GUJARAT TECHNOLOGICAL UNIVERSITY (GTU)

Competency-focused Outcome-based Green Curriculum-2021 (COGC-2021)
Semester-VI

Course Title: Textile Testing
(Course Code: 4362903)

Diploma programme in which this course is offered	Semester in which offered
Textile Manufacturing Technology	Sixth

1. RATIONALE

The ongoing advancements in textile manufacturing technology continuously enhance the quality of textiles. This, in turn, raises customer expectations. To ensure best quality as per the needs of the customer, many advances in textile testing are also taking place simultaneously. It is therefore essential for textile engineers to appreciate the importance of testing and to develop skills to test the textiles as per standards using advance testing methods. Textile testing is extremely important as it ensures quality and can eliminate any problems ahead of manufacturing. By textile testing we can easily detect the faults of machinery and materials during test of textiles. Knowledge of fibre, yarn and fabric testing parameters are essential for diploma engineer.Therefore, it is imperative for textile engineers to recognize the significance of testing and acquire the skills necessary to assess textiles in accordance with standards using advanced testing techniques. After completing this course, students will have the ability to assess textile material properties and interpret the results for specific end uses or subsequent processes. They will also be capable of identifying any shortcomings in the production process through testing outcomes and taking corrective actions to ensure quality. Consequently, this course holds a pivotal role in the education of textile engineers.

2. COMPETENCY

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

- **Apply knowledge of fibre, yarn and fabric testing for appropriate raw material selection, product development and process control to determine the quality throughout the textile product chain.**

3. COURSE OUTCOMES (COs)

The practical exercises, the underpinning knowledge and the relevant soft skills associated with the identified competency are to be developed in the student for the achievement of the following COs:

a) Employ various sampling techniques and standard atmospheric condition in textile testing.
b) Test the different fibre quality parameters using the relevant fibre testing instruments.
c) Measure yarn count, twist and irregularity using the relevant yarn testing instruments.
d) Test the different fabric quality parameters using the relevant fabric testing instruments.
e) Analyze the tensile properties of fibre, yarn and fabric using the tensile testing instruments.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P/2)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	CA	ESE	CA	ESE	
3	0	2	4	30*	70	25	25	150

(*): Out of 30 marks under the theory CA, 10 marks are for assessment of the micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessing the attainment 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, **CA** - Continuous Assessment; **ESE** -End Semester Examination.*

5. SUGGESTED PRACTICAL EXERCISES

The following practical outcomes (PrOs) are the sub-components of the COs. *Some of the **PrOs** marked **'*'** (in approx. Hrs column) are compulsory, as they are crucial for that particular CO at the 'Precision Level' of Dave's Taxonomy related to 'Psychomotor Domain'*.

Sr. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. required
1	Measure the fibre length parameters using Baer sorter.	II	02*
2	Determine the fibre length parameters using digital Fibrograph.	II	02*
3	Measure the Fibre strength parameter using Stelometer.	II	02*
4	Determine the Fibre fineness parameter using Sheffield Micronaire tester.	II	02*
5	Measure the count of yarn using wrap reel.	III	02*
6	Determine the yarn twist parameter using Continuous Twist Tester.	III	02*
7	Determine the yarn evenness using Uster evenness tester.	III	02*
8	Determine the drape of given fabric using drape meter.	IV	02*
9	Measure the crease recovery angle of given fabric.	IV	02*
10	Determine the lea CSP using lea strength tester.	IV	02*
11	Measure the grab strength and strip strength using Fabric tensile strength tester.	V	02*
12	Measure the tearing strength of fabric using tearing strength tester.	V	02*
13	Measure bursting strength of fabric using bursting strength tester.	V	02*
14	Determine the fibre properties using HVI and AFIS.	V	02*
	Minimum 14 Practical Exercises	**28 Hrs.**	

Note

i. *More **Practical Exercises** can be designed and offered by the respective course teacher to develop the industry relevant skills/outcomes to match the COs. The above table is only a suggestive list.*

ii. *The following are some **sample** 'Process' and 'Product' related skills (more may be added/deleted depending on the course) that occur in the above listed **Practical Exercises** of this course which are embedded in the COs and ultimately the competency.*

S. No.	Sample Performance Indicators for the PrOs	Weightage in %
1	Identify components.	10
2	Prepare experimental setup.	20
3	Operate the equipment setup or circuit.	20
4	Follow safe practices.	10
5	Record observations correctly.	20
6	Interpret the result and conclude.	20
Total		**100**

