Maharashtra State Board of Technical Education, Mumbai

Teaching And Examination Scheme For Post S.S.C. Diploma Courses

Program Name : Diploma in Textile Technology

Program Code : TC **With Effect From Academic Year: 2017 - 18**

Duration of Program : 6 Semesters **Duration : 16 Weeks**

Semester : Third **Scheme : I**

S. N.	Course Title	Course Abbreviation	Course Code	Teaching Scheme			Credit (L+T+P)	Examination Scheme												Grand Total
								Theory						Practical						
								Exam Duration in Hrs.	ESE		PA		Total		ESE		PA		Total	
				L	T	P			Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	Max Marks	Min Marks	
1	Technology of Textile Pretreatments	TTP	22360	4	-	4	8	3	70	28	30*	00	100	40	50#	20	50	20	100	40	200
2	Natural Substrates	NFI	22361	3	-	4	7	3	70	28	30*	00	100	40	50#	20	50	20	100	40	200
3	Industrial Chemistry	ICH	22362	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
4	Chemistry of Aromatics Compounds and Dyes	CAC	22363	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
5	Textile Testing	TTS	22364	4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	150
			Total	**19**	**-**	**14**	**33**	--	**350**	--	**150**	--	**500**	--	**175**	--	**175**	--	**350**	--	**850**

Student Contact Hours Per Week: **33 Hrs.** Medium of Instruction: **English**

Theory and practical periods of 60 minutes each. Total Marks : **850**

Abbreviations: ESE- End Semester Exam, PA- Progressive Assessment, L - Lectures, T - Tutorial, P - Practical

@ Internal Assessment, # External Assessment, *# On Line Examination, ^ Computer Based Assessment

* Under the theory PA, Out of 30 marks, 10 marks are for micro-project assessment 0to 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 LOs required for the attainment of the COs.

~ For the courses having ONLY Practical Examination, the PA marks Practical Part - with 60% weightage and Micro-Project Part with 40% weightage

- **If Candidate not securing minimum marks for passing in the "PA" part of practical of any course of any semester then the candidate shall be declared as "Detained" for that semester.**

Program Name : **Diploma in Textile Technology**

Program Code : **TC**

Semester : **Third**

Course Title : **Technology of Textile Pretreatments**

Course Code : **22360**

1. RATIONALE

In textile industry, many processes such as dyeing, printing, and finishing are carried out for production of quality textile. These major processes improve the aesthetic value of the textile as well as its market value. To get effective results of dyeing, printing, and finishing processes, the fabric should be free from any of the impurities such as size, oil, fat, wax and pigments, as their presence affect the quality of further textile processing. This course is developed in such a way that the fundamental information will help the diploma engineer to apply the concepts of textile pretreatment technologies to solve broad based problems in the textile industry.

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 different types of textile pre-treatment machines and processes.**

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:

a. Use relevant size paste on textile to improve its strength.
b. Use relevant mechanical process to remove the impurities from textiles.
c. Use relevant desizing process to remove size from textile.
d. Use relevant scouring process to improve absorbency of textile.
e. Use relevant bleaching process to improve whiteness of textile.
f. Use relevant mercerization process to improve luster of cotton.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory						Practical					
				Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
L	T	P			Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	4	8	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.

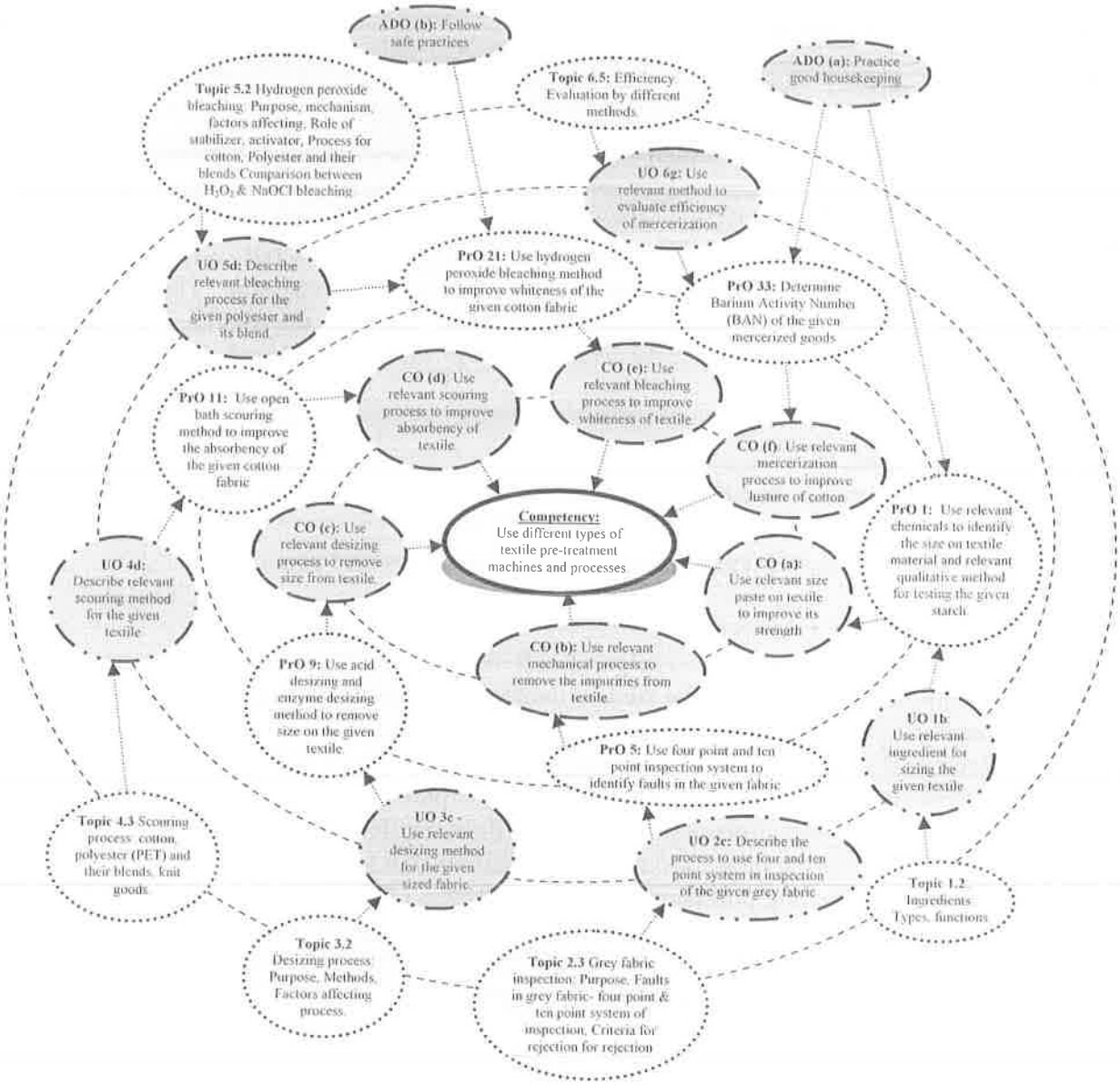

Figure 1 - Course Map

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 relevant chemicals to identify the size on textile material and relevant qualitative method for testing the given starch- Part I	I	2*
2.	Use relevant chemicals to identify the size on textile material and relevant qualitative method for testing the given starch- Part II	I	2
3.	Use relevant method to find moisture content, ash content and total dissolved solids in the given starch sample- Part I	I	2
4.	Use relevant method to find moisture content, ash content and total dissolved solids in the given starch sample- Part II	I	2
5.	Use four point and ten point inspection system to identify faults in the given fabric- Part I	II	2*
6.	Use four point and ten point inspection system to identify faults in the given fabric- Part II	II	2
7.	Use pilling tester to identify pilling tendency of the given fabric before and after singeing- Part I	II	2
8.	Use pilling tester to identify pilling tendency of the given fabric before and after singeing- Part II	II	2
9.	Use acid desizing and enzyme desizing method to remove size on the given textile- Part I	III	2*
10.	Use acid desizing and enzyme desizing method to remove size on the given textile- Part II	III	2
11.	Use open bath scouring method to improve the absorbency of the given cotton fabric- Part I	IV	2*
12.	Use open bath scouring method to improve the absorbency of the given cotton fabric- Part II	IV	2
13.	Use pressure boil scouring method to improve the absorbency of the given cotton fabric- Part I	IV	2
14.	Use pressure boil scouring method to improve the absorbency of the given cotton fabric- Part II	IV	2
15.	Use relevant scouring method to remove hydrophobic impurity from the given polyester and its blend- Part I	IV	2
16.	Use relevant scouring method to remove hydrophobic impurity from the given polyester and its blend- Part II	IV	2
17.	Use relevant degumming method to remove Serecin from the given silk fabric- Part I	IV	2
18.	Use relevant degumming method to remove Serecin from the given silk fabric- Part II	IV	2
19.	Use hypochlorite bleaching method to improve whiteness of the given cotton fabric- Part I	V	2*
20.	Use hypochlorite bleaching method to improve whiteness of the given cotton fabric- Part II	V	2
21.	Use hydrogen peroxide bleaching method to improve whiteness of the given cotton fabric- Part I	V	2
22.	Use hydrogen peroxide bleaching method to improve whiteness of the given cotton fabric- Part II	V	2
23.	Use combined scouring and bleaching method to improve absorbency and whiteness of the given cotton fabric- Part I	V	2

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
24.	Use combined scouring and bleaching method to improve absorbency and whiteness of the given cotton fabric- Part II	V	2
25.	Use relevant bleaching method for the given polyester and its blends- Part I	V	2
26.	Use relevant bleaching method for the given polyester and its blends- Part II	V	2
27.	Use open bath bleaching method for the given wool fabric- Part I	V	2
28.	Use open bath bleaching method for the given wool fabric- Part II	V	2
29.	Use open bath bleaching method for the given silk fabric- Part I	V	2
30.	Use open bath bleaching method for the given silk fabric- Part II	V	2
31.	Use hank mercerization method for the given cotton hank- Part I	VI	2*
32.	Use hank mercerization method for the given cotton hank- Part II	VI	2
33.	Determine Barium Activity Number (BAN) of the given mercerized goods- Part I	VI	2
34.	Determine Barium Activity Number (BAN) of the given mercerized goods- Part II	VI	2
	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 judicial 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:*

iii.

