

Program Name : Diploma in Textile Manufacturers
Program Code : TX
Semester : Third
Course Title : Yarn Testing
Course Code : 22369

1. RATIONALE

In textile industry, yarn is used as raw material to produce fabric. Quality of fabric depends on the yarn properties, yarn parameters and their quality control testing. The diploma engineer needs to have relevant knowledge and skills related to yarn testing. This subject intends to equip students with the concepts, principles and methods of testing of yarns, which are helpful in selection of raw materials for further processing of yarn, process control and quality assurance. The process improvement is also an important aspect, which requires lot of experimentation. Yarn testing requires recording of number of observations, which are to be analyzed, interpreted and used for best results. Therefore, knowledge of yarn testing is essential for controlling yarn manufacturing process. This course is developed in the way by which fundamental information will help the diploma engineers to apply the basic concepts of yarn testing to solve broad problems in textile manufacturing.

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 yarn testing in selection of raw materials and process control.

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:

- Apply yarn numbering system to determine its linear density.
- Test the yarn to determine its twist parameters by different methods.
- Measure yarn unevenness by different methods.
- Test yarn for its hairiness parameter by relevant method.
- Apply principle of tensile testing to determine yarn strengths.
- Evaluate physical properties of textured yarns.

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	-	2	5	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.

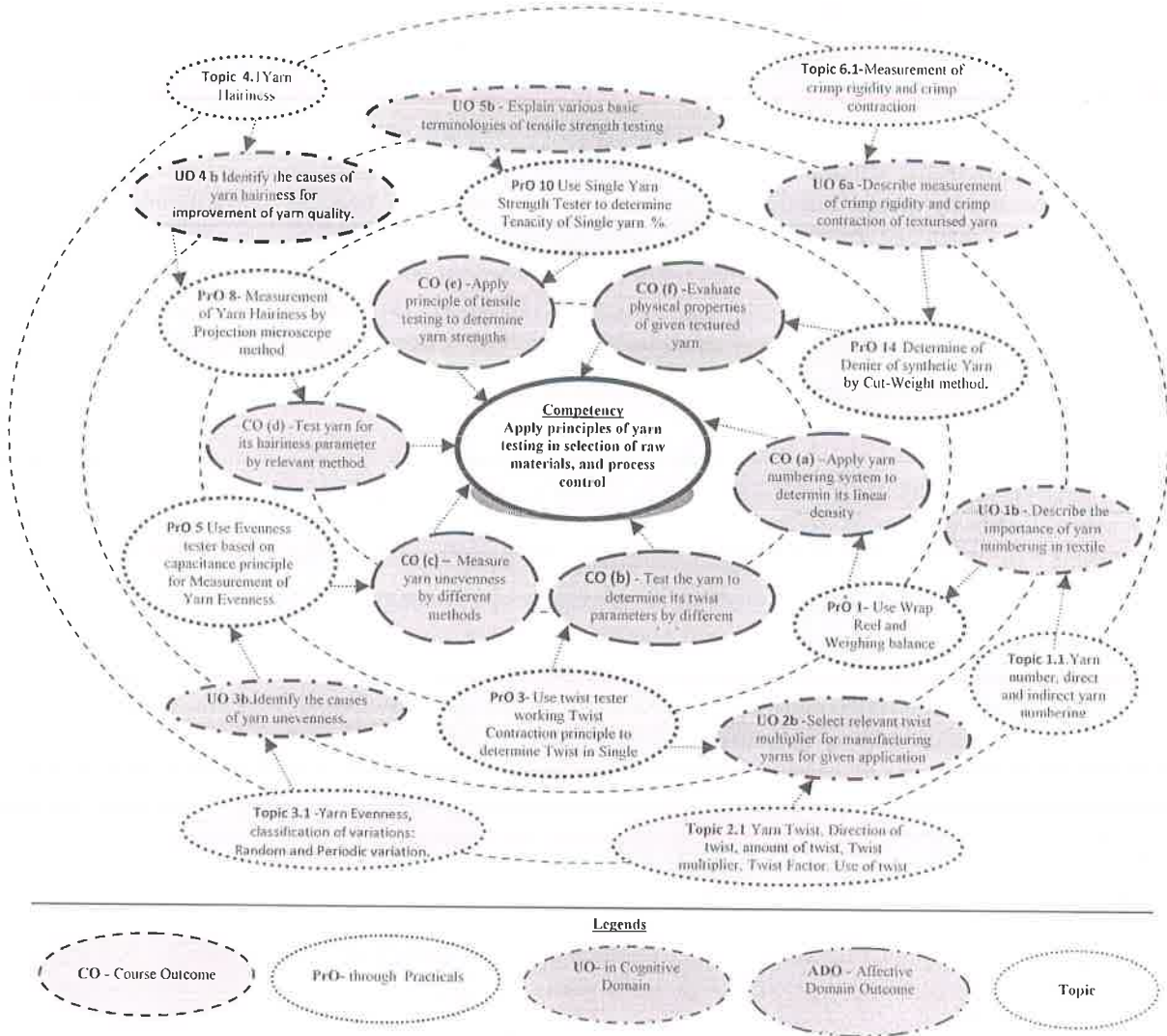


Figure 1 - Course Map

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 and Weighing balance to determine Yarn number	I	02*
2	Determine Yarn number of yarn removed from fabric	I	02
3	Use twist tester working Twist Contraction principle to determine	II	02*



S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	Twist in Single yarn.		
4	Use twist tester working on Untwisting principle to determine twist in Double yarn by Untwisting method.	II	02
5	Use Evenness tester based on capacitance principle for Measurement of Yarn Evenness.	III	02*
6	Grading of yarn by ASTM Yarn appearance method.	III	02
7	Estimation of Hank and Hank C.V. % of sliver and roving sample using wrap reel.	III	02