6. MAJOR EQUIPMENT/ INSTRUMENTSREQUIRED

This major equipment with broad specifications for the PrOs is a guide to procure them by the administrators to usher in uniformity of practical in all institutions across the state.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Fibre length measurement: Baer sorter: provided with 12 bottom combs and 3 top combs, imported needles brazed on brass strips, Standard accessories like velvet pad & tweezers.	1
2	Fibre length measurement: Digital fibrograph: To determine the span length of cotton fibre, Electronic Fibre Length Tester, based on Opto -electronic scanning unit, High speed sensing device, Calibrate with calibration cotton, Measuring Length upto 50mm, Span Length Measurement of 2.5%, 50%.	2
3	Fibre strength measurement: Stelometer: Determine the tensile strength or breaking tenacity and elongation of fibre bundle, Principle: constant rate of loading (CRL), Strength (breaking force) is measured from 2.0 to 7.0 kilogram, Elongation: 0 to 50 %, Gauge length: 0 and 1/8" (3.2 mm) ,Rate of loading : 1 kilogram per second.	3
4	Fiber fineness Tester with weighing scale: Sheffield Micronaire Tester: Determine the fineness value of cotton fibres in terms of micrograms per inch, Measuring Principle : Airflow Method, Measuring Range : 2.0 to 6.0 Micronaire , Measuring Accuracy : ± 0.1 Micronaire, Sample size : 4 grams ± 0.01 gram, Weighing scale : Capacity : 100 grams / Accuracy : 0.01 gram, Built-in calibration mode, Display : LED display.	4
5	Wrap reel: Minimum 5 skeins at a time, Perimeter 1.5 yds and Bobbin holding stand.	5
6	Electronic weighing balance: Determine the weight of Sliver , Roving and yarn , Capacity : 200 gm, Accuracy : 1 milligram , LCD display , Pan size: Minimum Ø 120 mm , with all calibrated weights.	5
7	Yarn twist tester: Continuous twist tester: Auto twist tester, Determine the twist of single ,double and open end yarn by untwist and twist principle, Specimen length adjustable 0-20",Selecion of S or Z twist, LCD display and provision to interface with printer, Feather touch operational keys, Specially designed yarn tensioning.	6

8	Yarn evenness tester: Uster evenness tester: evenness measurement of yarn, roving and sliver, capacitance principle, The CV% measured by Uster give a measure of variation of weight per unit length, measure the irregularity of material at high speed (2-100ft/min) and show both % of M.D and C.V. of material.	7
9	Fabric Drape meter: To determine the draping /hanging phenomenon of fabrics, Smooth precision engineered components for excellent performance, 1000W halogen lamp used for exposure, Sample Cutting template of 250mm diameter, having a centre hole for marking and cutting test specimen is supplied, With developing chamber, Supplied with manual where calculation for drape co-efficient is given, Complete with all accessories – Halogen Light Source, Cutting Template, 1Roll of Ammonia Paper.	8
10	Fabric Crease recovery tester: To determine Crease recovery of fabric, It is measured quantitatively in terms of crease recover angle, Made of heavy caste base with all parts of stainless steel, Size of test specimen: 40mm X 15mm, Creasing load:1 kg (Stainless steel), Angle measurement :On an Engraved circular scale graduated in 1 deg. Angle, Scale measurement: 0 - 180 degree.	9
11	Lea strength tester: To determine the lea strength of yarn , Electronic Lea strength tester, Measure the lea strength by load cell and latest micro coprocessor technology, Wall mounted with rugged steel base , Load range : 0 - 500 lbs (0-250 kgs), Instrument fully controlled by micro controller, LCD display, Accessories - UPS 1.0 KVA.	10
12	Fabric tensile strength tester: To determine grab and strip strength of fabric.	11
13	Fabric tearing strength tester: Determine the tearing strength of fabric, Maximum capacity up to 6.4 kg with adjustable cutting knife, Variable capacity 1.6 Kgs, 3.2 kgs,6.4 kg different fabric, Complete with accessories three calibration weights 1 sample making weights ,1 extra cutting blade and dust cover.	12
14	Fabric Bursting Strength Tester: Determine the bursting strength of fabric, Capacity: 35 Kg/Sq. Cm, Latest design with digital control panel, Maximum capacity 35 kg/ sq cm, Glycerine used as test fluid, Complete with all accessories including calibrated aluminium foil for calibration, Two diaphragms, & a clamp opening vice.	13
15	High volume instrument (HVI): To determine fibre properties namely length, strength, Length uniformity, elongation, micronaire, color, trash, Fully automatic sample preparation, auto combing and brushing for length and strength measurement. Testing speed within 26 – 30 seconds at each test of all 8 parameters.	14
16	Advance fibre information system(AFIS): To determine the important characteristics of cotton materials namely Card nep analysis, length applications, Card wire maintenance analysis ,Length applications ,Length analysis of comber and draw frame, Trash content analysis ,based on aeromechanical fibre processing, similar to opening and carding, followed by electro-optical sensing and then by high speed microprocessor based computing and data reporting.	14