S. No.	Performance Indicators	Weightage in %
1	Selection of suitable component, apparatus/instrument	20
2	Preparation of experimental set up	10
3	Setting and operation	10
4	Safety measures	10
5	Observations and Recording	10
6	Interpretation of result and Conclusion	20
7	Answer to sample questions	10
8	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. Demonstrate working as a leader/ team member.
d. Maintain tools and equipment.
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
- 'Organizing Level' in 2nd year
- 'Characterizing 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	Laboratory Glass Ware (Round bottom flask, condenser, pipettes, burettes, thermometer, and other related glassware) heating mantle	1, 2 , 3, 4, 33, 34
2	Fabric inspection machine (1 meter x 2 meter purging machine with top and bottom light source)	5, 6
3	ICI pilling tester	7, 8
4	Water bath (6 or 12 dye-pot holding capacity made of stainless steel which can be either gas heated or electrically heated with microprocessor control)	9, 10, 11, 12, 15 to 30
5	Dye-pots (made of stainless steel each of 250 or 500 ml capacity, which fits perfectly in water bath)	9, 10, 11, 12, 15 to 30
6	Steamer (which has the capacity to generate a pressure of 30 psi and can have a batch size of 02 to 05 kg.)	13, 14
7	Hank mercerization machine (which has a capacity to mercerize hank and lea)	31, 32

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 Sizing	1a. Describe with sketches the sizing process for the given textile and its importance. 1b. Describe the use of relevant ingredient for sizing the given textile. 1c. Compare properties of the relevant adhesives used in sizing process for the given textile. 1d. Select relevant starch to improve strength of the given textile with justification.	1.1 Sizing: Process, Purpose, 1.2 Ingredients: Types, functions 1.3 Adhesives: Classification, Starches- Properties, testing 1.4 Softeners: Types, properties, testing methods. 1.5 Size paste formulation: Cotton, P/C, P/V blended yarn

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	1e. Describe with sketches the relevant testing method for the given adhesives and softener. 1f. Formulate the relevant sizing recipe for the given textile.	
Unit– II Mechanical preparatory processes	2a. Describe with sketches the pretreatment process of the given fabric. 2b. Describe with sketches the procedure to identify problems in the given fabric. 2c. Describe with sketches the process to use four and ten point system in inspection of the given fabric. 2d. Describe type of machine used for inspection of the given fabric. 2e. Explain with sketches the shearing and cropping process for the given fabric. 2f. Explain with sketches the construction and working principle of shearing and cropping machine used for the given fabric. 2g. Describe with sketches the procedure of using singeing machine for singeing of the given fabric.	2.1 Mechanical Pretreatments: Importance, application, types 2.2 Pretreatment sequences: cotton, polyester, polyester / cotton, wool and silk. 2.3 Grey fabric inspection: Purpose, Faults in grey fabric- four point and ten point system of inspection, Criteria for rejection. 2.4 Shearing and cropping machine: 2 cutter and 4 cutter 2.5 Singeing: Importance, Construction and working principle of gas singeing machines for woven and knitted fabric.
Unit– III Desizing	3a. Identify the size present on the given fabric. 3b. Explain with sketches the mechanism of desizing for the given fabric. 3c. Describe with sketches the relevant desizing method for the given sized fabric. 3d. Describe with sketches the relevant method to evaluate efficiency of desizing of the given fabric.	3.1 Size on grey fabric: Identification 3.2 Desizing process: Purpose, Methods, Factors affecting process. 3.3 Desizing machines: Batch wise and continuous. 3.4 Desizing efficiency: Evaluation methods.
Unit-IV Scouring	4a. Describe with sketches the relevant scouring method to remove hydrophobic impurities from the given cotton fabric/ PET and its blends 4b. Describe with sketches the relevant pretreatment process for	4.1 Scouring: Importance, Mechanism and Reactions 4.2 Methods: Alkaline scouring, solvent scouring, bio-scouring. 4.3 Scouring process: cotton, polyester (PET) and their blends, knit goods.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	the given wool/silk. 4c. Describe with sketches the use of relevant machine for scouring of the given fabric. 4d. Describe the relevant method to evaluate efficiency of the given scouring process.	4.4 Scouring machine: Batch-wise, semi continuous and continuous 4.5 Wool: Scouring, Crabbing, carbonization, and milling. 4.6 Degumming of silk: Purpose, Methods - Soap, alkali, and enzyme. 4.7 Evaluation of scouring process efficiency.
Unit –V Bleaching	5a. Explain with sketches the mechanism of the given type of the bleaching process. 5b. Explain the factors affecting the given type of bleaching process. 5c. Describe with sketches the relevant bleaching process for the given textile/polyester and its blend. 5d. Describe relevant method to evaluate efficiency of the given bleaching process.	5.1 Sodium hypochlorite bleaching: Purpose, mechanism, Procedure for cotton, factors affecting. 5.2 Hydrogen peroxide bleaching: Purpose, mechanism, factors affecting, Role of stabilizer, activator, Process for cotton, Polyester and their blends Comparison between H_2O_2 and NaOCl bleaching. 5.3 Sodium chlorite bleaching: Mechanism, Procedure for polyester. 5.4 Wool, silk, knits and colored woven goods: Precautions, procedure. 5.5 Machines: Batch wise, semi continuous and continuous methods of bleaching. 5.6 Efficiency of bleaching: Evaluation methods.
Unit-VI Mercerization	6a. Explain the effects of mercerization on properties of the given type of fabric. 6b. Explain the structural changes in cellulose during mercerization of the given cotton. 6c. Describe the relevant factors affecting mercerization process of the given cotton. 6d. Select relevant machine for mercerization of the given textile with justification. 6e. Describe the relevant method to evaluate efficiency of mercerization of the given fabric.	6.1 Mercerization: Importance, changes occurred in fibre. 6.2 Causticization: Purpose, process. 6.3 Factors affecting the mercerization process. 6.4 Machines: Yarn mercerization, pad-chain, padless-chainless, hot mercerization, liquid ammonia mercerization. 6.5 Efficiency: Evaluation by different methods.

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	Sizing	10	02	02	03	07
II	Mechanical Preparatory Processes	10	02	04	03	09
III	Desizing	08	02	02	06	10
IV	Scouring	14	02	06	08	16
V	Bleaching	12	04	04	06	14
VI	Mercerization	10	04	04	06	14
Total		**64**	**16**	**22**	**32**	**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 textile process house and collect recipes used for pretreatments in textile process house.
b. Collect fabric samples at various stages in pretreatment and check their absorbency and whiteness.
c. Collect information of various pretreatment auxiliaries used in textile process house.
d. Visit textile process house and collect information of parameters used in mercerization for different sorts of fabric.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning 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. Encourage students to refer different websites to have deeper understanding of the subject.

g. Observe continuously and monitor the performance of students in Laboratory.
h. Assign unit wise assignments to group of 4 to 5 students for solving unit wise questions.
i. Use of video, animation films to explain concepts, facts and applications related to textile pretreatment.

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:

a. **Strength of chemicals:** Collect chemicals used in textile preparatory processes and determine their strength. Present the results.
b. **Auxiliaries:** Collect auxiliaries used in preparatory processes and prepare presentation including commercial/ industrial names.
c. **Role of oxidizing and reducing agent in wet processing:** Visit textile industry, collect information and photographs. Prepare presentation incorporating different oxidizing, reducing agents used in preparatory processes.
d. **Collection of sized samples:** Visit textile industry, collect sized samples of different GSM, count and construction. Prepare presentation.
e. **Collection of pretreated samples:** Collect pretreated samples at various stages for any four qualities of fabric, prepare presentation incorporating description of the collected samples.
f. **Comparison:** Compare the absorbency of cotton sample collected from textile industry, scoured by different methods for any four qualities of fabric. Prepare presentation.
g. **Performance Study:** Study, relation between various bleaching parameters on the whiteness and strength of any four qualities of fabric. Present the results.
h. **Performance Study:** Study relation between various mercerizing parameters on the absorbency, dyeability, Lustre and strength on different varieties. Present the results.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Textile Preparation and Dyeing	Choudhary, A. K. R.	Science Publishers, Enfield, NH, USA. 2006, ISBN: 9781578084043
2	Textile Sizing	Goswami. B. C.:	CRC Press. 2004,

S. No.	Title of Book	Author	Publication
		Anandjiwala, R. D.; Hall, D.	ISBN: 9780203913543
3	Chemical Processing of Polyester/ Cellulosic Blends	Mittal, R.M.; Trivedi, S. S.	ATIRA, Ahmedabad, 1983
4	Chemical Processing of Synthetic Fibres and Blends	Datye, K. V.; Vaidya, A. A.	Wiley-Blackwell, New York, 1984, ISBN: 9780471876540
5	Technology of Bleaching and Mercerizing	Shenai, V. A.	Sevak Publication, Mumbai, 2003
6	Chemical Technology in the Pretreatment Processes of Textile	Karmakar, S. R.	Elsevier Science Publication, Netherlands, 1999, ISBN: 9780444500601
7	Textile Finishing	Haywood, D.	Bradford, Eng. : Society of Dyers and Colourists, 2003, ISBN: 9780901956811
8	Textile Dyeing	Hauser, P	InTech, Chapters published December 14, 2011 under CC BY 3.0 license ISBN: 9789533075655
9	Technology of Textiles-Spinning and Weaving, Dyeing, Drying, Printing and Bleaching	EIRI Board	Engineers India Research Institute, ISBN: 9788186732489
10	The Complete Technology Book on Textile Processing With Effluents Treatment	NIIR Board	NIIR Board, 2004 ISBN: 8178330504

14. SUGGESTED SOFTWARE/ LEARNING WEBSITES

a. www.nptel.ac.in/courses/116102005/20
b. www.textilelearner.blogspot.in/2011/03/cotton-desizing-process_255.html
c. www.handprintingguiderajasthan.in/science-behind-preparatory-processes-for-hand printing/pre-treatment-of-cotton-fabric/
d. www.shodhganga.inflibnet.ac.in/bitstream/10603/24222/9/09_chapter4.pdf
e. www.textilelearner.blogspot.in/2011/03/scouring-treatments-of-cotton-silk-wool_4142.html
f. www.cdn.intechopen.com/pdfs-wm/25013.pdf
g. www.textilelearner.blogspot.in/2012/12/bleaching-of-cotton-fiberfabric-with.html
h. www.nptel.ac.in/courses/116102016/19
i. www.nptel.ac.in/courses/116102016/16
j. www.textilelearner.blogspot.in/2013/06/mercerization-process-of-cotton-fabric.html
k. www.thesmarttime.com/pretreatment/mercerization.html
l. www.nptel.ac.in/courses/116102016/20
m. www.linkedin.com/pulse/facebook-unveils-plan-tackle-fake-news-problem-google-lorraine-k-lee
n. www.textilelearner.blogspot.in/2013/07/pretreatment-process-of-silk.html
o. www.handprintingguiderajasthan.in/science-behind-preparatory-processes-for-hand-printing/pre-treatment-of-silk-fabric/
p. www.thesmarttime.com/pretreatment/scouring-of-wool.html

Program Name : **Diploma in Textile Technology**

Program Code : **TC**

Semester : **Third**

Course Title : **Natural Substrates**

Course Code : **22361**

1. RATIONALE

In textile industry, various chemical processes are carried out on variety of textile fibres. Chemical processing of textiles is an art of improving the overall quality of fibrous material. To achieve the high quality of fibrous material, the diploma engineers must have adequate knowledge of natural fibres, their chemical compositions, and their chemical as well as morphological structures. They must also possess adequate knowledge of physical as well as chemical properties and application areas of fibres. They need to adopt relevant methodology for chemical processing of diffrernt fibres. This course is developed in such a way by which fundamental information will help the diploma engineers to apply the basic concepts of natural fibres to solve broad based problems in textile industry.

