

Program Name : Diploma in Textile Technology
Program Code : TC
Semester : Fifth
Course Title : Printing of Synthetic Fibres
Course Code : 22576

1. RATIONALE

In textile industry, varieties of textile fibres undergo various chemical processes. The chemical processing of textile is a value addition process by way of increasing the aesthetic properties through printing and other relevant processes. To achieve the high quality prints, the diploma engineers must have adequate knowledge and skills related to the synthetic fibres, use of various dyes, chemicals, and relevant auxiliaries. They must also possess knowledge of relevant styles of printing and need to adopt relevant methodology for printing of different fabrics. This subject is developed in such a way that the knowledge and skills in the area of printing of synthetic textile fabrics will help the diploma engineer to solve broad based problems in the textile 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 relevant dyes, chemicals, and equipment for printing synthetic fibre fabrics.

3. COURSE OUTCOMES (COs)

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

- Select relevant thickener, ingredients, fixation method and style to print the polyester fabric.
- Use relevant style, dyes, pigments, ingredients and fixation method to print the synthetic and blended fabric.
- Use relevant ingredients, fixation method and style to print the acrylic fabric.
- Use relevant dyes, ingredients, fixation method and style to print the nylon fabric.
- Use relevant transfer printing machine as per complexity of the design to print the fabric.
- Use relevant ink, inkjet printing technology to print the fabric.

