

**ANNA UNIVERSITY, CHENNAI**  
**NON- AUTONOMOUS COLLEGES**  
**AFFILIATED TO ANNA UNIVERSITY**  
**M. TECH., TEXTILE TECHNOLOGY**  
**REGULATIONS 2025**

**PROGRAMME OUTCOMES (POs):**

<b>PO</b>	<b>Programme Outcomes</b>
<b>PO1</b>	An ability to independently carry out research /investigation and development work to solve practical problems
<b>PO2</b>	An ability to write and present a substantial technical report/document.
<b>PO3</b>	Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program

**PROGRAMME SPECIFIC OUTCOMES(PSOs):**

<b>PSO</b>	<b>Programme Specific Outcomes</b>
<b>PSO1</b>	Apply textile technology knowledge to develop innovative processes/products and manage industrial operations effectively.
<b>PSO2</b>	Demonstrate ethical responsibility and apply engineering and management principles to lead and execute projects in multidisciplinary teams.



**ANNA UNIVERSITY, CHENNAI**

**POSTGRADUATE CURRICULUM (NON-AUTONOMOUS AFFILIATED INSTITUTIONS)**

**Programme:** M. Tech., Textile Technology

**Regulations:** 2025

**Abbreviations:**

**BS** – Basic Science (Mathematics)

**L** – Laboratory Course

**ES** – Engineering Science (General (**G**),  
Programme Core (**PC**), Programme  
Elective (**PE**))

**T** – Theory

**SD** – Skill Development

**LIT** – Laboratory Integrated Theory

**SL** – Self Learning

**PW** – Project Work

**TCP** – Total Contact Period(s)

Semester - I									
S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.	MA25C08	Statistics for Technologists	T	3	1	0	4	4	ES (PC)
2.	TX25101	Polymer and Fibre Physics	LIT	3	0	2	5	4	ES (PC)
3.	TX25102	Theory of Short Staple Spinning	T	3	0	0	3	3	ES (PC)
4.	TX25103	Advances in Fabric Formation	T	3	0	0	3	3	ES (PC)
5.	TX25104	Wetting and Wicking of Textile Materials	T	3	0	0	3	3	ES (PC)
6.	TX25105	Textile Product Development Laboratory	L	0	0	4	4	2	SD
7.	TX25106	Technical Seminar	-	0	0	2	2	1	SD
<b>Total Credits</b>							<b>24</b>	<b>20</b>	

Semester - II									
S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.	TX25201	Theory of Textile Structures	T	2	1	0	3	3	ES (PC)
2.	TX25202	Automotive Textiles	T	3	0	0	3	3	ES (PC)
3.	TX25203	Textiles for Protection	T	3	0	0	3	3	ES (PC)
4.	TX25204	Theory of Coloration and Functional Finishes	T	3	0	0	3	3	ES (PC)
5.	---	Programme Elective I	T	3	0	0	3	3	ES (PE)
6.	---	Industry Oriented Course I	---	1	0	0	1	1	SD
7.	TX25205	Evaluation of Textile Materials	T	3	0	0	3	3	ES (PC)
8.	TX25206	Evaluation of Technical Textile Laboratory	L	0	0	4	4	2	SD
9.	TX25207	Advanced Textile Testing Laboratory	L	0	0	4	4	2	SD
10.	---	Self Learning Course	--	-	-	-	-	1	-
<b>Total Credits</b>							<b>27</b>	<b>24</b>	

Semester – III									
S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
<b>THEORY</b>									
1.	---	Programme Elective II	T	3	0	0	3	3	ES (PE)
2.	---	Programme Elective III	T	3	0	0	3	3	ES (PE)
3.	---	Programme Elective IV	T	3	0	0	3	3	ES (PE)
4.	---	Industry Oriented Course II	---	1	0	0	1	1	SD
5.	---	Programme Elective V	T	3	0	0	3	3	ES (PE)
6.	TX25301	Textile Product Engineering Laboratory	L	0	0	4	4	2	SD
7.	TX25302	Project Work I	---	0	0	12	12	6	SD
<b>Total Credits</b>							<b>29</b>	<b>21</b>	

