

Program Name : Diploma in Textile Technology
Program Code : TC
Semester : Fourth
Course Title : Printing of Natural Substrates
Course Code : 22459

1. RATIONALE

In textile industry, various chemical processes are carried out on variety of textile fibres. The chemical processing of textile is a value addition process by way of exhausting the aesthetic properties through printing and other processes. To achieve the high quality prints, the diploma engineer must have adequate knowledge of natural fibres, various dyes, chemicals and relevant auxiliaries. They must also possess knowledge of various styles of printing. They need to adopt relevant methodology for printing of different fabrics. This subject has been developed in such a way that the knowledge and skills in the area of printing of natural textile fabrics will help the diploma engineer 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:

- Use relevant printing dyes and equipment for printing natural 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 and ingredients for printing the given fabric.
- Use relevant printing method and style for the given job.
- Use relevant machine for printing based on complexity of design and production capacity.
- Formulate print paste for printing the given cotton using specified dyes.
- Develop pigment print on the given cotton fabric.
- Produce print on silk and wool using specified dyes.

4. TEACHING AND EXAMINATION SCHEME

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

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

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.

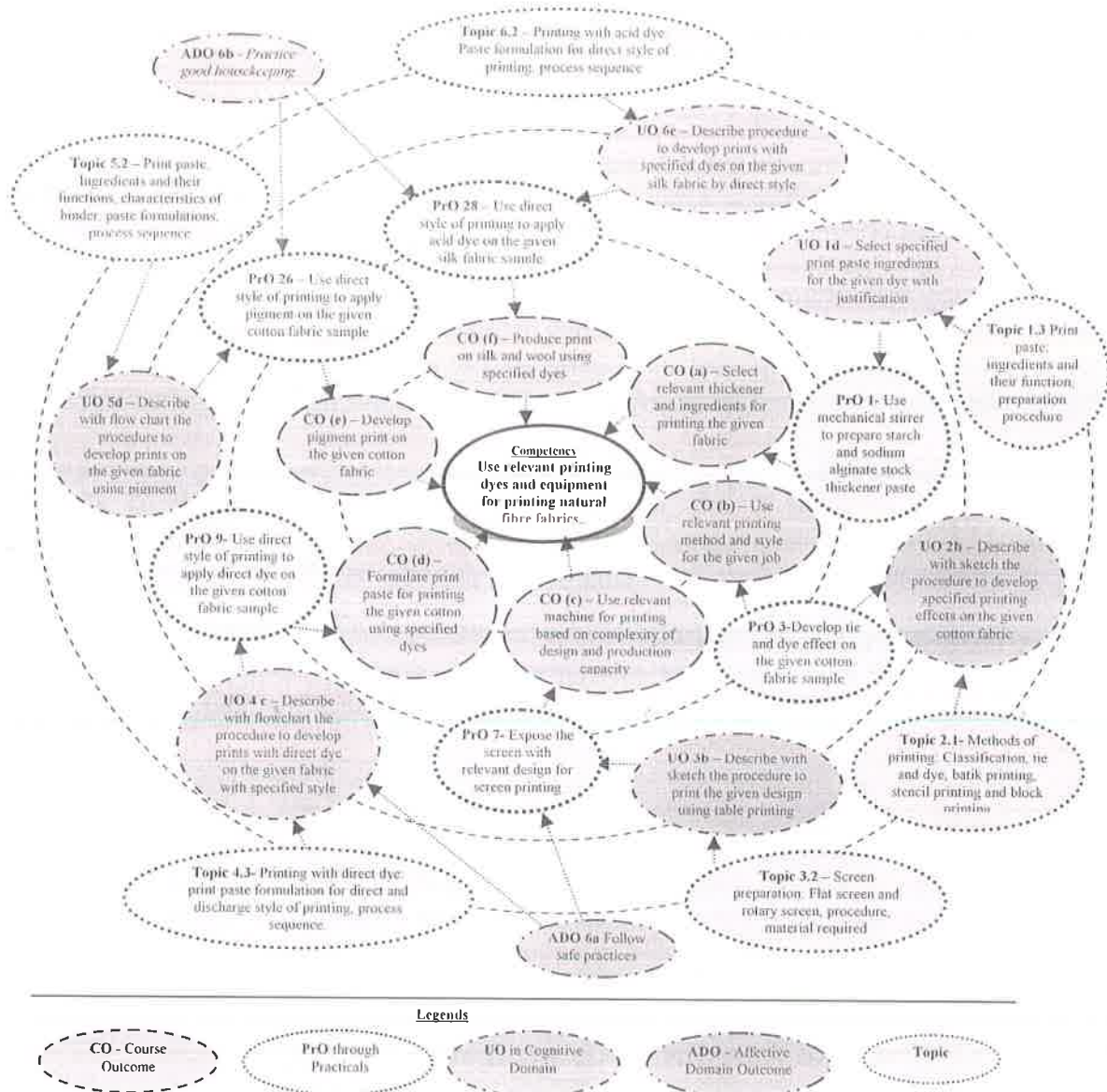


Figure 1 - Course Map

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 mechanical stirrer to prepare Starch and Sodium Alginate stock thickener paste.	I	02*
2	Use mechanical stirrer to prepare half emulsion and full emulsion thickener paste.	I	02*
3	Develop Tie and dye effect on the given cotton fabric sample	II	02*

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	(Part-I)		
4	Develop Tie and dye effect on the given cotton fabric sample (Part-II)	II	02
5	Develop batik effect on the given cotton fabric sample.(Part-I)	II	02*
6	Develop batik effect on the given cotton fabric sample.(Part-II)	II	02