2. COMPETENCY

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

- **Test various natural fibres to match relevant wet processing sequence.**

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:

a. Select relevant natural fibres according to their end uses.
b. Test properties of cotton to suit relevant wet processing sequence.
c. Test properties of bast fibre to suit relevant wet processing sequence.
d. Test properties of leaf fibre to suit relevant wet processing sequence.
e. Test properties of wool fibre to suit relevant wet processing sequence.
f. Test properties of silk fibre to suit relevant wet processing sequence.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		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 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.

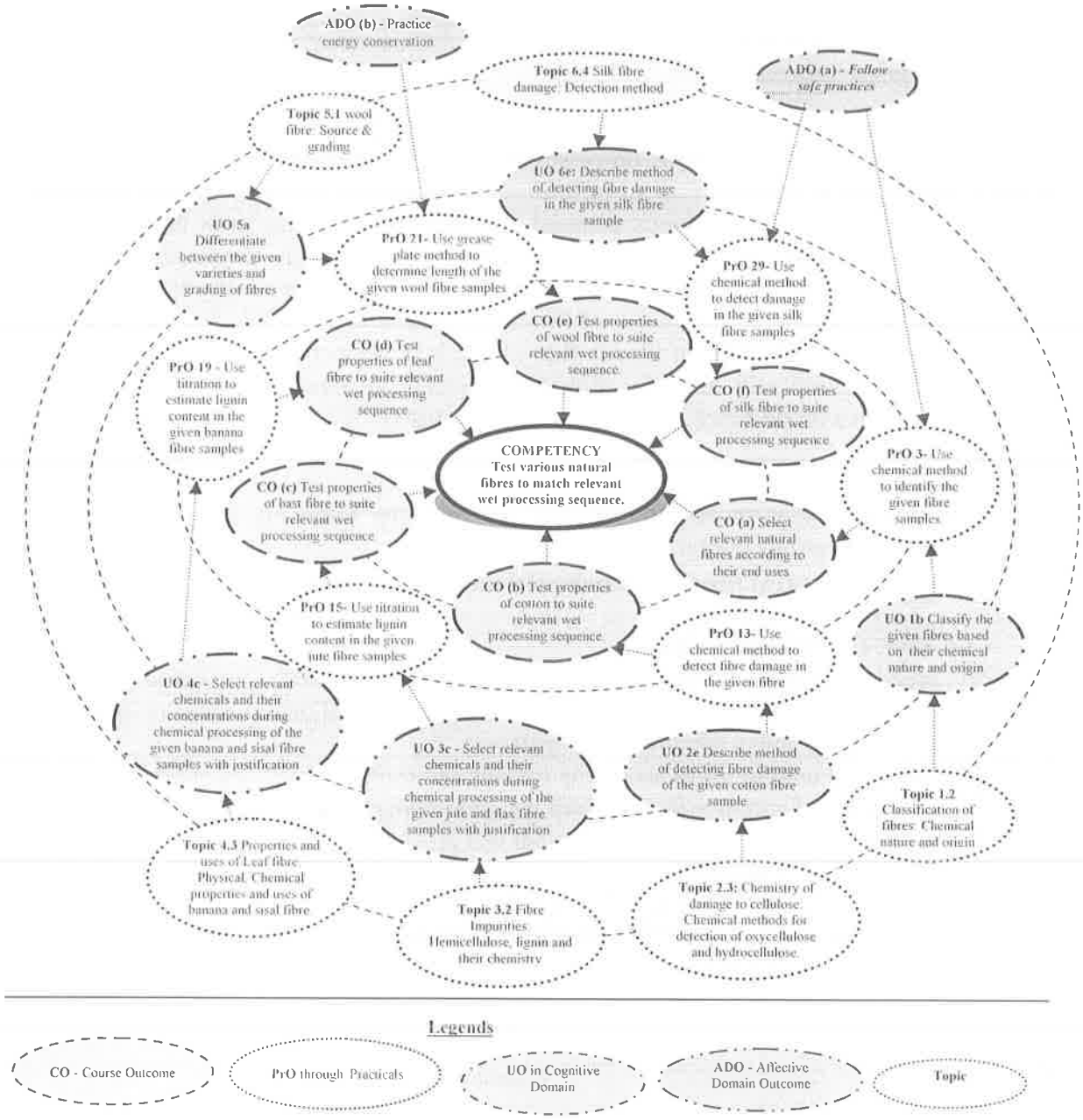

Figure 1 - Course Map

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 density gradiant column to identify class of the given fibre	I	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	samples- Part I		
2.	Use density gradiant column to identify class of the given fibre samples- Part II	I	02
3.	Use chemical method to identify the given fibre samples- Part I	I	02
4.	Use chemical method to identify the given fibre samples- Part II	I	02
5.	Use microscope to identify the given fibre samples- Part I	I	02
6.	Use microscope to identify the given fibre samples- Part II	I	02
7.	Determine moisture regain and moisture content of the given fibre samples- Part I	I	02
8.	Determine moisture regain and moisture content of the given fibre samples- Part II	I	02
9.	Use sodium hydroxide swelling method to determine maturity of the given cotton fibre- Part I	II	02*
10.	Use sodium hydroxide swelling method to determine maturity of the given cotton fibre- Part II	II	02
11.	Use titration method to determine accessible region of the given cotton samples- Part I	II	02
12.	Use titration method to determine accessible region of the given cotton samples- Part II	II	02
13.	Use chemical method to detect fibre damage in the given fibre samples- Part I	II	02
14.	Use chemical method to detect fibre damage in the given fibre samples- Part II	II	02
15.	Use titration to estimate lignin content in the given jute fibre samples- Part I	III	02*
16.	Use titration to estimate lignin content in the given jute fibre samples- Part II	III	02
17.	Use fibre strength tester to determine single fibre strength of the given flax fibre samples- Part I	III	02
18.	Use fibre strength tester to determine single fibre strength of the given flax fibre samples- Part II	III	02
19.	Use titration to estimate lignin content in the given banana fibre samples- Part I	IV	02*
20.	Use titration to estimate lignin content in the given banana fibre samples- Part II	IV	02
21.	Use grease plate method to determine length of the given wool fibre samples- Part I	V	02*
22.	Use grease plate method to determine length of the given wool fibre samples- Part II	V	02
23.	Use air flow principle instrument to determine fineness of the given wool fibre samples- Part I	V	02
24.	Use air flow principle instrument to determine fineness of the given wool fibre samples- Part II	V	02
25.	Use chemical method to detect damage in the given wool fibre samples- Part I	V	02
26.	Use chemical method to detect damage in the given wool fibre	V	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	samples- Part II		
27.	Use cut weight method to determine fineness of the given silk fibre samples- Part I	VI	02*
28.	Use cut weight method to determine fineness of the given silk fibre samples- Part II	VI	02
29.	Use cut weight method to determine fineness of the given silk fibre samples- Part III	VI	02
30.	Use chemical method to detect damage in the given silk fibre samples- Part I	VI	02
31.	Use chemical method to detect damage in the given silk fibre samples- Part II	VI	02
32.	Use chemical method to detect damage in the given silk fibre samples- Part III	VI	02
	Total		**64**

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 judicial 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	Selection of suitable component, apparatus/instrument	20
2	Preparation of experimental set up	10
3	Setting and operation	10
4	Safety measures	10
5	Observations and Recording	10
6	Interpretation of result and Conclusion	20
7	Answer to sample questions	10
8	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. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
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
- 'Organising Level' in 2nd year
- 'Characterising 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. S.No.
1.	Density gradiant column, known density solvants, standand density balls	1, 2
2.	Test tubes – 15 ml, test tube holder, 100 ml beaker, burner, etc.	3, 4
3.	Compound microscope, glass slides and cover glasses, dissection needles, scissors and tweezers, cross sectioning device, sharp blade etc.	5, 6, 9, 10
4.	Fibre samples, yarn, oven, desiccator, wrap reel etc.	7, 8
5.	250 ml Iodine flask, 10ml pipette, 50 ml burette, 250 ml beaker, 250 ml conical flask, etc.	11, 12
6.	250 ml beaker, glass rod, oven, desiccator	13, 14, 25, 26, 29, 30
7.	Oven, fibre sample, 250 ml beaker, glass rod	15, 16, 19. 20
8.	Fibre sample, fibre strength tester	17, 18
9.	Fibre samples, glass plate, grease, scale, divider, forceps etc.	21, 22
10.	Fibre samples, fibre fineness tester based on air flow principle	23, 24
11.	Fibre samples, weighting balance, template, etc.	27, 28

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 Textiles and Fibres	1a. Differentiate the properties of the given fabric sample based on substrate. 1b. Classify the given fibres based on their chemical nature and origin. 1c. Choose the given fibre based on the proeprties with justification. 1d. Differentiate between the specified regions of the given fibre structure.	1.1 Substrate: fibre, yarn, rope, fabrics, filament, 1.2 Classification of fibres: Chemical nature and origin. 1.3 Properties of fibre: Essential and desirable, degree of polymerization, moisture regain and moisture content 1.4 Fibre Structure: crystalline, mesomorphous and amorphous regions and their importance.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit– II Cotton	2a. Describe with sketches the method to determine maturity of the given cotton fibre. 2b. Select relevant chemicals to suit the cellulose structure for the given cotton with justification. 2c. Choose the relevant chemicals and their concentrations based on physical and chemical properties of the given cotton. 2d. Describe the method of detecting the fibre damage of the given cotton fibre sample. 2e. Describe with sketches the specified chemical method to detect fibre damage in the given sample.	2.1 Cotton: Cultivation and varieties of cotton, Morphological structure of cotton, Physical and chemical properties 2.2 Cellulose: Chemistry of cellulose and chemical composition, 2.3 Chemistry of damage to cellulose: Chemical methods for detection of oxycellulose and hydrocellulose.
Unit– III Bast Fibres	3a. Describe the properties of the given varieties of fibre. 3b. Describe with sketches the method to determine the chemical composition of the given fibre sample. 3c. Choose the relevant chemicals and their concentrations for the given fibre sample with justification. 3d. Describe with sketches the relevant method for retting and extraction of the given type of bast fibres.	3.1 Bast fibres: Cultivation of jute and flax, Retting and extraction of fibre, Morphological structure and chemical composition of jute and flax fibre. 3.2 Fibre Properties: Physical, Chemical and uses of jute and flax fibre, Lignin content in jute fibre, Fibre strength of flax fibre. 3.3 Fibre Impurities: Hemicellulose, lignin and their chemistry.
Unit-IV Leaf Fibres	4a. Differentiate the properties of the the specified type of fibres. 4b. Describe with sketches the relevant method to determine the chemical composition of the given type of fibres. 4c. Choose the relevant chemicals and their concentrations for processing the given fibre samples with justification. 4d. Describe with sketches the relevant method for retting and extraction of the given type of leaf fibres.	4.1 Leaf Fibre: Cultivation of banana and sisal, Morphological structure, Chemical composition of banana and sisal fibre. 4.2 Retting and extraction of fibre 4.3 Properties and uses of Leaf fibre: Physical, Chemical properties and uses of banana and sisal fibre. 4.4 Lignin content in banana fibre

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit –V Wool	5a. Select relevant chemicals to suit the chemical structure for processing of the given type of fibre with justification. 5b. Describe with sketches the revelant method for cleaning of the given wool fibre. 5c. Select relevant chemicals to suit the bonds during processing of the given type of fibre justification. 5d. Describe with sketches the given method to determine wool fibre length. 5e. Describe with sketches the use of given instrument instrument to determine wool fibre fineness.	5.1 Wool fibre: Source and grading, Structure of wool fibre: Morphological structure, chemical composition and structure of wool fibre 5.2 Cleaning of wool fibre: methods of cleaning. 5.3 Wool fibre Bonds: Selection of chemicals suiting the bonds. 5.4 Properties and uses of wool: Physical, chemical properties and uses, Selection of chemicals and their concentrations during chemical processing of wool fibre. 5.5 Wool fibre length: Grease plate method. 5.6 Wool fibre fineness: Use of air flow principle instrument.
Unit-VI Silk	6a. Describe with sketches the relevant method for sericulture and reeling the given fibre. 6b. Select the relevant chemicals to suit the morphological and chemical structure for processing of the given type of fibre with justification. 6c. Describe with sketches the method of detecting fibre damage of the given fibre sample. 6d. Describe with sketches the given method to determine given silk fibre sample fineness.	6.1 Silk Fibre: Varieties of Silk, Methods for Sericulture and reeling 6.2 Structure of silk fibre: Morphological structure and chemical composition. 6.3 Properties and uses of silk: Physical, chemical properties and uses of silk, Selection of chemicals and their concentrations during chemical processing of silk fibre. 6.4 Silk fibre damage: Detection method, Silk fibre fineness: Cut weight method.