Semester IV									
S. No.	Course Code	Course Title	Type	Periods per week			TCP	Credits	Category
				L	T	P			
1.	TX25401	Project Work II	---	0	0	24	24	12	SD
Total Credits							24	12	

#### PROGRAMME ELECTIVE COURSES (PE)

S. No.	Course Code	Course Title	Periods			Total Contact Periods	Credits
			L	T	P		
1.	TX25C01	Coated and Laminated Textiles	3	0	0	3	3
2.	TX25C02	Sustainability in Textile Industry	3	0	0	3	3
3.	TX25C03	Textile Reinforced Composites	3	0	0	3	3
4.	TX25C04	Functional Dyes	3	0	0	3	3
5.	TX25001	Alternative Spinning System	3	0	0	3	3
6.	TX25002	Process Control and Optimization in Yarn Spinning	3	0	0	3	3
7.	TX25003	Bioprocessing of Textiles	3	0	0	3	3
8.	TX25004	High Performance Textiles	3	0	0	3	3
9.	TX25005	Filtration Textiles	3	0	0	3	3
10.	TX25006	Clothing Science	3	0	0	3	3
11.	TX25007	Surface Treatments for Textiles	3	0	0	3	3
12.	TX25008	Sports and Agro Textiles	3	0	0	3	3
13.	TX25009	Synthesis and Application of Nanomaterials in Textile	3	0	0	3	3
14.	TX25010	Electrically Conductive and Electronic Wearable Textiles	3	0	0	3	3
15.	TX25011	Medical and Hygiene Textiles	3	0	0	3	3
16.	TX25012	Recycling of Textiles	3	0	0	3	3

# **Semester I**

MA25C08	Statistics for Technologists	L	T	P	C
		3	1	0	4

**Course Objective:**

To make the students to learn about the

- Probability distributions, sampling and testing of hypothesis.
- Process control using charts and process capability.
- Design of experiments for industry applications and
- Modeling the probabilistic phenomena.

**Probability Distribution and Estimations:** Applications of Binomial, Poisson, normal, t, exponential, chi-square, F and Weibull distributions in engineering; point estimates and interval estimations of the parameters of the distribution functions.

**Activity:** Use real or simulated data sets to fit different probability distributions (Binomial, Poisson, Normal, Weibull, etc.) using software or spreadsheets.

**Hypothesis Testing:** Sampling distribution; significance tests applicable– normal test, t-test, chi-square test and F- test; p-Values; selection of sample size and significance levels with relevance to industry applications; acceptance sampling.

**Activity:** Perform hypothesis tests (t-test, Chi-square, F-test) and interpret results.

**Analysis of Variance and Non-Parametric Tests:** Analysis of variance for different models; non-parametric tests – sign test, rank test, concordance test.

**Activity:** Conduct ANOVA and non-parametric tests on sample data.

**Process Control and Capability Analysis:** Control charts for variables and attributes – basis, development, interpretation, sensitizing rules, average run length; process capability analysis.

**Activity:** Create control charts and calculate process capability.

**Design and Analysis of Experiments:** 2k full-factorial designs; composite designs; robust designs; development of regression models, regression coefficients; adequacy test; process optimizations.

**Activity:** Demonstration of Design of experiments software tool.

**Weightage:** Continuous Assessment: 40%, End Semester Examinations: 60%

**Assessment Methodology:** Quiz (20%), Assignments (30%), Internal Examinations (50%)

**References:**

- 1 Chatfield, C. (1983). *Statistics for technology: A course in applied statistics*. Routledge. <https://doi.org/10.1201/9780203738467>
- 2 Leaf, G. A. V. (1984). *Practical statistics for the textile industry (Parts I & II)*. The Textile Institute.
- 3 Moen, R. D., Nolan, T. W., & Provost, L. P. (1998). *Quality improvement through planned experimentation*. McGraw-Hill.
- 4 Montgomery, D. C. (2000). *Design and analysis of experiments*. John Wiley & Sons.
- 5 Montgomery, D. C. (2002). *Introduction to statistical quality control*. John Wiley & Sons