7. AFFECTIVE DOMAIN OUTCOMES

The following ***sample*** Affective Domain Outcomes (ADOs) are embedded in many of the abovementioned COs and PrOs. More could be added to fulfill the development of this competency.

a) Work as a leader/a team member.
b) Follow ethical practices.
c) Follow safety precautions.
d) Practice environmentally friendly methods and processes.

The ADOs are best developed through the laboratory/field based exercises. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

i. 'Valuing Level' in 1st year
ii. 'Organization Level' in 2nd year.
iii. 'Characterization Level' in 3rd year.

8. UNDERPINNING THEORY

The major underpinning theory is given below based on the higher level UOs of *Revised Bloom's taxonomy* that are formulated for development of the COs and competency. If required, more such higher level UOs could be included by the course teacher to focus on attainment of COs and competency.

Unit	Unit Outcomes (UOs) (4 to 6 UOs at different level)	Topics and Sub-topics
Unit - I Introduction to Textile Testing	1a. Justify the objectives of textile testing. 1b. Identify standardization of testing. 1c. Describe the Standard atmospheric condition for testing. 1d. Differentiate various sampling methods.	1.1 Objectives of Textile Testing. 1.2 Standardization of Testing. 1.3 Standard atmospheric condition. 1.4 Sampling: Aim of Sampling 1.5 Types of Sampling: Random Sampling, Bias Sampling, Numerical Sampling, 1.6 Fibre sampling from bulk: Zoning technique, yarn and fabric sampling.
Unit – II Fibre Testing	2a. Identify the fibre length parameters. 2b. Explain working of bear sorter and digital fibrograph. 2c. Determine the Fibre Fineness parameters. 2d. Describe working of Sheffield micronaire and ATIRA fibre fineness tester. 2e. Determine the fibre maturity using caustic soda swelling method. 2f. Judge the Moisture content/ regain of fibre. 2g. Determine the trash content in cotton using Shirley Trash	2.1 Fibre length measurement: Importance, determination, fibre length parameter, baer sorter, digital fibrograph. 2.2 Fibre Fineness Measurement: Importance, different method of measuring, Airflow method, Sheffield Micronaire Tester, ATIRA fineness tester. 2.3 Fibre maturity: Importance, determination of maturity, Caustic soda swelling method 2.4 Fibre moister regain testing: Humidity and its importance, Conditioning oven method, Shirley moisture Tester 2.5 Trash content in cotton fibres: Determination of trash content in cotton, Shirley Trash Analyser.

	analyser.	
Unit – III Yarn Testing	3a. Describe the yarn numbering system. 3b. Measure yarn count. 3c. Determine the type of twist and its effect on fabric property. 3d. Describe different methods of twist measurements. 3e. Explain working of continuous twist tester and tension type twist tester. 3f. Classify different types of variations. 3g. Measure yarn evenness using Uster evenness tester.	3.1 Yarn count testing: yarn numbering system, Instrument used - Quadrant Balance, Knowles Balance and Wrap Reel. 3.2 Yarn Twist Testing: Type of twist, Effect of twist on fabric property, Different methods of twist measurement.-The straightened fibre method- Continuous Twist Tester.- Twist contraction method- Tension type twist tester. 3.3 Yarn evenness Testing: Classification of variations, Different method of measuring yarn evenness, Uster evenness tester.
Unit – IV Fabric Testing	4a. Identify the different quality parameters of fabric. 4b. Describe the working principle of the different fabric testing instrument. 4c. Determine the parameters related to fabric abrasion resistance. 4d. Describe procedures to test various parameters of the fabric. 4e. State factors responsible for pilling of fabrics. 4f. Measure air permeability and water permeability of fabric. 4g. Determine the flame resistance of fabric. 4h. Measure fabric stiffness, handle and drape of fabric. 4i. Determine the crease resistance of fabric. 4j. Describe the eco textile testing.	4.1 Quality parameters of fabric. 4.2 Shirley Thickness Tester. 4.3 Fabric abrasion resistance: Classification of abrasion, Factors affecting abrasion resistance testing, Assessment of abrasion damage, The B.F.T. abrasion Tester. 4.4 Pilling of fabrics: Factors responsible, I.C.I Pilling box Tester. 4.5 Measurement of Air and water permeability: Air permeability, Air resistance, Air porosity Air permeability Test, Water permeability, shower proof ,water proof, water repellent, Drop penetration Test, Spray Test, Shirley hydrostatic head test 4.6 Measurement of flame resistance: Vertical Test, Inclined Test. 4.7 Fabric stiffness, handle and Drape: Parameters affecting handle of fabric, Drape meter, Shirley stiffness tester. 4.8 Crease resistance and crease recovery tester. 4.9 Eco textiles testing.
Unit –V Tensile Property and Advancement in Testing	5a. State the different Tensile Terms. 5b. Describe the principle for measuring tensile strength of textile material. 5c. Describe the working principle of Fibre Strength tester. 5d. Explain working principle of Yarn Strength tester.	5.1 Tensile Terms: Load, breaking load, Stress, Mass stress, Tenacity, Strain, Initial Modulus, Work of Rupture, CSP, RKM Value. 5.2 Principle for testing tensile strength: CRT, CRL, CRE. 5.3 Fibre strength Testers: Stelometer, Pressley Strength Tester. 5.4 Single yarn strength Tester, Lea strength