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	Textiles and Fibres	09	04	04	10	18
II	Cotton	11	02	05	08	15
III	Bast fibres	07	02	02	05	09
IV	Leaf fibres	06	02	02	05	09
V	Wool	08	02	03	05	10

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
VI	Silk	07	02	02	05	09
Total		**48**	**14**	**18**	**38**	**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. Participate in Industry visit and report about the learning through visit.
b. Collect various fibre samples from different sources and check fibre lengths of these fibre samples.
c. Chart preparation – Physical and chemical properties of natural fibres.
d. Visit quality control department in textile industry and collect information of various testing methods of natural fibres.
e. Visit textile industry and collect information about chemicals used in wet processing of natural fibres.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning 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. Assign unit wise assignments to group of 4 to 5 students for solving unit wise questions.
h. Use of video, animation films to explain concepts, facts and applications related to variety of fibres.

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:

a. **Moisture Regain :** Collect 10 different fibre samples and measure its moisture regain and moisture content using relevant method and present the results.
b. **Maturity of cotton:** Collect 10 different cotton fibre samples from industries and determine fibre maturity coefficient using relevant method and present the results.
c. **Accessible Region:** Collect cotton fibre sample at various stages of chemical wet processing and determine accessible region using relevant method and present the results.
d. **Cotton Fibre Damage:** Collect 5 different cotton samples. Carry out desizing, scouring and bleaching of cotton fabric samples and assess it for damage and present the results.
e. **Cotton fibre Length:** Collect 10 different variety of cotton fibres and measure their lengths using grease plate method and present the results.
f. **Wool fibre Length:** Collect 10 different variety of wool fibres and measure their lengths using grease plate method and present the results.
g. **Cotton Fibre Fineness:** Collect 5 different variety of cotton fibre samples. Carry out scouring and bleaching of collected samples and measure their fineness using air flow principle instrument and present the results.
h. **Wool Fibre Fineness:** Collect 5 different variety of wool fibre samples. Carry out scouring and bleaching of collected samples and measure their fineness using air flow principle instrument and present the results.
i. **Cotton Single Fibre Strength:** Collect 10 different variety of cotton fibre samples and measure their fineness using cut weight method and compare it with air flow principle instrument.
j. **Wool Fibre Damage:** Collect 3 different wool fibre fabric samples. Carry out desizing, scouring and bleaching of these fabric samples and assess them for damage. Present the results.
k. **Silk Fibre Damage:** Collect 3 different silk fibre fabric samples. Carry out degumming and bleaching of silk fabric samples and access them for damage and present the results.
l. **Cotton Fibre Damage:** Treat the given cotton fibre fabric by varing the concentration of bleaching agent and assess it for damage. Present the results.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Handbook of Textile Fibres	Cook, J. G.	Woodhead Publication Ltd, England, 1984. ISBN: 9781855734845

S. No.	Title of Book	Author	Publication
2.	A Text Book of Fibre Science and Technology	Mishra, S. P.	New Age International, New Delhi (2000), ISBN: 9788122412505
3.	Handbook of Fibre Chemistry	Lewin, M.	Taylor and Francis Group, Boca Raton, 2006, ISBN: 9781855736849
4.	Bast and Other Plant Fibres	Franck, R. R.	Woodhead Publication Ltd., England, 2004, ISBN: 9781855736849
5.	Silk, Mohair, Cashmere and Other Luxury Fibres	Franck, R. R.	Woodhead Publication Ltd., England, 2001, ISBN: 9781855735408
6.	Wool, Science and Technology	Simpson, W. S.; Crawshaw, G. H.	Woodhead Publication Ltd., England, 2002, ISBN: 9781855735743
7.	Introduction to Textile Fibres	Murthy, H.V. S.	Woodhead Publication Ltd., England, 2002, ISBN: 9789385059094
8.	Silk Production, Processing and Marketing	Nanavaty, M.	Wiley Eastern Ltd., New Delhi., 1990, ISBN: 9788122402827
9.	Chemical Technology of Fibrous Materials	Sadov, F.; M. Korchagin, M.; Matetsky, A.	Mir Publishers, Moscow, 1978, ISBN: 9781124112170
10.	Fabric Care	D' Souza, N.	New Age International (P) New Delhi , 2014, ISBN: 9788122411430

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. slideshare.net/abiramprince
b. www.fibre2fashion.com/industry-article/
c. www.indiantextilejournal.com/News.apx
d. www.nirjaft.res.in/allied/allied.htm
e. www.isotextile.blogspot.com

Program Name : **Diploma in Textile Technology**

Program Code : **TC**

Semester : **Third**

Course Title : **Industrial Chemistry**

Course Code : **22362**

1. RATIONALE

In textile industry, various chemicals are used along with water in different processes. To maintain the quality of products at relevant stages of the process, measurement of various water quality parameters, selection of fuel, analysis of chemicals and auxiliaries are required. This course deals with fundamental information about testing methods of chemicals and auxiliaries. This course will help the diploma engineer to apply the basic principles of industrial chemistry to solve broad based problems and to create base of analytical techniques used for wet processing in textile industry.

2. COMPETENCY

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

- **Apply principles of chemistry for textile related industrial applications.**

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:

a. Measure quality parameters of water used in wet processing.
b. Select relevant fuel for boiler used in wet processing.
c. Choose relevant chemicals for wet processing.
d. Select relevant oil, soap, and detergent for wet processing.
e. Estimate the purity of chemicals used in textile industry.
f. Use metal complex compounds in textile industry.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme											
				Theory							Practical				
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20

(*): 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 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.

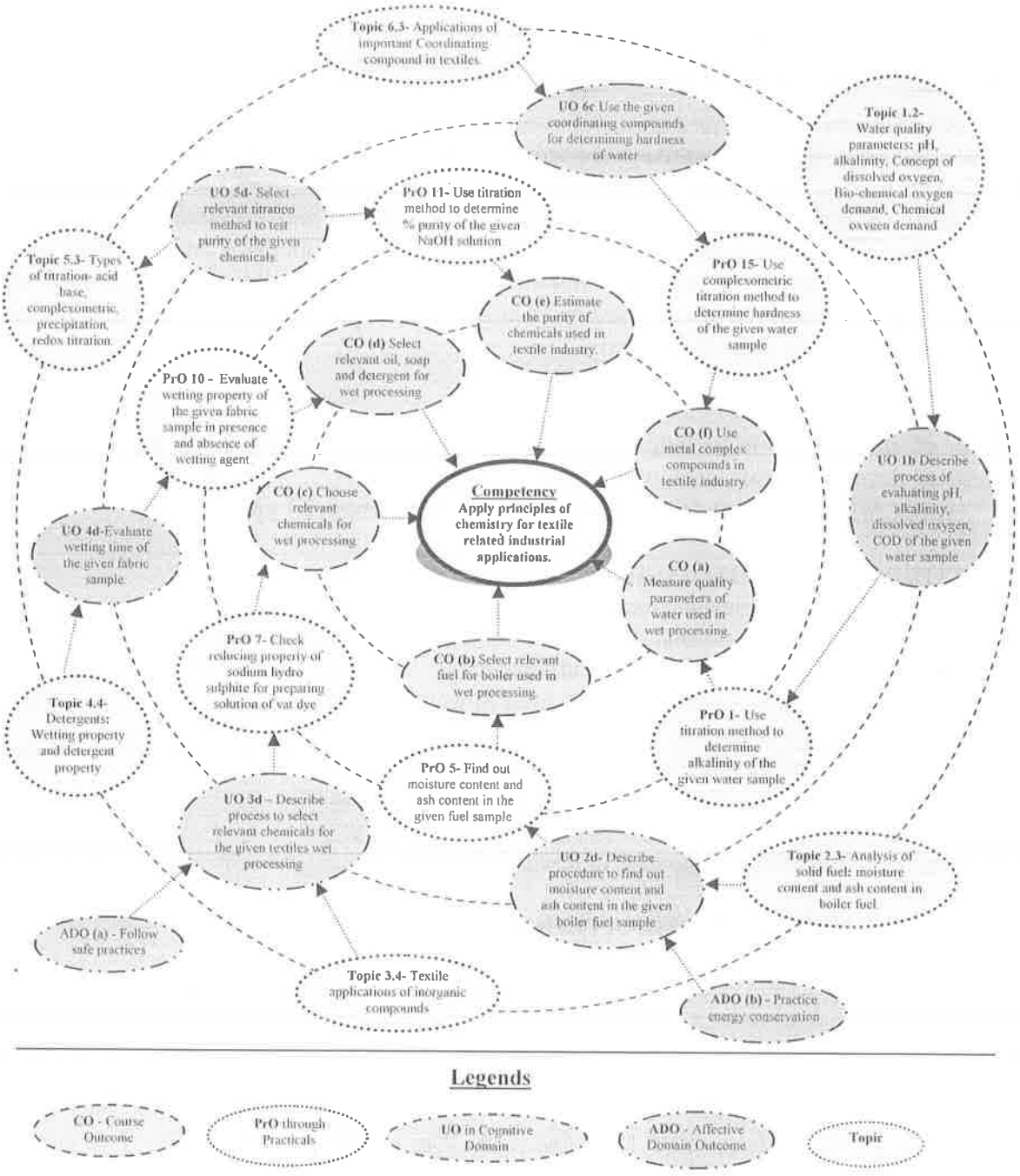

Figure 1 - Course Map

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 titration method to determine alkalinity of the given water sample.	I	02*
2.	Use titration method to determine dissolved oxygen present in the given water sample.	I	02
3.	Use evaporation method to: i. Determine total solids present in the given water sample. ii. Determine suspended solids and dissolved solid in the given water sample.	I	02
4.	Use titration method to determine chemical oxygen demand of the given water sample.	I	02
5.	Find moisture content and ash content in the given coal sample.	II	02*
6.	Find moisture content and ash content in the given bagasse sample.	II	02
7.	Check reducing property of sodium hydro sulphite for preparing the given solution of vat dye.	III	02*
8.	Find effects of dilution on pH of sodium hydroxide and sodium carbonate.	III	02
9.	Use titration method to determine saponification value of the given oil.	IV	02*
10.	Evaluate wetting property of the given fabric sample in presence and absence of wetting agent.	IV	02
11.	Use titration method to determine % purity of the given NaOH solution.	V	02*
12.	Use titration method to determine % purity of the given Na_2CO_3 solution.	V	02
13.	Use titration method to determine % purity of the given HCl solution	V	02
14.	Use titration method to determine % purity of the given acetic acid solution.	V	02
15.	Use complexometric titration method to determine hardness of the given water sample.	VI	02*
16.	Use titration method to determine strength of sodium hexameta phosphate.	VI	02
	Total		32