8	Measure Yarn Hairiness by Projection Microscope Method.	IV	02*
9	Measure Yarn Hairiness by optical Method	IV	02
10	Use Single Yarn Strength Tester to determine Tenacity of Single yarn and calculate C.V. %.	V	02*
11	Determine lea strength and CSP of given yarn sample using Lea Strength tester and calculate C.V. %.	V	02
12	Determine work of rupture by Ballistic strength tester	V	02
13	Determine bundle strength of Yarns using Stelometer.	V	02
14	Determine of Denier of synthetic Yarn by Cut-Weight method.	VI	02*
15	Determine Shrinkage% of Synthetic yarn for hot water and hot air.	VI	02
16	Determine crimp rigidity and crimp contraction of texturised yarn.	VI	02
	Total		32

Note

- 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.
- 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:

- Follow safety practices.
- Practice good housekeeping.
- Demonstrate working as a leader/a team member.
- 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. S. No.
1	Electronic balance, with the scale range of 0.001g to 500g. Pan size 100 mm; response time 3-5 sec.; power requirement 90-250 V, 10 watt.	1,2,7,114,
2	Microscope, with magnification ranges 5x to 100 x.	8
3	Electric oven inner size 18''x18''x18''; temperature range 100 to 250 ⁰ C. with the capacity of 40lt, moisture tester.	15
4	English Wrap reel with 1.5 yard circumference.	1
5	British Wrap reel with 1 meter circumference.	1
6	Single yarn twist tester based on twist contraction principle	3
7	Double yarn twist tester based on untwist principle	4
8	Yarn Evenness tester based on capacitance principle.	5
9	Black board wrapping machine.	6
10	Yarn Hairiness tester based on optical principle	9
11	Single yarn strength tester based on CRE principle (capacity 0-1000gmf).	10
12	Lea strength tester based on CRE or Pendulum lever principle (capacity 200lbs).	11
13	Bursting strength tester (capacity 0-50kg/cm ²).	12
14	Stelometer	13
15	Crimp rigidity tester.	16

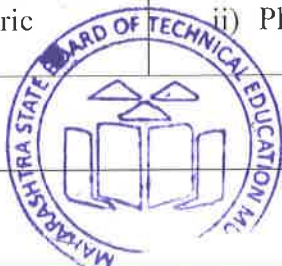
8. UNDERPINNING THEORY COMPONENTS

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 Linear density	1a. Describe the features of the given yarn numbering systems. 1b. Calculate weight, length and count of the given type of yarn using relevant yarn numbering system for the given situation. 1c. Calculate production rate of	1.1 Yarn number, direct and indirect yarn numbering systems 1.2 Direct yarn numbering: Tex, Denier Indirect yarn numbering: British, Metric, Worsted, Woolen, Linen. 1.3 Resultant count calculation. Weight, length and count of yarn