4. TEACHING AND EXAMINATION SCHEME

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

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

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



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

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

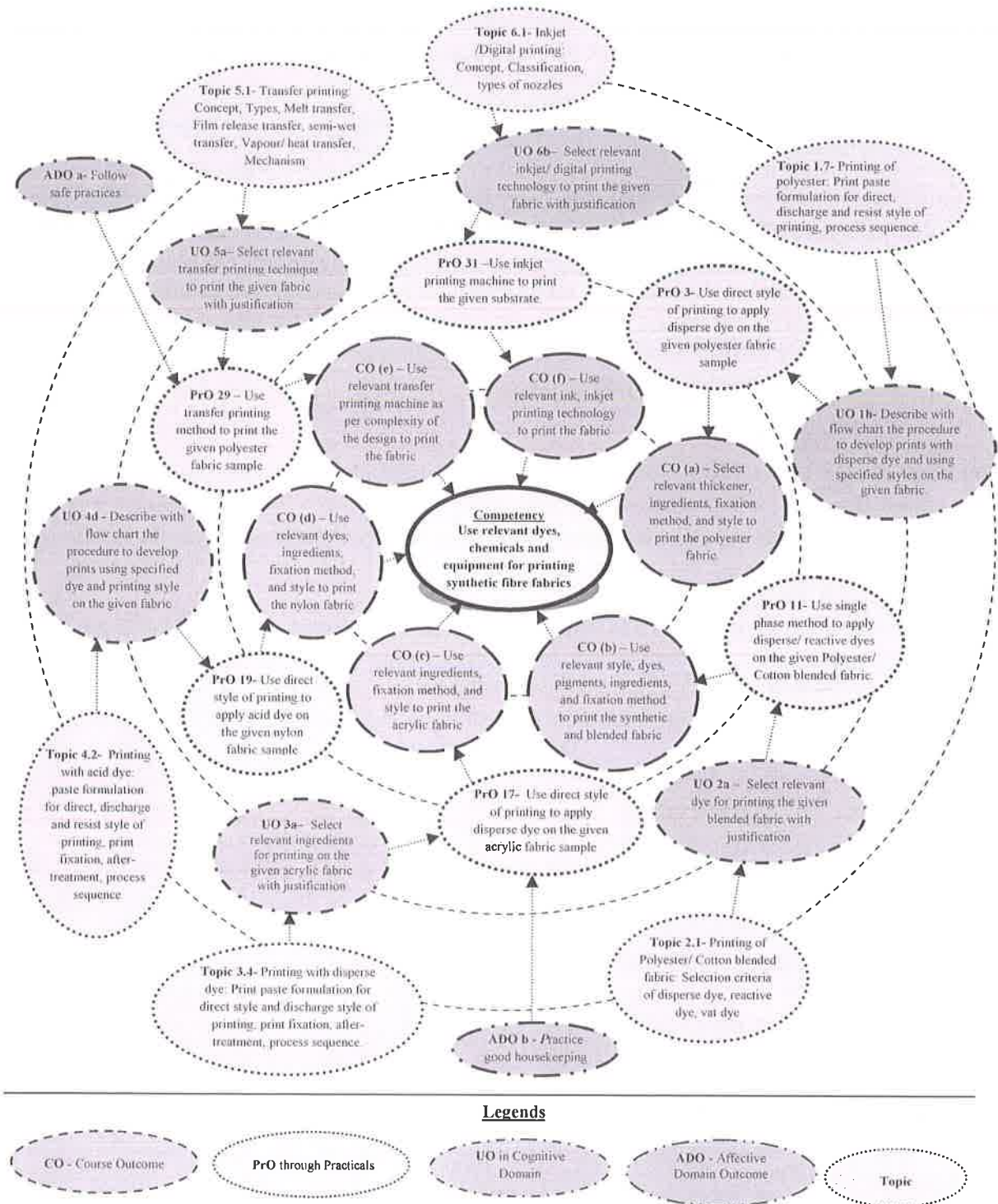


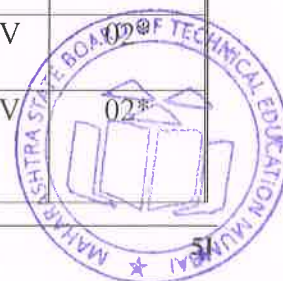
Figure 1 - Course Map

6. SUGGESTED PRACTICALS / EXERCISES

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



Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1	Use mechanical stirrer to prepare stock thickener paste.	I	02
2	Use mechanical stirrer to prepare reduction thickener paste.	I	02
3	Use direct style of printing to apply disperse dye on the given polyester fabric sample.(Part-I)	I	02*
4	Use direct style of printing to apply disperse dye on the given polyester fabric sample (Part-II)	I	02*
5	Use direct style of printing to apply disperse dye on the given polyester fabric sample by varying the carrier.(Part-I)	I	02*
6	Use direct style of printing to apply disperse dye on the given polyester fabric sample by varying the carrier. (Part-II)	I	02*
7	Use discharge style of printing to produce white discharge effect on the given disperse dyed polyester fabric sample. (Part-I)	I	02*
8	Use discharge style of printing to produce colour discharge effect on the given disperse dyed polyester fabric sample.(Part-II)	I	02*
9	Use resist style of printing to produce white resist effect on the given disperse dyed polyester fabric. (Part-I)	I	02*
10	Use resist style of printing to produce colour resist effect on the given disperse dyed polyester fabric. (Part-II)	I	02*
11	Use single phase method to apply disperse/ reactive dyes on the given Polyester/ Cotton blended fabric.	II	02*
12	Use two phase method to apply disperse/ reactive dyes on the given Polyester/ Cotton blended fabric.	II	02*
13	Apply pigment prints on the given Polyester/ Cotton blended fabric sample (Part-I)	II	02*
14	Apply pigment prints on the given Polyester/ Cotton blended fabric sample (Part-II)	II	02*
15	Use brasso style of printing to produce brasso effect on the given Polyester/cotton blended fabric. (Part-I)	II	02*
16	Use brasso style of printing to produce brasso effect on the given Polyester/cotton blended fabric. (Part-II)	II	02*
17	Use direct style of printing to apply disperse dye on the given acrylic fabric sample. (Part-I)	III	02*
18	Use direct style of printing to apply disperse dye on the given acrylic fabric sample. (Part-II)	III	02*
19	Use direct style of printing to apply acid dye on the given nylon fabric sample. (Part-I)	IV	02*
20	Use direct style of printing to apply acid dye on the given nylon fabric sample. (Part-II)	IV	02*
21	Use direct style of printing to apply metal complex dye on the given nylon fabric sample. (Part-I)	IV	02*
22	Use direct style of printing to apply metal complex dye on the given nylon fabric sample.(Part-II)	IV	02*
23	Use direct style of printing to apply Disperse dye on the given nylon fabric sample. (Part-I)	IV	02*
24	Use direct style of printing to apply Disperse dye on the given nylon fabric sample. (Part-II)	IV	02*
25	Use discharge style of printing to produce white discharge effect on the given Acid/ Metal complex/ Disperse dyed nylon fabric sample. (Part-I)	IV	02*



Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
26	Use discharge style of printing to produce colour discharge effect on the given Acid/ Metal complex/ Disperse dyed nylon fabric sample. (Part-II)	IV	02*
27	Use resist style of printing to produce white resist effect on the given Acid/ Metal complex/ Disperse dyed nylon fabric sample. (Part-I)	IV	02
28	Use resist style of printing to produce colour resist effect on the given Acid/ Metal complex/ Disperse dyed nylon fabric sample. (Part-II)	IV	02
29	Use transfer printing method to print the given polyester fabric sample. (Part-I)	V	02*
30	Use transfer printing method to print the given polyester fabric sample. (Part-II)	V	02*
31	Use inkjet printing machine to print the given substrate.	VI	02*
Total			62