	<b>Description of CO</b>	<b>PO</b>	<b>PSO1</b>	<b>PSO2</b>
CO1	Apply probability distributions to analyze and interpret engineering data.	PO1 (3), PO2(2),	2	1
CO2	Perform hypothesis testing, ANOVA, and non-parametric tests for decision-making.	PO1 (3), PO2(2), PO4(2)	3	2
CO3	Construct control charts and assess process capability in quality control.	PO1 (3), PO2(2), PO4(2)	1	2
CO4	Design and analyze experiments for process optimization.	PO1 (3), PO2(2), PO4(2)	1	3

TX25101	Polymer and Fibre Physics	L	T	P	C
		3	0	2	4
<p><b>Course Objective:</b></p> <p>To enable the students to learn about</p> <ul style="list-style-type: none"> <li>• Fundamentals of fibre forming polymer and its characteristics, polymerization techniques.</li> <li>• Different types of polymer and its nature, properties of polymeric fibres.</li> <li>• Conducting of experiments to characterize the polymers, fibres, yarn.</li> </ul>					
<p><b>Fundamentals of Polymer:</b> Classification of polymers; Fundamental definitions; synthetic fibre forming polymers; fundamental concepts of polymerization; molecular architecture in polymers, configuration, conformation; molecular weight and its influence on fibre formation.</p> <p><b>Activity:</b> Identify and classify different polymers; analyze molecular structures using sample data.</p>					
<p><b>Polymerization and Kinetics of Polymerization:</b> Chemistry of polymerization – chain polymerization, step polymerization; free radical polymerization – cationic polymerization – anionic polymerization; polycondensation; dilute solution properties, thermodynamics, kinetics of chain and step polymers, concentrated polymer solutions and polymer melts; molecular weight and size; viscosity, average molecular weight, degree of polymerization and polydispersity.</p> <p><b>Activity:</b> Model polymerization kinetics using reaction rate data; compare chain vs step polymerization.</p>					
<p><b>Rubbery and Glassy Polymers:</b> Polymer micro structure, chemical, geometrical; rubber elastic state, thermo-elastic behaviour and thermodynamics: energetic and entropic elastic forces; mechanical theory of rubber elasticity; swelling of rubbers in solvents; the glassy amorphous state- amorphous polymers, the glass transition temperature, non-equilibrium features of glassy polymers and physical ageing, theories for the glass transition, mechanical behaviour of glassy, amorphous polymers, structure of glassy, amorphous polymers.</p> <p><b>Activity:</b> Perform experiments or simulations on rubber elasticity and glass transition behavior.</p>					
<p><b>Molten and Crystalline Polymers:</b> The molten state, fundamental concepts in rheology, measurement of rheological properties of molten polymers, flexible-chain polymers, liquid-crystalline polymers; crystalline polymers- polymer crystallography, the crystal lamella, crystals grown from the melt and the crystal lamella stack, lattice indices, super molecular structure-methods of assessing super molecular structure, relaxation processes in semicrystalline polymers.</p> <p><b>Activity:</b> Measure and analyze rheological properties of polymer melts; study crystalline structures with microscopy images.</p>					
<p><b>Structure-Property Relationships:</b> Mechanical properties of natural and synthetic fibres; moisture sorption behaviour of natural and synthetic fibres; thermal, frictional and optical properties of fibres.</p> <p><b>Activity:</b> Test mechanical and thermal properties of natural vs synthetic fibers; analyze moisture absorption data.</p>					
<p><b>Weightage:</b> Continuous Assessment: 50%, End Semester Examinations: 50%</p>					
<p><b>Assessment Methodology:</b> Quiz (5%), Assignments (20%), Flipped Class (5%), Practical (30%), Internal Examinations (40%)</p>					

## List of Experiments

1. Molecular weight determination using GPC
2. Rheological studies using Brookefield viscometer
3. Determination of MFI
4. Birefringence measurement
5. Creep and Stress relaxation of filament
6. DSC Thermogram analysis of different fibres
7. Analysis of spectrogram
8. Analysis of VL curve
9. Interpretation of imperfections and faults
10. Analysis of tensile behavior of yarns
11. Thermal stability studies on fibres using TGA
12. Analysis – FTIR spectrograph and NMR graphs
13. Determination of crystallinity by XRD