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	yarn with given parameters in spinning process. 1d. Select relevant method for testing of yarn number of the given sample with justification. 1e. Calculate yarn diameter based on the given data.	numerical on Yarn numbering, production rate of yarn in spinning process. 1.5 Testing of yarn count: i) Yarn in package form (ASTM D-1907-89) ii) Yarn removed from fabric (IS-3442-98) 1.6 Relation between yarn count and yarn diameter.
Unit-II Yarn Twist	2a. Select relevant twist multiplier for manufacturing yarns for given situation with justification. 2b. Explain the effects of twist on properties of given yarn/fabric. 2c. Select relevant twist measurement method for given yarn sample with justification. 2d. Describe with sketches the procedure to determine the yarn twist by relevant method.	2.1 Yarn Twist, Direction of twist, amount of twist, Twist multiplier, Twist Factor. Use of twist multiplier. 2.2 Twist and yarn strength relationship: spun and filament yarn. Effect of twist on fabric properties. 2.3 Measurement of twist in single Yarn: Straightened yarn method (ASTM D-1422-92), Twist contraction method (ASTM D-1422-92), Twist to break method 2.4 Measurement of twist in Double Yarn: Take up Twister (untwisting principle)
Unit- III Yarn Evenness	3a. Classify the types of variation of the given yarns. 3b. Describe with sketches the measurement of yarn unevenness by given method. 3c. Apply results of analysis of spectrogram for identifying the faults of the specified machinery. 3d. Describe the effect of irregularity on the given yarn/fabric property.	3.1 Yarn Evenness, classification of variations: Random and Periodic variation. 3.2 Causes of unevenness 3.3 Terms and Definitions: U%, C.V. %, Limit irregularity, Index of Irregularity, addition of irregularity, reduction in irregularity. 3.4 Measurement of yarn unevenness: i) Cutting and weighting method ii) Visual examination (ASTM) iii) Capacitance principle 3.5 Analysis of Spectrogram. 3.6 Effects of Irregularity.
Unit-IV Yarn Hairiness	4a. Describe causes of Hairiness of the given yarn. 4b. Describe effects of Hairiness of the given yarn and fabric properties.	4.1 Yarn Hairiness: Causes and effects 4.2 Yarn hairiness testing: i) Microscopic method ii) Photoelectric method



Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	4c. Identify the causes of yarn hairiness for improvement of the given yarn quality. 4d. Describe with sketches the procedure to Measure yarn hairiness by given method.	
Unit –V Tensile Strength testing of yarn	5a. Explain the specified terminologies related to tensile strength testing. 5b. Identify the relevant factor affecting Yarn Strength of the given yarn with justification 5c. Describe with sketches the measurement method of yarn strength of the given yarn sample. 5d. Determine the count strength product of a given yarn sample for the given situation. 5e. Summarize various parameters of given advance strength testing machine.	5.1 Tensile strength, Load, Tenacity, Breaking Length, Elongation, Breaking extension, Breaking Strength 5.2 Load elongation curve, stress strain curve, Initial Young's modulus, Work of rupture, Work Factor, Elastic recovery, Instantaneous and time dependant effects. 5.3 Factors affecting tensile properties of textiles 5.4 Constant Rate of Extension (CRE), Constant Rate of Loading (CRL), Constant Rate of Traverse (CRT), Pendulum Lever principle and Strain Gauge Principle. 5.5 Yarn strength tester: Stelometer, Instron. 5.6 Yarn strength tester: Single yarn strength tester, Lea strength tester, Count strength product (CSP). Ballistic/Impact strength tester. 5.7 Features of advanced strength testing like Tensojet and Tensorapid.
Unit-VI Testing of Textured Yarn	6a. Describe with sketches the measurement procedure of crimp rigidity of given yarn by the given method 6b. Describe with sketches the measurement of crimp contraction of the given yarn by given method. 6c. Determine the dimensional stability of the given yarn for the given situation.	6.1 Measurement of crimp rigidity and crimp contraction of textured filament yarn by crimp rigidity tester. 6.2 Yarn bulk 6.3 Dimensional stability of synthetic yarn: Hot Air and Hot water

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 PER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Yarn Numbering	08	02	03	06	11
II	Yarn Twist	08	02	02	05	09
III	Yarn Evenness	12	02	04	10	16
IV	Yarn Hairiness	04	02	02	04	08
V	Tensile Strength Testing of Yarn	14	03	07	10	20
VI	Testing of Synthetic Yarn	02	02	02	02	06
Total		48	13	20	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:

- Market survey of different yarns of natural and man-made origin of different yarn numbers based on application and price.
- Library survey of different yarns used in the industry with respect to name of manufacturer, current price, counts of yarn and blend proportion.
- Prepare table for norms published by different research organizations for different yarn properties for various types of yarns.
- Prepare question bank referring old MSBTE question papers for yarn testing.