Note

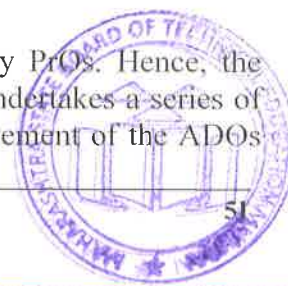
- i. A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicious mix of minimum 24 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level'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

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

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

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

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs



according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

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

7. MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

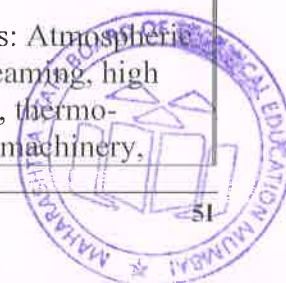
The major equipment with broad specifications mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1.	Dye Pots: 250 ml, 500 ml	3-28
2.	Glass rod	All
3.	Beaker: 50 ml, 100 ml, 150 ml, 200 ml, 500 ml, 1000 ml	All
4.	Measuring cylinder of capacity 10 ml, 25 ml, 100 ml and 1 lit	All
5.	Bunsen burner	All
6.	Pipette: 1 ml, 10 ml, 25 ml	All
7.	Plastic and metal Tray: 12" x 18"	All
8.	Electric drier: 230V, 200W	All
9.	Electric Iron: 230 V, 1000W	2-30
10.	Wooden Screen 10"x10"	1-28
11.	Rubber Squeeze: 8" width, 0.5 - 1cm thick,	1-28
12.	Laboratory Printing table: 3Ft x 2 Ft and 2.5 Ft Height	All
13.	Laboratory Stirrer: High Speed Mechanical Stirrer- 300 to 500 rpm	All
14.	Laboratory Pressure Steamer: Pressure up to 30 psi and Temperature up to 150 ^o C	3-12, 17-28
15.	Laboratory Drying, Curing and setting Chamber: temperature up to 220 ^o C, working width- 450 mm, length 1.7 meter, heater capacity- 8/16/24 kilo-watt.	All
16.	Laboratory Padding Mangle: Horizontal (60-80% Expression)	7-10, 25-28
17.	Plastic Mug: 0.5, 1 and 2 lit capacity	All
18.	Digital Weighing balance: 0.02 gm accuracy (300 gm)	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 Printing of Polyester	1a. Describe with flowchart the relevant fabric preparation process before printing the given fabric. 1b. Choose relevant preparation process for the given polyester fabric with justification. 1c. Describe with flowchart the stages involved in printing of the given fabric.	1.1 Fabric preparation: Importance of desizing, scouring, bleaching and heat-setting, 1.2 Printing stages: Fabric preparation, print paste preparation, actual printing, drying, print fixation, after-treatments. 1.3 Print fixation methods: Atmospheric steaming, pressure steaming, high temperature steaming, thermo-fixation, mechanism, machinery.



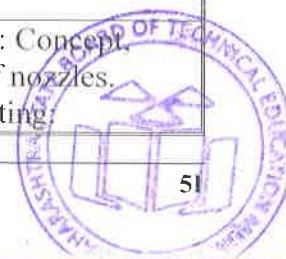
Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	<p>1d. Select relevant print fixation method for development of prints on the given fabric with justification.</p> <p>1e. Select relevant thickener based on the given print fixation method with justification.</p> <p>1f. Select relevant disperse dye based on the given print fixation method with justification.</p> <p>1g. Select relevant ingredients for printing of the given polyester using specified style of printing with justification.</p> <p>1h. Describe with flow chart the procedure to develop prints with disperse dye and using specified styles on the given fabric.</p> <p>1i. Explain with justification the importance of reduction clearing after-treatment for the given fabric.</p>	<p>advantages, and disadvantages.</p> <p>1.4 Thickeners: selection criteria for various fixation methods.</p> <p>1.5 Disperse dye: Properties, selection criteria based on print fixation method.</p> <p>1.6 Print paste ingredients: ingredients with their role</p> <p>1.7 Printing of polyester: Print paste formulation for direct, discharge and resist style of printing, process sequence.</p> <p>1.8 After-treatment: Reduction clearing, importance, process parameters</p>