7	Expose the screen with relevant design for screen printing (Part-I)	III	02*
8	Expose the screen with relevant design for screen printing (Part-II)	III	02
9	Use direct style of printing to apply direct dye on the given cotton fabric sample.(Part-I)	IV	02*
10	Use direct style of printing to apply direct dye on the given cotton fabric sample.(Part-II)	IV	02
11	Use direct style of printing to apply reactive dye on the given cotton fabric sample. (Part-I)	IV	02*
12	Use direct style of printing to apply reactive dye on the given cotton fabric sample. (Part-II)	IV	02
13	Use direct style of printing to apply azoic colours on the given cotton fabric sample.(Part-I)	IV	02*
14	Use direct style of printing to apply azoic colours on the given cotton fabric sample.(Part-II)	IV	02
15	Use direct style of printing to apply vat dye on the given cotton fabric sample. (Part-I)	IV	02*
16	Use direct style of printing to apply vat dye on the given cotton fabric sample. (Part-II)	IV	02
17	Develop magic style of printing on the given cotton fabric sample.	IV	02*
18	Develop crimp style of printing on the given cotton fabric sample.	IV	02*
19	Use discharge style of printing to produce white discharge effect on the given direct dyed cotton fabric sample.	IV	02*
20	Use discharge style of printing to produce colour discharge effect on the given direct dyed cotton fabric sample	IV	02*
21	Use discharge style of printing to produce white discharge effect on the given reactive dyed cotton fabric sample.	IV	02*
22	Use discharge style of printing to produce colour discharge effect on the given reactive dyed cotton fabric sample.	IV	02*
23	Use resist style of printing to produce white resist effect on the given reactive dyed cotton fabric sample.	IV	02*
24	Use resist style of printing to produce colour resist effect on the given reactive dyed cotton fabric sample.	IV	02*
25	Apply khadi print on the given cotton fabric sample.	IV	02
26	Use direct style of printing to apply pigment on the given cotton fabric sample (Part- I)	V	02*
27	Use direct style of printing to apply pigment on the given cotton fabric sample (Part- II)	V	02
28	Use direct style of printing to apply acid dye on the given silk	VI	02*



