bath method with disperse / reactive dyes to dye the given nylon/ cotton blend. (Part 2)	V	02



S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
31.	Use two-bath method with disperse/ metal complex dyes to dye the given acrylic/ wool blend. (Part 1)	V	02
32.	Use two-bath method with disperse/ metal complex dyes to dye the given acrylic/ wool blend. (Part 2)	V	02
33.	Use two-bath method with disperse/ metal complex dyes to dye the given polyester/ wool blend. (Part 1)	V	02*
34.	Use two-bath method with disperse/ metal complex dyes to dye the given polyester/ wool blend. (Part 2)	V	02*
Total			68

Note

- i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 24 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
- ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1.	Preparation of experimental set up	20
2.	Setting and operation	20
3.	Safety measures	10
4.	Observations and Recording	10
5.	Interpretation of result and Conclusion	20
6.	Answer to sample questions	10
7.	Submission of report in time	10
Total		100

The above PrOs also comprise of the following social skills/ attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/ field based experiences:

- a) Follow safety practices.
- b) Practice good housekeeping.
- c) Practice energy conservation.
- d) Work as a leader/a team member.
- e) Follow ethical Practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organisation Level' in 2nd year
- 'Characterisation Level' in 3rd year.



7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO No.
1	Water bath 10 liter capacity with 500 ml dye pots	1, 4,18
2	High temperature high pressure beaker dyeing machine with micro-processor and dye-pot of 250ml capacity	5, 10-12, 17, 18
3	Open bath beaker dyeing machine with micro-processor and dye-pot of 500 ml capacity	4,9-11, 15
4	Volumetric flask, measuring cylinder, pipette, weighing balance, beakers, thermometer.	All
5	Two bowl padding mangle	6,13,14,16
6	Relative dyes, chemicals and auxiliaries	All
7	Drying, Curing and Setting Chamber (Stenter), Working width: 450mm Max. Temperature -200 ^o C	6,13,14,16
8	Electronic balance with 0.001gm accuracy, capacity 300 gm.	All
9	Laboratory steamer, Maximum temperature: 130 ^o C, Maximum working pressure: 4 kg/sq cm, Electrical load: 4 Kw	13

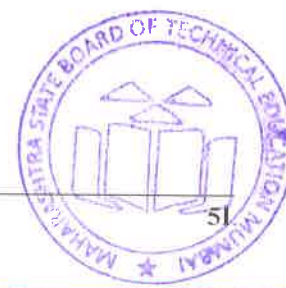
8. UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– I Effect of pretreatments and Dyeing machinery	1a. Describe with sketches the procedure to use disperse dye to analyse the dyeability of the given fabric sample. 1b. Explain the effects of scouring on dyeing quality of the given fabric with justification. 1c. Explain the effects of bleaching on dyeing quality of the given fabric with justification. 1d. Explain the effects of mercerization on dyeing quality of the given blend with justification. 1e. Explain with sketches the construction and working of the given dyeing machine.	1.1 Pretreatment: Concept, heat set and un-heat set polyester, dyeability, disperse dye 1.2 Effect of heat: Setting on polyester and nylon, 1.3 Effect of scouring: on polyester, nylon, acrylic, and blend. 1.4 Effect of bleaching: on polyester, nylon, acrylic, and blend. 1.5 Effect of mercerization: on blends. 1.6 Dyeing machines: Package dyeing, H.T. H.P. beam dyeing, Jet dyeing, soft-flow dyeing, continuous dyeing ranges (CDR) machines.
Unit– II Dyeing of polyester	2a. Describe with flow-chart the procedure to use disperse dye and relevant method to dye the given fabric. 2b. Describe with flow-chart the procedure to use the disperse dye and relevant method to	2.1 Dyeing of Polyester: Concept, methods of dyeing, compound shade, parameters affecting dyeing quality, time-temperature profile, textured and micro denier polyester. 2.2 Dyeing without carrier:



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	<p>develop compound shade on the given fabric.</p> <p>2c. Describe the use of disperse dye with relevant parameters affecting the dyeing quality of the given fabric with justification.</p> <p>2d. Describe with sketches the relevant disperse dyeing method with time-temperature profile for the given fabric.</p> <p>2e. Describe with sketch the relevant dyeing method with time-temperature profile for the given texturised and micro denier polyester.</p> <p>2f. Suggest the rectification for the stated dyeing defects in the given dyed polyester with relevant solutions.</p>	<p>procedure, advantages, and limitations,</p> <p>2.3 Carrier Dyeing: Types of carrier, procedure, advantages, and limitations.</p> <p>2.4 High Temperature High Pressure Dyeing: Procedure, advantages and limitations, rapid dyeing techniques</p> <p>2.5 Thermosol Dyeing: Procedure, advantages and limitations</p> <p>2.6 Mass colouration: Procedure, advantages and limitations</p> <p>2.7 Dyeing of texturized and micro denier PET: Precautions, procedures</p> <p>2.8 Dyeing defects and their remedies.</p>
Unit-III Dyeing of nylon	<p>3a. Describe with flowchart the procedure to use acid and metal complex dyes to dye the given nylon substrate.</p> <p>3b. Describe the application of acid dye with parameters affecting the dyeing quality of the given fabric with justification.</p> <p>3c. Describe with sketches the relevant dyeing mechanism of acid dyes on the given fabric.</p> <p>3d. Describe with flowchart the relevant basic dyeing method with time-temperature profile of the given fabric.</p> <p>3e. Suggest the rectification for the stated dyeing defects in the given dyed fabric with relevant solutions.</p>	<p>3.1 Dyeing of nylon: concept, dyeing methods, advantages, and limitations, parameters affecting the dyeing quality, time-temperature profile of the nylon fabric.</p> <p>3.2 Acid Dyes: Classification, dyeing mechanism, procedure, types of leveling agents, fastness properties</p> <p>3.3 Basic dyes: Classification, mechanism, procedure, fastness properties</p> <p>3.4 Metal complex dyes: Classification, mechanism, procedure, fastness properties</p> <p>3.5 Defects in dyeing of nylon and their remedies.</p>

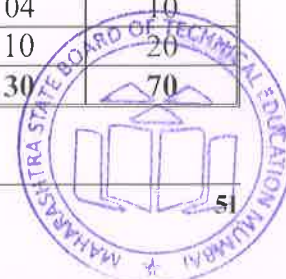


Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit –IV Dyeing of acrylic	4a. Describe with flowchart the procedure to use cationic and disperse dyes to dye the given acrylic substrate. 4b. Describe the application of cationic dye with parameters affecting the dyeing quality of the given fabric with justification. 4c. Explain the use of fibre saturation factor and dye saturation value in dyeing of the given fabric with justification. 4d. Select relevant comonomers for better dyeability of the given fabric with justification. 4e. Suggest the rectification for the stated dyeing defects in the given dyed fabric with relevant solutions.	4.1 Dyeing of acrylic: Concept, dyeing methods- with and without retarder, defitherm method, use of cationic and disperse dyes, parameters affecting the dyeing quality 4.2 Retarders: Types, Fibre saturation factor, dye saturation value 4.3 Fibre comonomers: Types, effect on dyeability of acrylic fabric. 4.4 Defects in dyeing of acrylic and their remedies.
Unit-V Dyeing of blends	5a. Describe with flowchart the procedure to develop colour effects on the given blend. 5b. Describe with sketch the procedure to use relevant dyeing method with the given dyes to dye the given blend. 5c. Compare the techno-commercial aspects of dyeing blends using relevant dyeing methods. 5d. Suggest the rectification for the stated dyeing defects in the given blend with relevant solutions.	5.1 Blend: Concept, types, advantages of blending, colour effects due to fibre blending 5.2 Commercial blends of polyester, nylon and acrylic 5.3 Dyeing Methods: Dyeing of polyester, nylon and acrylic blends by one-bath, two-bath and continuous methods with disperse/ direct/ reactive/ metal complex dyes. 5.4 Defects in dyeing of blends and their remedies.