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit-II Printing of Polyester and its blends	2a. Select relevant dye for printing the given blended fabric with justification. 2b. Select relevant print paste ingredients for printing the given blended fabric with justification. 2c. Describe with sketch the procedure to develop print with disperse-reactive system on the given blended fabric. 2d. Select relevant disperse-reactive dyes for the given method with justification. 2e. Describe with flow chart the procedure to develop prints with disperse-vat system and specified dyes on the given blended fabric. 2f. Describe with process sequence flowchart the application of single dye on the given blend. 2g. Select relevant ingredients for printing pigments on the given blended fabric with justification. 2h. Select relevant ingredients for the given style of printing with justification. 2i. Select relevant Polyester / Cotton blend composition for brasso style of printing with justification. 2j. Describe with flowchart the procedure to develop brasso prints on the given blended fabric.	2.1 Printing of Polyester/ Cotton blended fabric: Selection criteria of disperse dye, reactive dye, vat dye 2.2 Print paste: Ingredients, role of ingredients. 2.3 Printing with Disperse reactive system: selection criteria of dyes for single phase method, two phase method, and formulation based on blend composition, print fixation, process sequence, advantages, and limitations. 2.4 Printing with Disperse-Vat system: print paste formulation, print fixation, after-treatment, process sequence, advantages, and limitations. 2.5 Single dye application on Polyester / Cotton blend: Polystyrene dye, print paste ingredients, formulation, print fixation, after-treatment, process sequence 2.6 Printing of Polyester/Wool and Polyester/Acrylic blend: selection of disperse, acid, basic dyes, print paste ingredients, formulation, print fixation, after-treatment, process sequence 2.7 Pigment printing: Print paste ingredients, selection criteria of binder, formulation, fixation, process sequence, advantages, and limitations. 2.8 Brasso style of printing: Principle, mechanism, selection criteria of polyester/ cellulosic blend composition, ingredients, print paste formulation, development of print, after-treatment process sequence, advantages, and limitations.
Unit- III Printing of Acrylic	3a. Select relevant ingredients for printing on the given fabric with justification. 3b. Select relevant disperse dye based on specified print fixation method with justification. 3c. Describe with flowchart the procedure to formulate paste for the given dye. 3d. Describe with flowchart the	3.1. Print paste ingredients: ingredients, role. 3.2. Print fixation: Atmospheric steaming, pressure steaming, high temperature steaming, thermo fixation, selection criteria of dyes. 3.3. Paste formulation: Procedure for the given dye. 3.4. Printing with disperse dye: Print paste formulation for direct style and discharge style of printing, print



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	procedure to develop prints with disperse dye on the given fabric using specified styles.	fixation, after-treatment, process sequence.
Unit-IV Printing of Nylon	<p>4a. Select relevant print paste ingredients to print the given fabric using specified style with justification.</p> <p>4b. Describe with flowchart the procedure to formulate paste for the given dye.</p> <p>4c. Describe with flowchart the procedure to develop prints using specified dye and printing style on the given fabric.</p> <p>4d. Describe with flowchart the procedure to use specified style of printing to produce white resist effect on the given fabric sample.</p>	<p>4.1 Preparation of Nylon fabric: Importance of scouring, bleaching, heat setting.</p> <p>4.2 Printing with acid dye: paste formulation for direct, discharge and resist style of printing, print fixation, after-treatment, process sequence.</p> <p>4.3 Printing with metal complex dye: paste formulation for direct, discharge and resist style of printing, print fixation, after-treatment, process sequence.</p> <p>4.4 Printing with disperse dye: paste formulation for direct, discharge and resist style of printing, print fixation, after-treatment, process sequence.</p>
Unit –V Transfer Printing	<p>5a. Select relevant transfer printing technique to print the given fabric with justification.</p> <p>5b. Select relevant transfer printing paper based on the given characteristics with justification.</p> <p>5c. Select relevant disperse dye and ink to print the given material for transfer printing with justification.</p> <p>5d. Select relevant printing machine to print the given material with justification.</p> <p>5e. Select relevant transfer printing machine to print the given textile substrate based on complexity of design with justification.</p> <p>5f. Describe with sketch the procedure to print the given design using flat bed presses transfer printing machine.</p> <p>5g. Describe with sketch, working of the given transfer printing machine.</p>	<p>5.1 Transfer printing: Concept, Types, Melt transfer, Film release transfer, semi-wet transfer, Vapour/ heat transfer, Mechanism</p> <p>5.2 Transfer printing paper: characteristics of paper</p> <p>5.3 Transfer printing ink: characteristics of disperse dye, ink</p> <p>5.4 Transfer paper printing machine: Gravure printing, Flexographic printing, Lithographic printing, technical features, advantages, and limitations.</p> <p>5.5 Flat bed presses Transfer printing machine: Technical features, Production capacity, advantages and limitations.</p> <p>5.6 Continuous transfer printing machine: Technical features, Production capacity, advantages and limitations.</p> <p>5.7 Vacuum transfer printing machine: technical features, Production capacity, advantages and limitations.</p>
Unit VI Inkjet/ Digital	<p>6a Describe with sketch, the working of the given inkjet/digital printing technology.</p>	<p>6.1 Inkjet /Digital printing: Concept, Classification, types of nozzles.</p> <p>6.2 Continuous Inkjet printing</p>