S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	fabric sample.		
29	Use direct style of printing to apply metal complex dye on the given silk fabric sample.	VI	02*
30	Use direct style of printing to apply basic dye on the given silk fabric sample.	VI	02*
31	Use direct style of printing to apply acid / basic dye on the given wool fabric sample.	VI	02*
32	Use direct style of printing to apply metal complex dye on the given silk fabric sample.	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 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	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 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.	Dye Pots: 250 ml, 500 ml	All
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"	2
8.	Electric drier: 230V, 200W	All
9.	Electric Iron: 230 V, 1000W	All
10.	Wooden Screen 10"x10"	3 and 5-16
11.	Rubber Squeegee: 8" width	5-16
12.	Laboratory Printing table: 3Ft x 2 Ft and 2.5 Ft Height	5-16
13.	Laboratory Stirrer: High Speed Mechanical Stirrer- 300 to 500 rpm	4-16
14.	Lab. Pressure Steamer: 30 psi and 150 ^o C	5-16
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)	7,11,12,13
17.	Plastic Mug of 0.5, 1 and 2 lit capacity	1,2, 4-16
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 Textile Printing	1a. Differentiate between dyeing and printing processes based on the given criteria. 1b. Describe with with flow chart various stages involved in printing of the given fabric. 1c. Select relevant process for preparation of the given cotton fabric with justification. 1d. Select specified print paste ingredients for the given dye with justification. 1e. Classify the thickeners based on the given source and chemistry. 1f. Choose relevant thickener based	1.1 Dyeing and printing: Purpose and differentiation 1.2 Printing stages: Fabric preparation, print paste preparation, printing, drying, fixation of prints, after treatments 1.3 Print paste: Ingredients and their functions, Preparation procedure 1.4 Thickeners: Classification, chemistry of thickeners, advantages and limitations, selection criteria for various dyes



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	on the given dye/pigment with justification.	
Unit-II Methods and Styles of Printing	2a. Classify the methods of printing for the given fabric. 2b. Describe with sketch the procedure to develop specified printing effects on the given cotton fabric. 2c. Classify styles of printing for the given fabric. 2d. Choose relevant style of printing for the given design with justification.	2.1 Methods of printing: classification, procedures, tie and dye, batik printing, stencil printing, block printing, advantages and limitations. 2.2 Style of Printing: Classification. Principle of direct style, discharge style and resist style, dye selection criteria for discharge printing.
Unit- III Printing Machinery	3a. Design table for printing the given design using table printing. 3b. Describe with sketch the procedure to print the given design using table printing. 3c. Describe with sketch the procedure to prepare screen for the given printing machine. 3d. Describe with flowchart the procedure to print the given design using specified printing machine.	3.1. Table printing: Technical features, faults, causes and remedies 3.2. Screen preparation: Flat screen, rotary screen, procedure, material required. 3.3. Flat-bed printing: Technical features, production capacity, types and sizes of squeegees, advantages and limitations. 3.4. Rotary screen printing: Technical features, production capacity, types and sizes of squeezes, advantages and limitations
Unit-IV Printing of Cotton	4a. Select relevant fixation method and machinery for the given fabric with justification. 4b. Describe with flowchart the procedure to formulate paste for the given dye. 4c. Describe with flowchart the procedure to develop prints with direct dye on the given fabric with specified style. 4d. Describe procedure to develop prints with reactive dye on the given fabric with specified style. 4e. Describe procedure to develop prints with vat dye on the given fabric with specified style. 4f. Describe procedure to develop prints with azoic colours on the given fabric with specified style. 4g. Describe procedure to produce	4.1 Print Fixation: Methods- steaming, curing, polymerising, fixation mechanisms. 4.2 Steaming machineries: Star ager and rapid ager, loop ager, working and applications. 4.3 Printing with direct dye: Print paste formulation for direct style and discharge style of printing, process sequence. 4.4 Printing with reactive dye: Print paste formulation for direct style and discharge and resist style of printing, process sequence. 4.5 Printing with vat dye: Print paste formulation for direct style of printing, process sequence. 4.6 Printing with azoic colours: Print paste formulation for direct style of printing, process sequence.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	the specified print effects on the given fabric.	4.7 Special print effects: Khadi printing, magic style, crimp style, process sequence.
Unit –V Printing with pigment on cotton	5a. Describe the principle of pigment printing for the given fabric. 5b. Select the relevant pigment for printing on the given fabric with justification. 5c. Select the relevant ingredients for pigment printing on the given fabric with justification. 5d. Describe with flow chart the procedure to develop prints on the given fabric using pigment. 5e. Differentiate between printing using pigment and dyes on the given fabric.	5.1 Pigment printing: Principle, mechanism, classification and requirements of pigments. 5.2 Print paste: Ingredients and their functions, characteristics of binder, print paste formulation, process sequence. 5.3 Advantages and disadvantages of pigment printing over printing using dyes.
Unit VI Printing of Wool and Silk	6a. Choose relevant preparation process before printing for the given fabric with justification. 6b. Describe with sketch the procedure to develop prints with specified dyes on the given silk fabric by direct style. 6c. Describe procedure to develop prints with specified dyes on the given wool fabric by direct style.	6.1 Fabric preparation: process sequence for wool, silk 6.2 Printing with acid dye: paste formulation for direct style of printing, process sequence. 6.3 Printing with basic dye: paste formulation for direct style of printing, process sequence. 6.4 Printing with metal complex dye: paste formulation for direct style of printing, process sequence.