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 judicial mix of minimum 12 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	Selection of suitable component, apparatus/instrument	20
2	Preparation of experimental set up	10

S. No.	Performance Indicators	Weightage in %
3	Setting and operation	10
4	Safety measures	10
5	Observations and Recording	10
6	Interpretation of result and Conclusion	20
7	Answer to sample questions	10
8	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. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
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
- 'Organising Level' in 2nd year
- 'Characterising 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.	Electronic balance 1000 g, with least count 0.05gram	1 to 12
2.	Watch glass	5,6
3.	Borosilicate glass beaker (100ml, 150ml, 250ml), borosilicate glass volumetric flask (100ml, 250ml), soda glass rod.	1,2,3,4,5, 6, 9 to 16
4.	Porcelain Evaporating dish	3
5.	Water Condenser	4,8
6.	Silica crucible	5,6
7.	Pipette (10ml, 25ml and 10ml, 25ml graduated), burette (0.1ml least count, volume 50ml), borosilicate glass conical flask (250ml), burette stand	1,2,4,9,10 , 11
8.	Hot plate 1000 W, 230 Volt	3
9.	Chemicals – sodium hydroxide, sodium carbonate, hydrochloric acid, sulphuric acid, alkalized reagent, ferrous ammonium sulphate ferrion indicator, phenolphthalein indicator, methyl orange indicator, vat dye, sodium hydro sulphite potassium hydroxide (laboratory grade)	All

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 Water	1a. Explain effect of the given impurities on wet processing. 1b. Describe with sketches the process of evaluating pH, alkalinity, dissolved oxygen, COD of the given water sample. 1c. Differentiate between temporary and permanent hardness of the given water sample. 1d. Describe with sketches the method to determine total solids, suspended, and dissolved solids present in the given water sample.	1.1 Water: Impurities, their effects on textile wet processing. 1.2 Water quality parameters: pH, alkalinity, Concept of dissolved oxygen, Bio-chemical Oxygen Demand, Chemical Oxygen Demand. 1.3 Hardness of water: temporary, permanent, Units of hardness (ppm and mg/lit). 1.4 Scale and sludge: formation of scale and sludge in boilers, priming, and foaming. 1.5 Water softening methods: Ion exchangers and RO method.
Unit– II Boiler Fuels	2a. Classify the given boiler fuels based on the characteristics. 2b. Explain calorific value of the given fuel and its unit. 2c. Describe with sketches the procedure to find out moisture content and ash content in the given boiler fuel sample. 2d. Select the relevant boiler fuel for the given situation with justification.	2.1 Fuels: Classification, characteristics of good fuel. 2.2 Calorific value and its units: lower and higher calorific value, use of Bomb calorimeter. 2.3 Analysis of solid fuel: moisture content and ash content in boiler fuel.
Unit– III Chemistry of inorganic compounds	3a. Identify chemical structure of the given compounds used in textile industry with justification. 3b. Explain the chemical properties of the given acid. 3c. Explain chemical properties of the specified Inorganic compounds. 3d. Describe with sketches the process to select relevant chemicals for the given textile wet processing.	3.1 Inorganic compounds: Chemical structures of ammonium sulphate, sodium carbonate, sodium hydroxide, sodium sulphate, sodium hydro sulphite, hydrogen peroxide. 3.2 Acids: Chemical properties and uses of Sulphuric acid, Hydrochloric acid. 3.3 Chemical properties of ammonium sulphate, sodium carbonate, sodium hydroxide, sodium sulphate, sodium hydro sulphite, hydrogen peroxide. 3.4 Textile applications of inorganic

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		compounds.
Unit-IV Oils, Soaps and Detergents	4a. Determine the saponification value of the given oil. 4b. Describe the chemical properties of the given oil for the given situation 4c. Determine the wetting time of the given fabric sample. 4d. Describe with sketches the procedure to determine Saponification value of the given oil. 4e. Describe with sketches the procedure to evaluate wetting property of the specified fabric sample in the given situation.	4.1 Oils: Chemical nature of oils and fats, analytical methods to find Saponification value, iodine value of oil. 4.2 Chemical properties of oil: iodine value, hydrogenation, hydrolysis o: water hydrolysis and alkali hydrolysis. 4.3 Soaps: physical properties- soap solution as colloidal electrolyte, surface tension and interfacial tension lowering, foaming property. 4.4 Detergents: Wetting property and detergent property.
Unit –V Testing of Chemicals	5a. Classify testing methods of the given chemicals. 5b. Justify the importance of accuracy, precision, and precautions for titration of the given solution. 5c. Describe the primary and secondary standards used in the given titration. 5d. Select relevant titration method to test the purity of the given chemicals.	5.1 Textile chemicals: Testing Techniques- Qualitative and quantitative analysis, 5.2 Volumetric analysis: accuracy, precision, primary, and secondary standards used in titration, 5.3 Types of titration- acid base, complexometric, precipitation, redox titration.
Unit-VI Coordinating Compounds	6a. Explain the given co-ordination theory. 6b. Explain the factors affecting the stability of the given type of ions. 6c. Describe with sketches the use of the given coordinating compounds for the given situation. 6d. Describe with sketches the process to select sequestering agent of relevant strength for the given process.	6.1 Co-ordination compounds: Co-ordination number, Werner's Co-ordination theory, 6.2 Factors affecting the stabilities of complex ions and co-ordination compounds, 6.3 Applications of important Coordinating compound in textiles.

***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	Water	12	2	4	6	12
II	Fuels	08	2	2	6	10
III	Chemistry of some inorganic compounds	12	2	4	6	12
IV	Oils soaps and detergents	12	2	4	6	12
V	Testing of chemicals	12	2	4	8	14
VI	Coordinating compounds	08	2	3	5	10
Total		**64**	**12**	**21**	**37**	**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 textile industry; locate boiler and collect photographs of scales formed on different parts of boiler.
b. Collect information of various fuels used in boilers of different textile industries.
c. Visit quality control department in textile industry and collect information of various testing methods.
d. Collect information about relevant oils used in sizing, spin finish, thermo-pack, and as lubricant.
e. Visit textile industry and collect information about chemicals used in wet processing.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning 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 course content.
h. Assign unit wise assignments to group of 4 to 5 students for solving unit wise questions.
i. Use video, animation to explain concepts, facts, and applications related to variety of industrial chemicals.

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:

a. **Quality parameters of water used in textiles:** Collect samples of water used in textile industry and determine the alkalinity, hardness, and total solid of these samples. Present the results in report and seminar.
b. **Determine calorific value of fuel:** Collect various fuel samples such as bagasse, wood, coal and determine calorific value of fuel using Bomb calorimeter. Present the results.
c. **Applications of various acids**: Prepare solutions of acids by varying concentration, measure their pH values. Prepare presentation on applications of various acids, used in textile industry for relevant wet processing.
d. **Physical properties of compounds**: Collect samples of chemicals used in wet processing, test their physical properties and prepare comparative chart of these compounds. Present the results.
e. **Role of sodium compounds**: Collect all sodium compounds used in textile industry, Prepare comparative chart on role of all sodium compounds used in wet processing. Present the results.
f. **Select soaps and detergent:** Collect different wetting agents from laboratory; and check wetting time of given fabric with and without applying surface active agents. Present the results.
g. **Estimate purity of chemicals:** Collect chemicals such as sulphuric acid, sodium hydroxide; sodium carbonate used in wet processing and checks the purity of these compounds. Present the results.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication

S. No.	Title of Book	Author	Publication
1	Handbook of Industrial Chemistry: Organic Chemicals	Mohammad Farhat Ali; Bassam, M. El Ali, James G. Speight	McGraw-Hill Education, New Delhi, ISBN: 9780071410373
2	Engineering Chemistry	Jain & Jain	Dhanpat Rai and sons; New Delhi, 2015, ISBN: 9352160002
3	Industrial Chemistry (including Chemical Engineering)	Sharma, B.K.	Goel Publishing House, Gandhinagar, 1997 ISBN: 9788187224006
4	Engineering Chemistry	Dara, S. S.	S. Chand. Publication, New Delhi, 2013, ISBN: 8121997658
5	Practical Chemistry	Pandey, O. P.; Bajpai, D. N.; Giri, S.	S. Chand. Publication, New Delhi, 2016, ISBN: 9788121908122

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.prezi.com/n58ay35pn6hc/characteristics-of-water-used-in-the-textile-industry/
b. www.bib.irb.hr/datoteka/649108.Dekanic_WASTEWATER.pps
c. www.ignou.ac.in/upload/unit-3.pdf
d. www.quora.com/How-do-we-calculate-the-calorific-value-of-a-fuel
e. www.slideshare.net/ssuserf2233e/chemicals-used-in-textile-wet-processing-their-function-assignment-work
f. www.textilefashionstudy.com/list-of-basic-chemicals-used-for-knit-dyeing-chemicals-and-auxiliaries/
g. www.slideshare.net/muhammedthahir129/soap-and-detergents 15243636?next_slideshow=2oils soaps and detergents
h. www.mvla.net/view/27581.pdf
i. www.en.wikipedia.org/wiki/Analytical_chemistry#Quantitative_analysis
j. www.cabrillo.edu/~dscoggin/chem1b/lecturenotes/Ch23%20Coordination (a).ppt

Program Name : **Diploma in Textile Technology**

Program Code : **TC**

Semester : **Third**

Course Title : **Chemistry of Aromatic Compounds and Dyes**

Course Code : **22363**

1. RATIONALE

In textile industries, various types of synthetic dyes and pigments are used for dyeing and printing of textiles. These are the important stages in the textile wet processing. The quality of dyes and pigments used for dyeing and printing of fabric determines the quality, aesthetic value and market value of the fabric. Most of the synthetic dyes and pigments are aromatic organic compounds. Aromatic compounds called dye intermediates are used in the synthesis and manufacturing of different dyes. Therefore, the knowledge of physical and chemical properties of aromatic compounds will help the diploma engineers to understand the structure and properties of dyes and pigments. This course is developed in the way by which fundamental information will help the diploma engineers to apply the basic concepts of aromatic chemistry to solve broad based problems in dyeing and printing 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 aromatic compounds and dyes in textile processing.**

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:

a. Identify relevant processes for manufacturing of dyes.
b. Select relevant aromatic compounds for manufacturing of dye intermediates.
c. Prepare relevant azo dyes by diazotization and coupling.
d. Prepare relevant dye intermediates by sulfonation, nitration, and reduction.
e. Select relevant dyes for dyeing of fabrics.
f. Prepare dyes based on chemical structure and properties.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	

(*): 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 UOs required for the attainment of the COs.