## References:

1. Baird, D. G., & Collias, D. I. (2014). Polymer processing: Principles and design. Wiley.
2. Billmeyer, F. W. (1984). Textbook of polymer science (3rd ed.). Wiley.
3. Gedde, U. W. (1995). Polymer physics. Chapman & Hall.
4. Gordon, M. (1963). High polymers. Addison-Wesley.
5. Gupta, V. B., & Kothari, V. K. (1985). Man-made fibre production. Chapman & Hall.
6. Hongu, T., & Phillips, G. (1997). New fibres. Woodhead Publishing.
7. Kothari, V. K. (2000). Textile fibres: Developments and innovations. IAFL Publication.
8. Odian, G. (1991). Principles of polymerization (3rd ed.). Wiley.
9. Sperling, L. H. (1986). Introduction to physical polymer science. Wiley.
10. Walczak, Z. K. (2002). Processes of fiber formation. Elsevier Science.
11. Zhang, X. (2014). Fundamentals of fiber science. DEStech Publications.

	Description of CO	PO	PSO1	PSO2
CO1	Classify polymers and interpret their molecular structures and architectures.	PO1 (3), PO2(2),	1	2
CO2	Explain polymerization methods and analyze their reaction kinetics.	PO1 (3), PO2(2), PO4(2)	2	3
CO3	Evaluate the mechanical, rheological, and crystalline behavior of polymers.	PO1 (3), PO2(2), PO4(2)	1	2
CO4	Correlate polymer structure with thermal, mechanical, and moisture properties in fibers.	PO1 (3), PO2(2), PO4(2)	1	3

TX25102	Theory of Short Staple Spinning	L	T	P	C
		3	0	0	3
<p><b>Course Objective:</b></p> <ul style="list-style-type: none"> <li>To enable the students to learn the theory of various operations carried out at different stages of yarn spinning</li> </ul>					
<p><b>Fibre Dispersion and Cleaning:</b> Necessity of fibre-individualization; fibre opening and cleaning in blow-room machinery; forces acting on the fibre during carding operation; the mechanism of fibre dispersion, fibre transfer, short fibre removal and trash removal; entanglement and disentanglement of fibres; the new approaches to improve fibre-dispersion in carding operation; mechanism of removal of short fibre and trash in comber.</p> <p><b>Activity:</b> Observe and analyze fibre dispersion and trash removal efficiency in carding machine samples.</p>					
<p><b>Fibre Straightening, Neps Removal:</b> Theory of hook formation; measurement of fibre extent, influence of fibre extent on yarn quality; improvement of fibre-extent by carding, drafting and combing actions; generation of neps, neps removal in carding and combing.</p> <p><b>Activity:</b> Measure fibre extent and assess nep count before and after carding/combing.</p>					
<p><b>Attenuation:</b> Principle of roller drafting and its application in yarn production; ideal drafting; factors affecting drafting force, fibre dynamics during drafting, drafting irregularities and their causes and remedies; effect of amount of draft and draft distribution on strand irregularity; the function of aprons in roller drafting; limitation of apron-drafting and the scope for improvement; mechanism of wire-point drafting and its application in yarn production; merits and demerits of wire-point drafting; comparison of wire-point drafting with roller drafting.</p> <p><b>Activity:</b> Conduct drafting experiments to identify irregularities and evaluate drafting force.</p>					
<p><b>Twisting:</b> Twisted yarn geometry, forces acting on fibre and yarn during twisting, effect of fibre helix angle on strength, parameters affecting optimum twist level; balloon and spinning triangle formation and their effects on yarn quality and productivity; fundamental requirement to create real twist in a strand, mechanism of twisting in ring spinning, separation of twisting and winding actions of yarn; ply twisting, twist balance; modified twisting principles - open end twisting, false twisting, two nozzle air-jet twisting, air-vortex twisting, up-twisting, two-for-one twisting, hollow-spindle twisting; merits and demerits of modern twisting system.</p> <p><b>Activity:</b> Test yarn samples with varying twist levels to study effects on strength and quality.</p>					
<p><b>Fibre Blending and Levelling:</b> Importance of achieving homogeneous blending in fibre-mix; types of mixing during spinning preparatory process; lateral and longitudinal fibre blending; analysis of fibre blend index values; process parameters of spinning machinery for processing blended material; influence of intermediate product uniformity on yarn uniformity; different methods of levelling adopted during spinning processes.</p> <p><b>Activity:</b> Calculate blend uniformity using blend index and compare yarn uniformity from blended fibres.</p>					
<p><b>Weightage:</b> Continuous Assessment: 40%, End Semester Examinations: 60%</p>					