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	Textile Printing	07	02	04	04	10
II	Methods and Styles of Printing	08	02	04	04	10
III	Printing Machinery	10	04	04	06	14
IV	Printing of Cotton	14	04	06	12	22
V	Printing with pigment on cotton	03	02	02	02	06
VI	Printing of wool and silk	06	02	02	04	08
Total		48	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:

- Survey market for different dyes, pigments, auxiliaries, and chemicals. Compare them based on print effects, fastness properties, and ecological aspects and costing.
- Collect information about novel printing techniques being used in different industries.
- Prepare table for different chemicals used in printing of cotton fabric and their role in printing paste.

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:

- Massive open online courses (*MOOCs*) may be used to teach various topics/ sub topics.
- '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.
- 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).
- With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.
- Guide student(s) in undertaking micro-projects.
- Encourage students to refer different websites to have deeper understanding of the subject.
- Assign unit wise assignments to group of 4 to 5 students for solving unit wise questions.
- Use of video, animation films to explain concepts, facts and applications related to printing of natural 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:

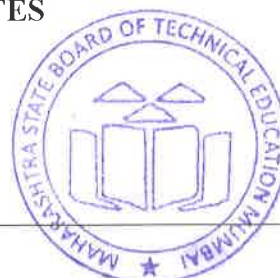
- a. **Print sample analysis:** Visit textile printing industries/ market shops and collect at least 50 different printed samples of cotton/ silk/ wool fabrics. Classify them with respect to style and method of printing, class of dye used for printing. Present the results.
- b. **Print fault analysis:** 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. Evaluate their wash fastness, rubbing fastness and light fastness properties using specified ISO tests. Present the results with end use of the tested fabric samples.
- d. **Analyse performance of thickeners:** Collect different types of thickeners used in textile printing industries. Analyze their performance with respect to viscosity, stability under the given conditions of pH and colour yield. Present the results.
- e. **Analysis of printed design:** visit industries and market shops, collect at least 50 printed samples of different varieties, and analyse the design with respect to type of pattern, number of colours in the design, percent coverage of colour, overlapping, and blotches. Estimate print paste consumption. Present the results.
- f. **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.
- g. **Short film on working of machine:** Visit different textile printing industries. Observe the working operations of machine at various stages and capture those processes using video camera. Edit the videos as per specified process sequence and make a short film. Present the short film.

13. SUGGESTED LEARNING RESOURCES

Sr. No.	Title of Book	Author	Publication
1.	Technology of Printing. Vol- IV	Shenai, V. A.	Sevak Publications, Mumbai 1990
2.	Textile Printing	Miles, L.W.C.	Society of Dyers and Colourists, 1981, ISBN: 9780901956330
3.	Silk dyeing, Printing and Finishing	Gulrajani, M. L.	Department of Textile Technology, IIT Delhi, 1988
4.	Dyeing and Printing	Cockett, S. R.; Hilton, K. A.	Leonard Hill Books Ltd. London, 1961, ISBN: 9781114785724
5.	Introduction to Textile Printing	Clarke, W.	Wood-head Publishing Ltd. Swaston, Cambridge, 1974 ISBN: 9781855739949
6.	Silk Dyeing, Printing and Finishing	Hurst, George Henry	Bell, London, 1901 Rarebooks Club.com (e-copy), 2012, ISBN: 9781130986525

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. en.m.wikipedia.org/wiki/Textile_printing
- b. www.zepriint.com/Fabric_Printing
- c. www.textilefashionstudy.com
- d. www.teonline.com/knowledge_centre



- e. www.cotton.org
- f. www.textileapex.blogspot.com
- g. www.zimmer-usa.com
- h. www.oecotextiles.wordpress.com
- i. m.textileprintingmachines.net
- j. www.bestdye.com/Tie-Dye
- k. www.india-crafts.com/textile_products
- l. www.textilelearner.blogspot.com/