Legends: ***L****-Lecture;* ***T*** *– Tutorial/Teacher Guided Theory Practical;* ***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.

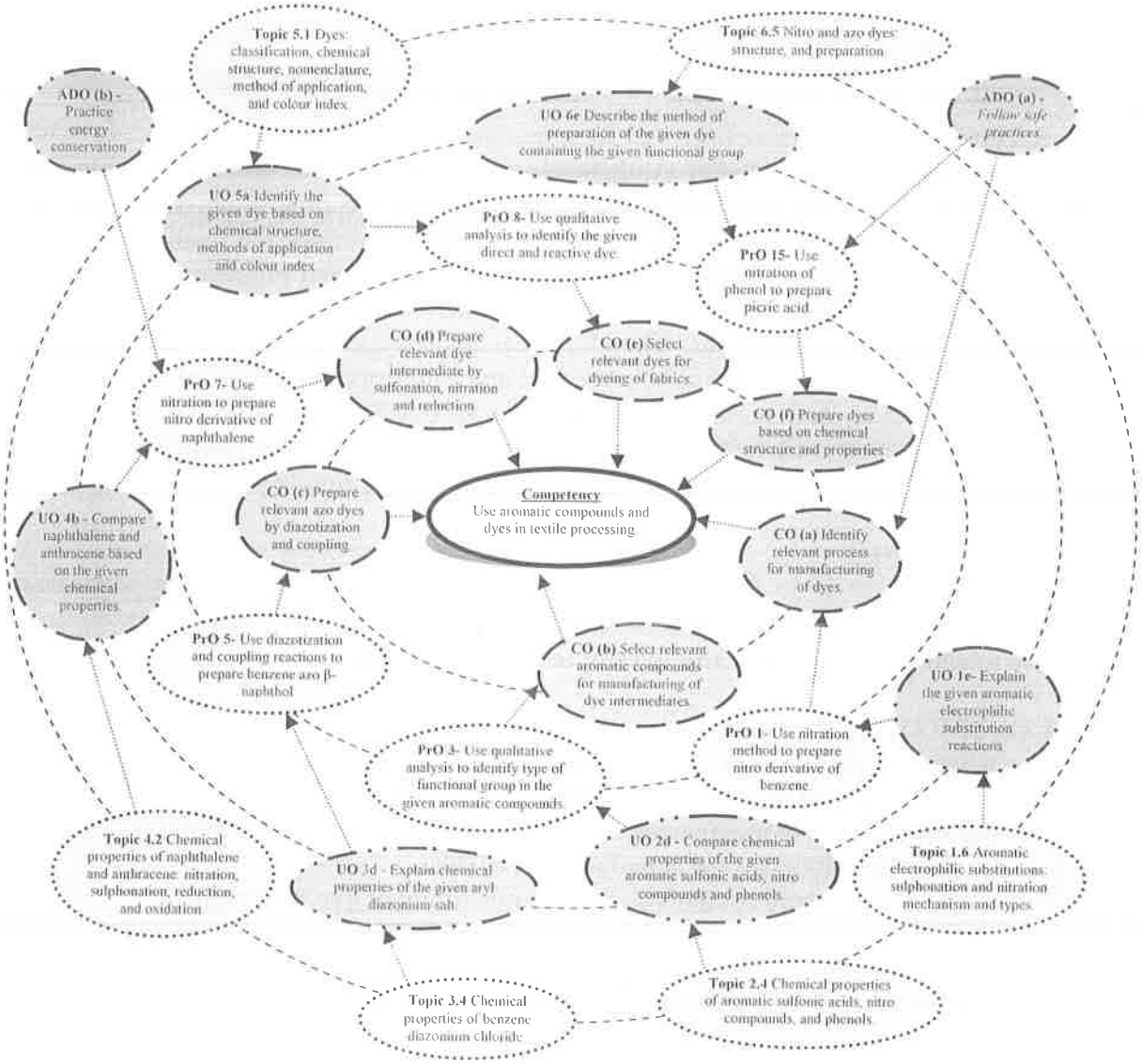

Figure 1 - Course Map

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 nitration method to prepare nitro derivative of benzene	1	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
2	Use qualitative analysis to identify type of functional group in the given aromatic compounds.-COOH, Phenolic-OH, -CHO	II	02
3	Use qualitative analysis to identify type of functional group in the given aromatic compounds. -CO, $-NH_2$,$-NO_2$	II	02*
4	Prepare phenol formaldehyde resin	II	02
5	Use diazotization and coupling reactions to prepare benzene azo β-naphthol	III	02*
6	Use diazotization method to estimate aromatic amines	III	02
7	Use nitration to prepare nitro derivative of naphthalene	IV	02*
8	Use qualitative analysis to identify the given direct and reactive dye	V	02
9	Use qualitative analysis to identify the given Sulphur and vat dye	V	02*
10	Use qualitative analysis to identify the given acid, basic and disperse dye	V	02
11	Use qualitative analysis to identify direct and reactive dye on the given fiber	V	02
12	Use qualitative analysis to identify azoic, Sulphur and vat dye on the given fiber	V	02
13	Use spotting method to determine solubility of the given dye sample	V	02
14	Use qualitative analysis to identify acid, basic and disperse dye on the given fiber	V	02
15	Use nitration of phenol to prepare picric acid	VI	02*
16	Use diazotization and coupling reactions to prepare p-amino benzene (aniline yellow)	VI	02
	Total		**32**

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 judicial mix of minimum 12 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	Selection of suitable component, apparatus/ instrument	20
2	Preparation of experimental set up	10
3	Setting and operation	10
4	Safety measures	10
5	Observations and Recording	10
6	Interpretation of result and Conclusion	20
7	Answer to sample questions	10
8	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. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
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
- 'Organising Level' in 2nd year
- 'Characterising 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.	Borosilicate test tubes (diameter-13 mm, length-100 mm), beakers (150 ml, 250 ml), soda glass rod, test tube holder, test tube stand	3, 7, 8, 9, 10, 11, 12
2.	Bunsen burner (diameter-11 mm, height-125 mm, gas inlet-8 mm), tripod stand, wire gauze	3, 7, 8, 9, 10, 11, 12
3.	Burette stand, clamp	2, 4, 5, 16
4.	Burette (50 ml), pipette (25 ml), conical flask (250 ml)	3, 4, 5, 16
5.	Simple funnel (rim-120 mm, stem length-120 mm), filter paper, suction pump, porcelain Buchner funnel (inside diameter-14.5 mm, perforated area diameter-11 mm, depth-8.5 mm)	1, 2, 6, 13, 14, 15
6.	Round bottom flask (200 ml)	1, 2, 6, 13, 14, 15
7.	Coil reflux condenser (24/40, 200 mm)	1, 2, 6, 13, 14, 15

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 Aromatic Hydrocarbons	1a. Explain characteristics of the specified aromatic compounds. 1b. Identify the given aromatic compounds by their functional groups. 1c. Describe with sketches the	1.1 Aliphatic and aromatic compounds: difference. 1.2 Aromatic compounds: functional groups, structure, and nomenclature. 1.3 Coal tar distillation

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	process of separation of relevant aromatic compounds in coal tar. 1d. Describe with sketches the method of preparing benzene and toluene from the given material. 1e. Explain the given aromatic electrophilic substitution reaction.	1.4 Benzene: preparation methods- From coal tar, aromatization of n-hexane and acetylene. 1.5 Toluene: preparation methods- from coal tar, aromatization of n-heptane, by Friedel-Craft's alkylation, by Wurtz-Fittig reaction. 1.6 Aromatic electrophilic substitutions: sulphonation and nitration- mechanism and types.
Unit– II Aromatic sulfonic acids, nitro compounds and phenols	2a. Describe with sketches the the method of preparation of the given aromatic sulfonic acid. 2b. Describe with sketches the the method of preparation of the given aromatic nitro compound. 2c. Describe with sketches the the method of preparation of the given phenol. 2d. Compare chemical properties of the given aromatic sulfonic acids, nitro compounds, and phenols. 2e. Explain with sketches the industrial applications of the given aromatic sulphonic acid, nitro compound, and phenol.	2.1 Benzene sulphonic acid: preparation methods- direct sulphonation of benzene, oxidation of thiophenol, aryl sulphonyl chlorides. 2.2 Nitro benzene: preparation methods- direct nitration of benzene, oxidation of aryl amines benzene diazonium chloride. 2.3 Phenol: preparation methods- from chlorobenzene (Dow's process), cumene, benzene diazonium chloride. 2.4 Chemical properties of aromatic sulphonic acids, nitro compounds, and phenols. 2.5 Industrial applications
Unit– III Aromatic amines and aryl diazonium salts	3a. Describe with sketches the the method of preparation of the given aromatic amine. 3b. Explain chemical properties of the given aromatic amines. 3c. Describe with sketches the the method of preparation of the given aryl diazonium salt. 3d. Explain chemical properties of the given aryl diazonium salt.	3.1 Aniline: preparation methods- from nitrobenzene, azo compounds. 3.2 Chemical properties of aniline: nitration, sulfonation, oxidation, reaction with nitrous acid. 3.3 Benzene diazonium chloride: preparation method- diazotization of aniline. 3.4 Chemical properties of benzene diazonium chloride.
Unit-IV Polynuclear hydrocarbons and dye	4a. Identify polynuclear hydrocarbons based on nomenclature, classification, and resonating structure. 4b. Compare naphthalene and anthracene based on the given	4.1 Polynuclear hydrocarbons: nomenclature, classification, and resonating structure. 4.2 Chemical properties of naphthalene and anthracene: nitration, sulfonation, reduction,

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
intermediates	chemical properties. 4c. Identify the given dye intermediates based on nomenclature and structure. 4d. Describe with sketches the the method of preparing the given dye intermediate by sulfonation, nitration, and reduction.	and oxidation. 4.3 Dye intermediates: nomenclature and structure of H-acid, J-acid, G-acid, Naphthionic acid, Gamma acid, and Schaffer's acid.
Unit –V Elements of dyestuff industry	5a. Identify the given dye based on chemical structure, method of application and colour index. 5b. Explain general characteristics of the given dye. 5c. Describe with sketches the method of determining solubility of the given dye. 5d. Classify the given pigments based on chemical composition. 5e. Differentiate between the given dyes and pigments based on solubility, light fastness, and chemical bonding.	5.1 Dyes: classification, chemical structure, nomenclature, method of application, and colour index. 5.2 Dyes general characteristics: solubility, fastness, affinity, low cost, easy availability, ecofriendly, and bright shades. 5.3 Pigments: classification, chemical structure. 5.4 Dyes and pigments: solubility, light fastness, and chemical bonding.
Unit-VI Dyes-Structure and property relationship	6a. Identify the factors governing absorption of light by the given organic compounds. 6b. Explain the relationship between colour and chemical constitution of the given dye. 6c. Explain the relationship between chemical structure and substantivity of the given dye. 6d. Explain the relationship between chemical structure and fastness properties of the given dye. 6e. Describe with sketches the the method of preparation of the given dye containing the given functional group.	6.1 Absorption of light by organic compounds: valence bond theory and molecular orbital theory. 6.2 Colour and chemical constitution of dye: Witt's theory, chromophore, Auxochrome. 6.3 Substantivity: Relation between chemical structure of dye and substantivity, linearity, co-planarity. 6.4 Fastness property: Types, relation between fastness and structure of dye. 6.5 Nitro and azo dyes: structure and preparation.