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
- Assign unit wise tutorials to group of 4 to 5 students for solving problems unit wise.
- Assign micro projects to group of 4 to 5 students and let them prepare and present the project through PPT. Group shall submit a report which is limited to 5 pages.

- h. Use of video, animation films to explain concepts, facts and applications related to yarn testing.
- i. In respect of item 10 above, teachers need to ensure to create opportunities and provisions for such co-curricular activities.

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 Numbering:** Collect yarns of different yarn number and prepare a chart from higher number to lower number in each system. Also prepare a chart for conversion of yarn number from one system to another.
- b. **Yarn Numbering:** Each batch will solve 50 numerical on yarn numbering.
- c. **Yarn Twist:** Collect different yarn samples used for different applications like hosiery, warp, weft, voile, fancy yarn, crepe yarn. Identify direction of twist and calculate amount of twist and twist multiplier. Prepare chart for the same.
- d. **Yarn Evenness:** Collect and prepare chart of yarn samples for different faults like thick, thin, neps and also collect norms for imperfections of at least 10 counts.
- e. **Yarn Hairiness:** Collect 10 yarn samples from course to fine, measure yarn hairiness by optical method. Plot a graph of hairiness parameter against count and interpret the result.
- f. **Tensile Strength:** Draw schematic diagrams of different principles and instruments based on them for tensile strength testing. Test two yarn samples of different counts on these instruments and prepare a chart for test results.
- g. **Testing of Synthetic yarn:** Collect 5 samples of texturised yarn and calculate crimp rigidity and crimp contraction.
- h. **Testing of Synthetic yarn:** Collect 5 samples of synthetic yarn, heat set the same at different temperatures varying from 180⁰ to 210⁰C. Test dimensional stability by hot boiling water test method.

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1	Physical Properties of Textile Yarns'	Morton, W.E; Hearle, J.W	Wood head publishing 2008. ISBN 9781845692209.
2	Hand book of Textile Testing-part-1: Testing and		SP 15-1:Published 1989 Bureau of Indian Standards(BIS)

S. No.	Title of Book	Author	Publication
	grading of textile yarns.		
3	Textile Testing Physical, Chemical and Microscopical	Skinkle, John H.	Chemical Publishing Co Inc (1940) ASIN: B001OMN6VS
4	Principles of Textile Testing	Booth, J. E.	CBS publishers and distributors private ltd. 1996.New Delhi India. ISBN:9788123905150
5	Testing and Quality Management	Kothari, V.K.	IAFL, New Delhi 1999 ISBN 819010330X, 9788190103305
6	Hand book of Textile Testing and Quality Control	Grover,E.B; Hamby, D.C.	Textile Book Publishers, 1960 - Technology and Engineering the University of Michigan.
7	Physical Testing of Textiles	Saville, B.P.	Wood head publishing limited -2002 Cambridge England.CRC press ISBN: 0849305683.
8	Methods of Tests, Yarn, Yarn and Fabric	--	CIRCOT, Mumbai
9	A Practical Guide to Textile Testing	Amutha,K.	Wood head Publishing New Delhi India.2016; ISBN:9789385059070 .

14. SUGGESTED SOFTWARE/LEARNING WEBSITES

- a. Textilelearner.blogspot.in/2012/05/yarn-numbering-system-yarn-count-direct.html
- b. Textilestudycenter.com/yarn-numbering-system/
- c. textilelearner.blogspot.in/2013/03/yarn-twist-relationship-between-yarn.html
- d. nptel.ac.in/courses/116102029/64
- e. www.slideshare.net/fahim55/yarn-twist
- f. textilelearner.blogspot.in/2013/03/yarn-twist-relationship-between-yarn.html
- g. nptel.ac.in/courses/116102029/37
- h. textilelearner.blogspot.com/2012/05/yarn-evenness-unevenness-irregularity.html
- i. textilestudycenter.com/yarn-evenness-ii-classification/
- j. nptel.ac.in/courses/116102029/29
- k. nptel.ac.in/courses/116102029/38
- l. www.scribd.com/doc/201648794/SITRA-NORMS-SPINNING-MILLS-2010
- m. www.uster.com/fileadmin/customer/Services/USTER_Statistics/Application_handbook_USTER_Statistics_2013.pdf