**Assessment Methodology:** Quiz (20%), Assignments (30%), Internal Examinations (50%)

**References:**

1. Grosberg, P., & Iype, C. (1999). Yarn production: Theoretical aspects. Textile Institute.
2. Iredale, J. A. (1992). Yarn preparation: A handbook. Intermediate Technology.
3. Klein, W. (2014). The Rieter manual of spinning, Vol. 1. Rieter Machine Works Ltd.
4. Klein, W. (2014). The Rieter manual of spinning, Vol. 2. Rieter Machine Works Ltd.
5. Klein, W. (2014). The Rieter manual of spinning, Vols. 1–3. Rieter Machine Works Ltd.
6. Lawrence, C. A. (2003). Fundamentals of spun yarn technology. CRC Press.
7. Lord, P. R. (1999). Yarn production: Science, technology and economics. Textile Institute.
8. Oxtoby, E. (1987). Spun yarn technology. Butterworth.
9. Salhotra, K. R., & Chattopadhyay, R. (1998). Book of papers on blow room, card. Indian Institute of Technology Delhi.
10. Shaw, J. (1982). Short-staple ring spinning. Textile Progress, The Textile Institute.

	<b>Description of CO</b>	<b>PO</b>	<b>PSO1</b>	<b>PSO2</b>
CO1	Explain the fibre dispersion and cleaning for yarn production.	PO1(3), PO2(2),	2	3
CO2	Improve fibre straightening and nep removal techniques.	PO1(3), PO2(2), PO4(2)	3	2
CO3	Analyze and correct irregularities in the drafting process.	PO1 (3), PO2(2), PO4(2)	2	1
CO4	Apply modern twisting and blending techniques for yarn uniformity.	PO1 (3), PO2(2), PO4(2)	1	3

TX25103	Advances In Fabric Formation	L	T	P	C
		3	0	0	3
<p><b>Course Objective:</b></p> <p>To enable the students to learn about</p> <ul style="list-style-type: none"> <li>Advances in fabric formation and their structural features, characteristics and application.</li> </ul>					
<p><b>Woven Fabrics:</b> Principle of fabric formation and fabric structure – circular woven fabrics, narrow fabric; advances in 3-D woven fabrics – principle of hollow, shell and nodal fabric formations; Noobing – principle and fabric structure; applications.</p> <p><b>Activity:</b> Examine and compare samples of circular, 3D woven, and noobing fabrics.</p>					
<p><b>Knitted Fabrics:</b> Advances in circular knitting – loop transfer, seam less knitting and sliver knitting techniques; 3-D knitted fabrics – circular and flat weft knit techniques, applications; spacer fabrics – weft and warp knit techniques, applications.</p> <p><b>Activity:</b> Identify knitting techniques by analyzing various knitted fabric samples.</p>					
<p><b>Braided Fabrics:</b> Principle and production of 3-D braided structures – Cartesian braiding, rotary braiding, and hexagonal; advances in track and column braiding – production of tubular and bifurcated structure; applications.</p> <p><b>Activity:</b> Observe and classify different 3D braided structures using fabric samples or images.</p>					
<p><b>Auxetic Fabrics:</b> Introduction to auxetic materials – polymer, fiber and yarn; Auxetic fabric structure; principle and production of woven, weft knit, warp knit and nonwoven auxetic fabrics; 3D auxetic fabrics; braided auxetic fabrics; applications.</p> <p><b>Activity:</b> Test mechanical properties of auxetic fabric samples and observe their unique behavior.</p>					
<p><b>Smart Fabrics:</b> Definition and classifications; production and development of smart fibre and yarn; smart fabric structure and preparation, weaving, knitting and braiding technique; applications.</p> <p><b>Activity:</b> Research and present applications of different smart fabrics in industry.</p>					
<p><b>Weightage:</b> Continuous Assessment: 40%, End Semester Examinations: 60%</p>					
<p><b>Assessment Methodology:</b> Quiz (20%), Assignments (30%), Internal Examinations (50%)</p>					
<p><b>References:</b></p> <ol style="list-style-type: none"> <li>Au, K. F. (2011). Advances in knitting technology. Woodhead Publishing.</li> <li>Chen, X. (2015). Advances in 3D textiles. Woodhead Publishing.</li> <li>Kellie, G. (2016). Advances in technical nonwovens. Woodhead Publishing.</li> <li>Kyosev, Y. (2016). Recent developments in braiding and narrow weaving. Springer.</li> <li>McLoughlin, J., &amp; Sabir, T. (2018). High-performance apparel. Woodhead Publishing.</li> <li>Vassiliadis, S. (2011). Advances in modern woven fabrics technology. InTech.</li> </ol>					