***Note**: To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' 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	Aromatic Hydrocarbons	10	02	04	06	12
II	Aromatic sulphonic acids, nitro compounds and phenols	08	02	03	05	10
III	Aromatic amines and aryl diazonium salts	12	02	03	05	10
IV	Polynuclear hydrocarbons and dye intermediates	08	02	03	05	10
V	Elements of dyestuff industry	14	02	04	08	14
VI	Dyes- Structure and property relationship	12	02	04	08	14
TOTAL		**64**	**12**	**21**	**37**	**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. Collect information about dyes from various dye manufactures and prepare report/ presentation.
b. Visit dyeing unit in textile industry, collect photographs related to the process of different dye solution preparation and compare it with laboratory method. Prepare a report/ presentation.
c. Find relevance between class of dye, colour shed and chromophore present in dye. Prepare a report/ presentation.
d. Visit nearby textile industry and collect information about the dyes used. Prepare a report/ presentation.
e. Visit quality control department in textile industry and collect information about testing of dyes. Prepare a presentation on testing methods used in industry.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning 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 are 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 course content.
h. Assign unit wise assignments to group of 4 to 5 students for solving unit wise questions.
i. Use video, animation to explain concepts, facts, and applications related to variety of industrial chemicals.

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:

a. **Collection of Dyes Samples**- Collect samples of reactive, vat, disperse, direct and Sulphur dyes from manufacturers/ textile industry and prepare presentation based on structure and colour index.
b. **Dye intermediates** - Prepare presentation on different types of dye intermediates used in textile industry, based on the structure, IUPAC name, and method of preparation.
c. **Qualitative analysis of dye samples**- Collect samples of different dyes, use qualitative analysis to detect their type and report the results in presentation form.
d. **Qualitative analysis of dyed fabrics**- Collect samples of dyed fabrics from textile industries, use qualitative analysis to detect type of dye on fabric and report the results in presentation form.
e. **Preparation of azoic dyes**- Prepare different types of azoic dyes by choosing diazotization and coupling reactions and report the results in presentation form.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	A textbook of Organic Chemistry	Bahl, A.; Bahl, B. S.	S. Chand Publishing, New Delhi, 2016, ISBN: 9789352531967
2.	A textbook of Organic Chemistry	Tewari, K. S.; Vishnoi, N. K.	Vikas Publishing House, Noida (UP), 2015, ISBN:

S. No.	Title of Book	Author	Publication
			9788125918578
3.	Organic Chemistry	Gupta, S. S.	Oxford University Press, New Delhi, 2016, ISBN: 9780199451647
4.	Practical Chemistry	Pandey, O. P.; Bajpai, D. N.; Giri, S.	S. Chand Publishing, New Delhi, 2016, ISBN: 9788121908122
5.	The Chemistry of Synthetic Dyes, Vol-V	Venkatraman, K.	Academic Press, Elsevier, USA, 2012, ISBN: 9780127170053
6.	Synthetic Dyes	Chatwal, G. R.	Himalaya Publishing House, Mumbai, 2009, ISBN: 9788184882193
7.	Chemistry of Dyes and Principles of Dyeing (Technology of Textile Processing)	Shenai, V. A.	Sevak Publications, Mumbai, 1983

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. en.wikipedia.org/wiki/Category:Aromatic_compounds
b. www.britannica.com/science/aromatic-compound
c. www.britannica.com/science/sulfonic-acid
d. staff.um.edu.mt/ratk1/BenzeneSulphonicAcids.htm
e. chemistry.tutorvista.com/organic-chemistry/nitro-group.html
f. en.wikipedia.org/wiki/Phenols
g. www.britannica.com/science/phenol
h. en.wikipedia.org/wiki/Aromatic_amine
i. chem.libretexts.org/Core/Organic_Chemistry/Amines/Reactivity_of_Amines/Reactions_of_Aryl_Diazonium_Salts
j. en.wikipedia.org/wiki/Naphthalene
k. en.wikipedia.org/wiki/Anthracene
l. www.britannica.com/technology/dye
m. en.wikipedia.org/wiki/Dye
n. en.wikipedia.org/wiki/Color_index

Program Name : **Diploma in Textile Technology**

Program Code : **TC**

Semester : **Third**

Course Title : **Textile Testing**

Course Code : **22364**

1. RATIONALE

In textile industry, the quality textile is manufactured through many processes such as dyeing, printing, and finishing. These major processes improve the aesthetic as well as the market value of textile. To maintain good quality production of textile, testing of yarn, and fabric at various stages is very essential. Knowledge and skills related to various testing parameters such as yarn strength, tensile properties of fabric, water and air relation of fabric, etc. are essential for diploma engineer. This course is developed in such a way that basic concepts and principles of yarn and fabric testing will help the diploma engineer to evaluate the properties and quality of yarn and fabric as well as prepare them to solve broad based problems in textile industry.

2. COMPETENCY

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

- **Test yarns and fabrics based on physical properties.**

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:

a. Perform yarn testing.
b. Select fabric based on dimensional properties for relevant application.
c. Select relevant fabric based on its serviceability for given application.
d. Test handle-and-comfort properties of fabric.
e. Select yarn and fabric based on their tensile properties.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Theory							Practical						
L	T	P		Paper Hrs.	ESE		PA		Total		ESE		PA		Total		
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	
4	-	2	6	3	70	28	30*	00	100	40	25@	10	25	10	50	20	

(*): 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.

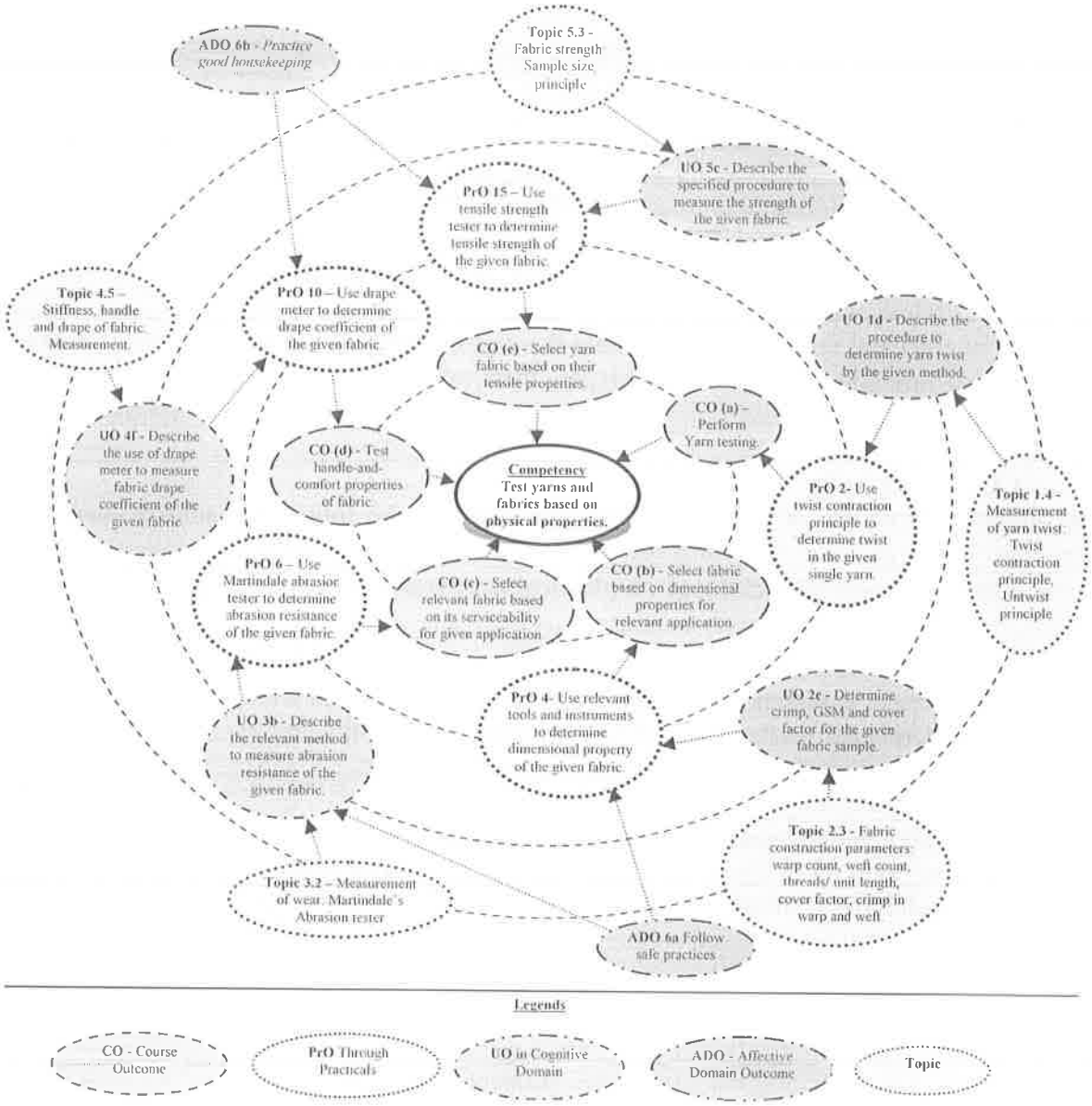

Figure 1 - Course Map

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 wrap reel to determine yarn number (Ne, Nm, Tex and Denier) of the given yarn.	I	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
2	Use twist contraction principle to determine twist in the given single yarn.	I	01
3	Use twist and untwist principle to determine twist in the given double yarn.	I	01
4	Use relevant tools and instruments to determine dimensional properties of the given fabric (Thread count, Threads/Inch, Thread Crimp, GSM, Cover Factor, and Fabric Cover).	II	02*
5	Determine shrinkage of the given fabric with hot water and hot air.	II	02
6	Use Martindale abrasion tester to determine abrasion resistance of the given fabric.	III	02*
7	Use ICI pill box tester to grade the given fabric based on its pilling property.	III	02
8	Use crease recovery tester to determine crease recovery angle of the given fabric.	IV	02*
9	Use stiffness tester to determine bending modulus of the given fabric.	IV	02
10	Use drape meter to determine drape coefficient of the given fabric.	IV	02
11	Use spray tester to determine water repellency and Hydrostatic water head tester to determine water proofness of the given fabric.	IV	02
12	Use air permeability tester to determine air permeability of the given fabric.	IV	02
13	Use single yarn strength tester to determine breaking load and elongation of the given yarn.	V	02*
14	Use lea strength tester to determine lea strength and count strength product (CSP) of the given yarn.	V	02
15	Use tensile strength tester to determine tensile strength of the given fabric.	V	02
16	Use Elmendorf tearing strength tester to determine tearing strength of the given fabric.	V	02
17	Use bursting strength tester to determine bursting strength of the given fabric.	V	02
	Total		**32**