Note: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'

9. SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Effect of pretreatments and Dyeing machinery	08	04	04	06	14
II	Dyeing of polyester	10	04	06	06	16
III	Dyeing of nylon	06	02	04	04	10
IV	Dyeing of acrylic	06	02	04	04	10
V	Dyeing of blends	18	04	06	10	20
Total		48	16	24	30	70



Legends: R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)

Note: This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess students with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:

- a) Visit any synthetic process house nearby and collect information from the processing in-charge about various processes conducted.
- b) Write report on visit to dye house and compare the existing process conditions.
- c) Collect information on safety precautions of various chemicals and machinery used in the process house.
- d) Collect information using various sources to prepare chart of dyes, chemicals, and machines available in the market.
- e) Library /Internet survey of developments in synthetic fibre dyeing.
- f) Prepare presentation incorporating visuals, photographs, animations, video on process sequence of synthetic fabric production.
- g) Collect information from the synthetic process house about the faults in dyeing and relevant remedies.
- h) Collect information from the synthetic process house about the good work practices adopted in synthetic fabric dyeing.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

- a) Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.
- b) '*L*' in item No. 4 does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.
- c) About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the COs through classroom presentations (see implementation guideline for details).
- d) With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- e) Guide student(s) in undertaking micro-projects.
- f) Demonstrate students thoroughly before they start doing the practice.
- g) Encourage students to refer different websites to have deeper understanding of the subject.
- h) Observe continuously and monitor the performance of students in Lab

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be *individually* undertaken to build up the skill and confidence in every student to become problem solver so



that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should **not exceed three**.

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than **16 (sixteen) student engagement hours** during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

- Importance of pretreatments:** Collect various pretreated samples of polyester and carry out dyeing under similar conditions and compare dyeability.
- Dyeing of polyester, nylon and acrylic:** Dye different varieties of polyester/ nylon/ acrylic with same dyes and dyeing conditions, compare their dyeuptake and find out fastness properties.
- Dyeing of Different commercial blends of polyester, nylon and acrylic:** Collect different commercial dyed blends from different industries and reproduce the same in the laboratory.
- Dyeing machineries used in industries:** Collect information from different manufacturers of machineries used in dyeing of synthetic fabrics and compare their working, structure and techno commercial importance.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Chemical Processing of Textiles: Preparatory processes and dyeing	Koushik, C. V.; Josico, A. I.	NCUTE, 8th Floor, Main Building, IIT, New Delhi, 2003
2.	Textile processing and properties	Vigo, T. L.	Elsevier Science B.V. Amsterdam 1994, ISBN: 9780444882240
3.	The dyeing of cellulosic fibres	Clifford Preston	Society of Dyers and Colourists. England, 1986, ISBN: 9780901956439
4.	Dyeing and Chemical Technology of Textile Fibres	Trotman, E. R.	John Wiley and Sons Inc., New Delhi, 1985, ISBN: 9780471809104
5.	Technology of Dyeing	Shenai, V. A.	Sevak Publications Mumbai, 1984
6.	Handbook of Textile and Industrial Dyeing	Clarke, M.	Woodhead Publishing, UK, 2011 ISBN: 9781845696962
7.	Dyeing of Polyester and Its Blends	Gulrajani, M. L.	Textile Department, IIT, Delhi 1987
8.	Chemical Processing of Synthetic Fibres and Blends	Datye, K. V.; Vaidya, A. A.	John Wiley and Sons Inc., New York, 1984, ISBN: 9780471876540

14. SOFTWARE/LEARNING WEBSITES

- www.study.com/academy/lesson/what-is-dyeing-in-textiles.html
- www.fibre2fashion.com/industry-article/3871/dyeing?page=1
- www.dyes-pigments.standardcon.com/batch-dyeing-process.html



- d) www.dyes-pigments.standardcon.com/continuous-dyeing-process.htmlwww.en.wikipedia.org/wiki/Dyeing
- e) www.teonline.com/knowledge-centre/dyeing-fiber-to-apparel.html
- f) www.teonline.com/knowledge-centre/dyeing.html
- g) www.textilelearner.blogspot.in/2011/12/methods-of-dyeing-different-dyeing.html
- h) www.dyes-pigments.standardcon.com/semi-continuous-process.html
- i) www.dyes-pigments.standardcon.com/pigment-dyeing.html