	<b>Description of CO</b>	<b>PO</b>	<b>PSO1</b>	<b>PSO2</b>
CO1	Explain the principles and structural variations of woven fabrics, including 3D and noobing fabrics.	PO1(3), PO2(2),	3	2
CO2	Describe advanced knitting techniques and identify different knitted fabric types.	PO1(3), PO2(2), PO4(2)	2	3
CO3	Classify braided fabric structures and explain various braiding methods.	PO1 (3), PO2(2), PO4(2)	3	2
CO4	Analyze the production techniques and unique properties of auxetic fabrics.	PO1 (3), PO2(2), PO4(2)	1	3

TX25104	Wetting and Wicking of Textile Materials	L	T	P	C
		3	0	0	3
<p><b>Course Objective:</b> This course aims</p> <ul style="list-style-type: none"> <li>• To enable the students to analyse the mathematical representation of power system components and solution techniques and generalise the power flow analysis using various methods.</li> <li>• To infer the knowledge of the different types of faults and its calculation using computer method and mathematical model.</li> <li>• To know the concept of numerical integration methods to analyse power system transient stability.</li> </ul>					
<p><b>Fundamentals on Wetting:</b> Surface tension of liquids and theories on its measurements; equilibrium state of a liquid on a solid; solid-liquid interaction in immersion, penetration, adhesion and spreading.</p> <p><b>Activity:</b> Measure surface tension of liquids using standard methods and analyze wetting behavior on solids.</p>					
<p><b>Characterization of Wetting:</b> Determination of wetting force and work of adhesion; measurement of contact angle using Goniometry and tensiometry; critical assessment of the above techniques; importance of wetting of fabrics and its assessment.</p> <p><b>Activity:</b> Use a goniometer to measure contact angles on fabric samples and interpret results.</p>					
<p><b>Wicking in yarns and Fabrics:</b> Fundamentals of wicking; wicking in yarns and its measurement; wicking in fabrics from an infinite and finite reservoir; studies on factors affecting wetting and wicking in fibres and fibrous assemblies; mathematical models of wetting and wicking.</p> <p><b>Activity:</b> Perform wicking tests on yarn and fabric samples; analyze effect of different parameters.</p>					
<p><b>Modification of Substrates:</b> Effect of substrate modification on wetting and wicking behavior: chemical, enzyme, plasma; coating and lamination; finishing.</p> <p><b>Activity:</b> Compare wicking behavior before and after substrate modification treatments.</p>					
<p><b>Application:</b> Areas of wetting and wicking of fibrous materials; role of wetting and wicking on dyeing and printing, and comfort behavior of textiles; significance of wetting and wicking in medical and hygiene products; usefulness of wetting and wicking in industrial and domestic products.</p> <p><b>Activity:</b> Case study analysis of wetting and wicking impact on textile applications.</p>					
<p><b>Weightage:</b> Continuous Assessment: 40%, End Semester Examinations: 60%</p>					
<p><b>Assessment Methodology:</b> Quiz (20%), Assignments (30%), Internal Examinations (50%)</p>					
<p><b>References:</b></p> <ol style="list-style-type: none"> <li>1 Huang, H., Ye, C., &amp; Sun, W. (2008). Moisture transport in fibrous clothing assemblies. <i>Journal of Engineering Mathematics</i>.</li> <li>2 Ningtao. (2009). <i>Liquid transport and wicking in nonwoven materials</i>. VDM Verlag Dr. Müller.</li> <li>3 Pan, N., &amp; Gibson, P. (2006). <i>Thermal and moisture transport in fibrous materials</i>. Woodhead Publishing.</li> <li>4 Pan, N., &amp; Zhong, W. (2006). Fluid transport phenomenon in fibrous materials. <i>Journal of Textile Progress</i>, 38(1).</li> <li>5 Patnaik, A., Rengasamy, R. S., Kothari, V. K., &amp; Ghosh, A. (2006). Wetting and wicking in fibrous materials. <i>Journal of Textile Progress</i>, 38(1).</li> </ol>					