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Printing	6b Select relevant inkjet/ digital printing technology to print the given fabric with justification 6c Select relevant ink or dye to print the given fabric with justification. 6d Distinguish between the given printing and conventional printing processes.	Binary deflection inkjet printing, Multi-level deflection inkjet printing, Technical features, advantages, and limitations. 6.3 Drop on demand inkjet printing: technical features, advantages, and limitations. 6.4 Ink for inkjet: Characteristics of ink, dyes for printing. 6.5 Comparison between inkjet/ digital printing and conventional printing.

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	Printing of Polyester	10	02	06	06	14
II	Printing of Polyester and its blends	12	04	05	07	16
III	Printing of Acrylic	04	01	03	04	08
IV	Printing of Nylon	06	02	04	04	10
V	Transfer Printing	09	04	04	04	12
VI	Inkjet/ Digital printing	07	02	04	04	10
Total		48	15	26	29	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:

- Survey the market and collect details of different dyes, pigments, auxiliaries, chemicals, available and compare them based on the print effects, fastness properties, and ecological aspects and costing.
- Visit industries to collect information about novel printing techniques used in different industries.
- Visit the printing industries and note down process flow in printing department.
- Collect the various print samples and make a chart with their application.
- Write and publish an article based on topics / knowledge in the subject.



11. SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES (if any)

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

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

12. SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be *individually* undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should *not exceed three*.

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

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

- a) **Print sample analysis:** Visit textile printing industries/ market shops and collect at least 50 different printed samples of Polyester/ Blended/ Acrylic/ Nylon fabrics. Classify them with respect to style of printing, class of dye used for printing. Present the results.
- b) **Print fault analysis:** Visit industries and market shops and collect at least 50 samples of different varieties printed on different machines and examine the faults in the printed samples. Present the results.
- c) **Evaluate fastness properties of printed fabric:** Collect different printed fabric samples developed by various fixation methods. Evaluate their wash fastness, rubbing fastness and light fastness properties using specified ISO tests. Compare the result. Present the results.
- d) **Optimize the chemical concentration:** Compare the effect of different concentrations of chemicals used in print paste on the colour yield of prints and find optimized concentration. Prepare shade card. Present the results.
- e) **Optimize the printing process control parameters:** Compare the effect of process control parameters e.g. print paste viscosity, number of strokes by squeegee, type of



squeezee, print fixation conditions, after-treatments on the colour yield of printed fabric. Prepare shade card. Present the results.

- f) **Short film on working of machine:** Visit different textile printing industries. Observe the working operations of machines at various stages and capture video clips. Edit the video clips as per specified process sequence and make a short film. Present the short film.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Technology of Printing. Volume – IV	Shenai, V. A.	Sevak Publications, Mumbai, 1990
2.	Textile Printing	Miles, L.W.C.	Society of Dyers and Colourists, UK, 1981, ISBN: 9780901956330
3.	Dyeing and Printing	Cockett, S. R.; Hilton, K. A.	Leonard Hill Books Ltd. London, 1961, ISBN: 9781114785724
4.	Introduction to Textile Printing	Clarke, W.	Wood-head Publishing Ltd. Swaston, Cambridge, 1974 ISBN: 9781855739949
5.	Textile Spinning, Weaving, Finishing and Printing	NIIR Board of consultants and Engineers	Asia Pacific Business Press Inc. Delhi, 2016, ISBN: 9788178331638
6.	Heat Transfer Techniques	Dawn Dupree	Bloomsbury publishing India Private 1 Jan. 2011, ISBN: 9781408109113
7.	Dyeing and Screen Printing on Textiles	Joanna Kinnersly Taylor	A & C Black Publishers Ltd., London, UK. 1 Jan 2012 ISBN: 9781408124758
8.	Inkjet Textile Printing	Christina Cie	Wood-head Publishing Ltd. Swaston, Cambridge, 3 Feb 2015 ISBN: 9780857092304

14. SOFTWARE/LEARNING WEBSITES

- www.utsavfashion.com/saree/brasso-work
- textilefashionstudy.com/what-is-pigment-printing
- textileapex.blogspot.in/2014/03/pigment-printing-advantages-disadvantages.html?m=1
- Transfer Printing- youtu.be/vRgs915qg50
- Inkjet printing - youtu.be/IACTGPuefNI
- Inkjet printing- youtu.be/OMpR9xZEPkQ