	5e. Explain the working principle of fabric Strength testers. 5f. Describe the working of High-Volume Instrument (HVI). 5g. Describe the working of UTM. 5h. Describe the working of AFIS.	tester. 5.5 Fabric strength tester. 5.6 Hydraulic Bursting Strength Tester. 5.7 Tearing Strength Tester. 5.8 High Volume Instrument-HVI. 5.9 Universal testing machine -UTM. 5.10 Advance fibre information system-AFIS.

9. SUGGESTED SPECIFICATION TABLE FOR QUESTIONPAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Textile Testing.	4	4	4	2	10
II	Fibre Testing.	8	3	6	4	13
III	Yarn Testing.	8	3	6	4	13
IV	Fabric Testing.	10	4	6	4	14
V	Tensile Property and Advancement in Testing.	12	6	8	6	20
Total		**42**	**20**	**30**	**20**	**70**

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

Note*: This specification table provides general guidelines to assist student for their learning and to teachers to teach and question paper designers/setters to formulate test items/questions assess the attainment of the UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary slightly from above table.*

10. SUGGESTED STUDENT ACTIVITIES

Other than the classroom and laboratory learning, following are the suggested student-related ***cocurricular*** 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 small report of 5 pages for each activity. They should also collect/record physical evidences such as photographs/videos of the activities for their (student's) portfolio which will be useful for their placement interviews:

a) Prepare comprehensive laboratory reports for the textile tests they perform.
b) Assignments on latest innovations and trends in textile testing.
c) Evaluate and compare textile products in the market, assessing their quality and compliance with testing standards.
d) Arrange visits to textile testing laboratories or facilities where students can observe and learn about the latest testing equipment and techniques.
e) Plan field trips to textile manufacturing facilities where students can witness the entire manufacturing process, including testing procedures, from raw materials to finished products.
f) Assignment structured according to specific topics, with a focus on internet-based content.

g) Present a seminar PPT on any of relevant topic of the Textile testing.
h) Prepare internet based assignment course topic wise.
i) Explore library/internet facilities for preparing report on fibre, yarn and fabric 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:

a) Massive open online courses (***MOOCs***) may be used to teach various topics/sub topics.
b) Guide student(s) in undertaking micro-projects.
c) ***'L" in section No. 4***means different types of teaching methods that are to be employed by teachers to develop the outcomes.
d) About ***20% of the topics/sub-topics*** which are relatively simpler or descriptive in nature is to be given to the students for ***self-learning***, but to be assessed using different assessment methods.
e) With respect to ***section No.10***, teachers need to ensure to create opportunities and provisions for ***co-curricular activities***.
f) Guide students on how to address issues on environment and sustainability.
g) Guide students for using data manuals.