	<b>Description of CO</b>	<b>PO</b>	<b>PSO1</b>	<b>PSO2</b>
CO1	Explain the fundamentals of wetting, surface tension, and their role in textiles.	PO2(2), PO4(2)	2	3
CO2	Measure and interpret wetting behavior using contact angle techniques.	PO1(3), PO2(2), PO4(2)	3	1
CO3	Describe wicking mechanisms in yarns and fabrics.	PO1 (3), PO2(2), PO4(2)	3	2
CO4	Evaluate how substrate modifications affect wetting and wicking in textile applications.	PO1 (3), PO2(2), PO4(2)	2	2

TX25105	Textile Product Development Laboratory	L	T	P	C
		0	0	4	2

**Course Objective:**

This course aims

- To enable the students to analyse the mathematical representation of power system components and solution techniques and generalise the power flow analysis using various methods.
- To infer the knowledge of the different types of faults and its calculation using computer method and mathematical model.
- To know the concept of numerical integration methods to analyse power system transient stability.

1. Development of narrow fabric
2. Development of flat bed- knit structure
3. Development of seamless garment
4. Development of nanofibrous web
5. Development of fibrous web
6. Development of textile reinforced composite
7. Development of core spun yarn
8. Development of metalized yarn
9. Development of metalized fabric
10. Development of electronic textile
11. Development of multilayer fabric and laminated

**Weightage:** Continuous Assessment: 60%, End Semester Examinations: 40%

**Assessment Methodology:** Project (30%), Assignment (10%), Practical (30%), Internal Examinations (30%)

	Description of CO	PO	PSO1	PSO2
CO1	Develop advanced textile structures and innovative yarns.	PO2(2), PO4(2)	2	3
CO2	Fabricate specialized fabrics and textile composites.	PO1(3), PO2(2), PO4(2)	3	1
CO3	Create smart and electronic textiles with functional applications.	PO1 (3), PO2(2), PO4(2)	3	2

**Objective**

To enable the students to learn about the structure of ideal and real yarn, migration of fibres in the yarn, breakage mechanism of yarn, mechanics of blended yarns and relationship between structure and property of yarns produced by different spinning systems.

**Yarn Geometry**

Elements of yarn geometry; geometry of helix and its application to yarn structures; yarn diameter, packing of fibres in yarn; relation between yarn parameters; estimation of packing density and radial packing density of yarn; effect of yarn packing density on quality of fabric; geometry of folded yarns

**Fibre Migration**

Twist contraction and retraction; migration characteristics in continuous filament and spun yarns; effect of various parameters on migration; measurement of fibre migration in yarn; effect of migration on tensile behaviors and hairiness of the yarn

**Yarn Mechanics**

Analysis of tensile behavior, prediction of breakage - continuous filament yarn and spun yarn; effect of fibre properties and geometrical configuration of yarn on the tensile and bending properties of yarn; design of yarn structures for certain functional uses

**Blended Yarn Mechanics**

Concept of elongation balance; effect of properties of constituent fibres and blend composition on behavior of blended yarns; blend irregularity- lateral and longitudinal blend irregularity, measurement, effect on yarn and fabric property

**Fabric Mechanics**

Pierce's geometry of plain weave fabrics; crimp balance equation; theoretical treatment of fabric deformation in tension, bending and shear; geometry of nonwoven and knitted fabrics

6

Solving the problems using computer spreadsheet

**OUTCOMES:**

Upon the completion of this course the student can

- CO1. Explain the geometry of yarn; solve the relationship between different structural parameters of yarn
- CO2. Explain the migration of filaments, fibres in yarn; measure fibre migration characteristics of yarn
- CO3. Interpret the theory of tensile behaviour of filament and spun yarns and factors influencing it; predict the strength of yarn
- CO4. Evaluate the blending irregularity and analyze the effect on fabric quality
- CO5. Demonstrate Pierce's models explaining the geometry of woven fabric

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**Course Articulation Matrix:**

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	3	1	3
CO2	2	1	3	3	1	3
CO3	2	1	3	3	1	3
CO4	2	1	3	3	1	3
CO5	2	1	3	3	1	3
<b>Overall CO</b>	2	1	3	3	1	3

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives**

To enable the students to learn about

- Textiles used in automotive textiles and their functional requirements
- Evaluation of textile materials used for automobile applications.