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 judicial mix of minimum 12 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	Selection of suitable component, apparatus/instrument	20
2	Preparation of experimental set up	10
3	Setting and operation	10
4	Safety measures	10

S. No.	Performance Indicators	Weightage in %
5	Observations and Recording	10
6	Interpretation of result and Conclusion	20
7	Answer to sample questions	10
8	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. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
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
- 'Organising Level' in 2nd year and
- 'Characterising 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.	Electronic balance, scale range - 0.001g to 500 g. Pan size 100 mm; response time 3-5 sec.; power requirement 90-250 V, 10 watt.	1, 2, 3, 4, 6, 9, 11, 12
2.	English Wrap reel with 1.5 yard circumference, British Wrap reel with 1 meter circumference.	1, 2, 3, 11, 12
3.	Single yarn twist tester based on twist contraction principle.	2
4.	Double yarn twist tester based on 'twist and untwist' principle.	3
5.	Electric oven inner size 18''x18''x18''; temperature range 100^0 to 250^0 C with the capacity of 40 liters.	5
6.	Martindale abrasion tester with multi-directional rotation with 9-12 kPa pressure at 60 rpm.	6
7.	ICI pill box tester with cork lined dimensions of box 9" X 9" X 9".	7
8.	Crease recovery angle tester - angle range 0^0 to 180^0.	8
9.	Stiffness tester based on canti lever principle with tilt angle 41.5^0.	9
10.	Drape meter with sodium vapor lamp.	10
11.	Single yarn strength tester based on CRE principle (capacity 0 -1000 gmf).	11
12.	Lea strength tester based on CRE or Pendulum lever principle (capacity 200 lbs).	12

S. No.	Equipment Name with Broad Specifications	PrO. No.
13.	Fabric tensile strength tester based on CRE or pendulum lever principle (capacity 0 to 250 kilogram-force (kgf)).	13
14.	Elmendorf tearing strength tester with range 1600 to 6400 gmf.	14
15.	Bursting strength tester (capacity 0 -50 kg/cm^2).	15
16.	Spray test tester with flask capacity 250 ml.	16
17.	Air-permeability tester with 20 cm^2 test head.	17

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 Yarn Testing	1a. Differentiate between the specified yarn count systems. 1b. Describe the effect of twist on the properties given type of yarn/ fabric. 1c. Describe with sketches the procedure to determine yarn twist by the given method. 1d. Explain the impact of unevenness on the properties of the given type of yarn/fabric.	1.1 Yarn numbering: Direct, Indirect. 1.2 Yarn Count: British count, Metric count, Tex, Denier count, Standard method of determination of yarn count with electronic balance. 1.3 Properties: Yarn Twist, Twist Direction, effect of twist on yarn and fabric properties. 1.4 Measurement of yarn twist: Twist contraction principle, Untwist principle 1.5 Yarn evenness: types of variations in yarn, Random and Periodic 1.6 Unevenness: expressions,U%, C.V. %, Imperfections, Effect of yarn unevenness on Yarn and Fabric properties.
Unit-II Fabric Sampling and Dimensional Properties	2a. Describe with sketches the given fabric sampling method for textile testing. 2b. Select fabric based on dimensional properties for the given application with justification. 2c. Determine crimp, GSM and cover factor for the given fabric sample. 2d. Describe with sketches to test the shrinkage of the given fabric sample and its suitability for relevant application.	2.1 Sampling method: Biased and Random sampling 2.2 Fabric dimensional properties: fabric length, width, thickness, weight. 2.3 Fabric construction parameters: warp count, weft count, threads/ unit length, cover factor, crimp in warp and weft. 2.4 Dimensional stability of fabric: measurement for hot water and hot air.
Unit– III Fabric	3a. Select fabric for the given data based on abrasion test with	3.1 Serviceability, wear, and abrasion.

Serviceability	justification. 3b. Describe with sketches the relevant method to measure abrasion resistance of the given fabric. 3c. Describe with sketches the process to measure pilling resistance of the given fabric. 3d. Rate the given fabric for pilling resistance with justification.	3.2 Measurement of wear: Martindale's Abrasion tester. 3.3 Pilling of fabric: factors responsible, pilling resistance. 3.4 Measurement: ICI Pill box tester.
Unit-IV Fabric Comfort and Handle Properties	4a. Choose the relevant water fabric relation test for the given fabric with justification. 4b. Describe with sketches the specified test procedure to measure fabric water relation. 4c. Rate the given fabric sample for water repellency with justification. 4d. Describe with sketches the method to measure fabric air relation for the given sample. 4e. Describe with sketches the use of drape meter to measure fabric drape coefficient of the given fabric. 4f. Describe with sketches the procedure to measure fabric crease recovery angle of the given fabric.	4.1 Water and air relation to fabric: absorbency, waterproof, shower proof and water repellent fabrics, basic concept of wetting- contact angle 4.2 Measurement: Spray test, Hydrostatic water head test 4.3 Air Properties: Air-permeability, Air-resistance, Air-porosity, measurement of air permeability, factors affecting air permeability. 4.4 T.I.V. (Thermal Insulation Value.): Purpose ad applications. 4.5 Stiffness, handle and drape of fabric: Measurement 4.6 Crease recovery: measurement by crease recovery angle.
Unit –V Tensile Strength	5a. Select relevant tensile strength test method for the given fabric with justification. 5b. Describe with sketches the specified procedure to measure yarn strength of the given fabric. 5c. Describe with sketches the procedure to measure the strength of the given fabric. 5d. Describe with sketches the procedure measure tensile, tearing and bursting strengths of the given fabric.	5.1 Fabric Properties: Tensile Strength, load, elongation, mass stress, tenacity, elastic recovery. 5.2 Yarn strength: measurement of single yarn strength and lea strength of yarn (CSP). 5.3 Fabric strength: Sample size, principle. 5.4 Measurement of tensile strength, tearing strength and bursting strength.

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	Yarn Testing	16	03	05	07	15
II	Fabric Sampling and Dimensional Properties	10	04	04	04	12
III	Fabric Serviceability	12	02	04	04	10
IV	Fabric Comfort and Handle Properties	14	04	05	08	17
V	Tensile Strength	12	04	05	07	16
Total		**64**	**17**	**23**	**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. Market survey of different yarns and fabrics and compare them based on their properties, applications, and prices.
b. Library survey regarding yarns and fabrics used in different industries.
c. Prepare table for different chemicals used in fabric wet processing of cotton and their effects on fabric properties after treatment.
d. Prepare question bank referring earlier MSBTE question papers.
e. Give seminar on relevant topic.

11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

These are sample strategies, which the teacher can use to accelerate the attainment of the various learning 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. Encourage students to refer different websites to have deeper understanding of the subject.
g. Assign unit wise assignments to group of 4 to 5 students for solving unit wise questions.

h. Use of video, animation films to explain concepts, facts and applications related to textile testing.

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:

a. **Yarn Number:** Visit industries and market shops and collect at least 20 yarn samples of various sizes, and yarns with different yarn numbers according to yarn numbering systems. Find the current price and end use of the yarn samples collected, present the results.
b. **Yarn Evenness:** Collect different yarn samples with faults such as thick, thin, and neps. Find out the problems occur due to such faults in yarn after chemical processes such as scouring, bleaching, dyeing and finishing.
c. **Fabric Thickness:** Collect and prepare chart of different fabric sample with different thickness and also find the end use of that fabric.
d. **Fabric GSM:** Collect fabric samples with different GSM and find out the effect of each chemical process such as scouring, bleaching, dyeing and finishing on fabric GSM. Present your results.
e. **Fabric Shrinkage:** Evaluate the effect of every stage of chemical processing such as scouring, bleaching, dyeing, and finishing on the shrinkage of fabric. Present your report.
f. **Fabric serviceability:** Evaluate the effect of every stage of chemical processing such as scouring, bleaching, dyeing, and finishing on the serviceability properties of fabric. Present your report.
g. **Fabric Handle:** Evaluate the effect of every stage of chemical processing such as scouring, bleaching, dyeing, and finishing on the Handle properties of fabric. Present your report.
h. **Fabric Comfort:** Evaluate the effect of every stage of chemical processing such as scouring, bleaching, dyeing, and finishing on the Air-Permeability of fabric. Present your report.
i. **Fabric Comfort:** Evaluate the effect of every stage of chemical processing such as scouring, bleaching, dyeing, and finishing on Water relation of fabric. Present your report.
j. **Yarn strength:** Evaluate the effect of every stage of chemical processing such as scouring, bleaching, dyeing, and finishing on Yarn strength of fabric. Present your report.

k. **Tensile strength:** Evaluate the effect of every stage of chemical processing such as scouring, bleaching, dyeing, and finishing on Tensile strength of fabric. Present your report.

l. **Tearing and Bursting strength:** Evaluate the effect of every stage of chemical processing such as scouring, bleaching, dyeing, and finishing on Tearing and bursting strength of fabric. Present your report.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Principles of Textile Testing	Booth, J. E.	CBS Publishers and Distributors Private Ltd., New Delhi, 2013, ISBN: 9788123905150
2.	Physical Testing of Textiles	Saville, B.P.	Wood Head Publishing Limited, Cambridge, England, 2002 ISBN: 9781855733671
3.	Textile Testing Fibre and Yarn Testing	Koushik, C.V.; Chandrasekaran, R.	NCUTE Publication, IIT New Delhi.
4.	Textile Testing - Physical, Chemical and Microscopical	Skinkle, John H.	Chemical Publishing Co Inc., Brooklyn, N.Y., 1940, ASIN: B001OMN6VS
5.	Testing and Quality Management	Kothari, V.K.	IAFL, New Delhi, 1999 ISBN: 9788190103305
6.	Hand book of Textile Testing and Quality Control	Grover, E.B; Hamby, D.C.	John Wiley and Sons Inc., 1960, ISBN: 9780470329016
7.	Methods of Tests, Fibre, Yarn and Fabric	--	CIRCOT, Mumbai
8.	A Practical Guide to Textile Testing	Amutha K.	Wood Head Publishing, New Delhi, 2016. ISBN: 9789385059070

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

a. www.nptel.ac.in/courses/106105085/4
b. www.nptel.ac.in/courses/116102029/3
c. www.nptel.ac.in/courses/116102029/10
d. www.nptel.ac.in/courses/116102029/30
e. www.nptel.ac.in/courses/116102029/38
f. www.nptel.ac.in/courses/116102029/43
g. www.nptel.ac.in/courses/116102029/46
h. www.nptel.ac.in/courses/116102029/48
i. www.nptel.ac.in/courses/116102029/51
j. www.nptel.ac.in/courses/116102029/57
k. www.nptel.ac.in/courses/116102029/63
l. www.nptel.ac.in/courses/116102029/66
m. www.textilecentre.blogspot.com/