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-projects are group-based (group of 3 to 5). However, **in the fifth and sixth semesters**, 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 duration of the micro project should be about **14-16*(fourteen to sixteen) student engagement hours*** during the course. The students 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. This should relate highly with competency of the course and the COs. Similar micro-projects could be added by the concerned course teacher:

a) **Sampling**: Prepare comparative chart or report on types of sampling, methods of fiber yarn and fabric sampling technique. Collect sample of fiber, yarn and fabric for testing.
b) **Fiber testing**: To analyze and compare the fiber length, strength, fineness, and moisture content of different types of fibers (e.g., natural, and synthetic fibers.), Prepare report, chart or small model on different fiber testing instrument.
c) **Yarn testing**: Investigate the influence of twist on the properties of yarn and to determine the optimal twist for desired characteristics. To systematically investigate and analyze the key properties of yarn, including twist, strength, and linear density, and to understand the interplay between these factors, Prepare report, chart or small model on yarn tensile testing instrument.
d) **Fabric testing**: To investigate and analyze various properties of fabric, including the impact of twist on fabric structure, abrasion resistance, pilling, air permeability, handle, thickness, and

other relevant characteristics, Prepare report, chart or small model on different fabric testing instrument.

e) **Tensile Property:** To determine the tensile strength of different types of fibers, yarn and fabric compare their performance, investigate and analyze tensile properties of fabric, Prepare report, chart or small model on different tensile testing instrument.

f) **Advancement in Testing:** To investigate and analyze various fiber properties using advance testing instrument. Prepare report on working principle and features of advance testing instruments.

g) **Environmental aspect in textile testing laboratory**: Prepare the report of environmental aspect in textile testing laboratory. Such as Energy Consumption, ECO textile testing,Water Usage, Waste Generation, Chemical Usage, Green Certifications (ISO14001).

13. SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication with place, year and ISBN
1	Principles of Textile Testing.	J. E. Booth	CBS Publishers AND distributors PVT LTD 1996 New Delhi India (15 September 2018)ISBN 10:81-239-0515-7, ISBN-13: 978-8123905150
2	Textile testing	P. Angappan & R. Gopalakrishnan	S.S.M.I.T.T Staff and students' Co-op Stores Ltd, Valayakkaranoor, Tamil Nadu 2002
3	Testing and Quality Management	V. K. Kothari	IAFL Publications, New Delhi. ISBN 819010330X,9788190103305
4	Handbook of Textile Testing and Quality Control	E. B. Grover and D. S. Hamby	Textile book publishers 1960-Technology and engineering the university of michigari.
5	Textile Testing and Analysis	Collier, Billie J	PHI Learning, New Delhi ISBN-10 0134882148, ISBN-13 978-0134882147.
6	Physical Testing of Textiles	B. P. Saville	Woodhead Publishing Ltd-2002, Cambridge EnglandISBN:1855733676 CRC pressISBN:0-8493-0568-3
7	Textile testing	Skinkle, John H.	Chemical Pub. Co., New York

14. SOFTWARE/LEARNING WEBSITES

1. https://archive.nptel.ac.in/courses/116/102/116102029/
2. https://archive.nptel.ac.in/courses/116/102/116102049/
3. https://textilestudycenter.com/
4. http://www.uster.com/en/instruments/fiber-testing/uster-hvi/
5. http://www.atira.in/Testing.aspx/
6. https://www.onlinetextileacademy.com/category/textile-testing/
7. https://textilelearner.net/different-types-of-textile-testing-methods/
8. https://textilestudycenter.com/library/

15. PO-COMPETENCY-CO MAPPING

Semester -VI	Textile Testing (Course Code: 4362903)						
	Pos						
Competency & Course Outcomes	PO 1 Basic & Discipline specific knowledge	PO 2 Problem Analysis	PO 3 Design/ development of solutions	PO 4 Engineering Tools, Experimentation &Testing	PO 5 Engineering practices for society, sustainability & environment	PO 6 Project Management	PO 7 Life-long learning
Competency	Apply knowledge of fibre, yarn and fabric testing for appropriate raw material selection, product development and process control to determine the quality throughout the textile product chain.						
CO a) Employ various sampling techniques and standard atmospheric condition in textile testing.	1	-	2	2	1	-	2
CO b) Test the different fibre quality parameters using the relevant fibre testing instruments.	2	3	3	3	2	2	2
CO c) Measure yarn count, twist and irregularity using the relevant yarn testing instruments.	3	3	2	3	2	3	3
CO d) Test the different fabric quality parameters using the relevant fabric testing instruments.	2	2	2	3	2	2	3
CO e) Analyze the tensile properties of fibre, yarn and fabric using the tensile testing instruments.	3	2	3	3	2	2	3

Legend: '**3'** for high, '**2**' for medium, **'1'** for low or **'-'** for the relevant correlation of each CO with PO.

16. COURSE CURRICULUM DEVELOPMENT COMMITTEE

GTU Resource Persons

S. No.	Name and Designation	Institute	Contact No.	Email
1	Smt P. M. Parmar, Lecturer in Textile Technology	R. C. Technical Institute, Ahmedabad	079-27664785	pritimparmar84@gmail.com
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