**Overview of Automotive Textiles**

Automotive textiles: Market and future trends, characteristics requirements of fiber, yarn and fabric for transportation, advancement in fabric manufacturing for automotive sector; NVH requirements in automotive application

**Automotive Trims**

Properties requirements and manufacturing of textile materials used in automobiles – tire cord, seat covers, floor covering; textile materials for automotive exterior trims - convertibles, truck covers, front end cover, tire cover; automotive safety restraint system in automobiles- air bag, seat belt.

**Non Wovens for Automobile Application**

Role of non woven in automotive industry- critical issues in non woven applications in automobiles; applications of non woven in boot liners, headliners, trunk, upholstery backing, door trim pad, etc; non woven in automobile filters- Oil, fuel, cabin and air filter.

**Composite in Automotive Textiles**

Polymer composites for automobiles and road safety – bumper, headliner, crash absorber element etc; textile reinforced composites in automobile: design and manufacturing; application of coated fabrics in transportation field. Multilayer textile composite for seat upholstery – property requirements and manufacturing

**Evaluation**

Automotive legislation in India – performance, safety and durability evaluation of textile material used in transportation industry; evaluation of coated fabrics for transportation

**Outcomes**

Upon completion of this course, the student shall be able to

CO1: Explain the textile requirements for automobile applications

CO2: Demonstrate and design product for automobile applications

CO3: Summarize the requirements and use of non woven in automobiles

CO4: Illustrate the role of composite in automotive industry

CO5: Identify and analyze the performance of textiles to be used in automotive industry

**References:**

1. Horrocks A.R. and Anand S.C., "Handbook of Technical Textiles", The Textile Institute, Manchester, 2000, ISBN: 1855733854.
2. R. A. Chapman, "Application of non wovens in technical textiles", Woodhead Publishing, ISBN-13: 978-1-84569-974-1
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**Course Articulation Matrix:**

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3	2	3	3
CO2	3	3	3	2	2	2
CO3	1	2	2	2	3	3
CO4	3	2	2	2	3	3
CO5	2	1	2	3	3	2
<b>Overall CO</b>	2	2	2.4	2.2	2.8	2.6

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives:**

To enable the students to learn about

- Functional requirements of protective clothing
- Selection of fibre, yarn and fabric for protective clothing
- Evaluation of protective clothing

**Protective Textiles**

Introduction and types of protection; classification of protective textiles; consumption and growth of protective textiles; standard for protective textiles; requirements for protective textiles – social and technical, health and safety; risk assessment; progress and future of protective textiles in India.

**Mechanical Impact Protection**

Introduction and nature of mechanical impact; types of mechanical impact; requirements of fibre, yarn and fabric for different mechanical impact; factors in designing of protective garment for soldiers, policeman, security person, motorcyclist; concept of cut resistance garment; standards and testing.

**Thermal and Cold Protection**

Introduction to fire, heat and cold protection; fibre, yarn and fabric requirements; designing of multilayer fabric; chemical finishes for fabric; designing of protective garment for thermal and cold protection; standards and testing.

**Chemical and Radiation Protection**

Nature and type of chemical environment; fibre, yarn and fabric requirements for chemical protection; designing of protective garment for chemical protection; introduction to radiation protection; types of radiation; development of fibre, yarn and fabric for radiation protection; design of protective garments for radiation protection; standards and testing.

**Biological Protection**

Introduction and types of biological protection; microorganism and their types; fibre, yarn and fabric requirements for biological protection; fabric finishes for biological protection; designing of protective garment for biological protection; standards and testing.

**Outcomes:**

Upon completion of the course, the students will be able to

CO1: Elucidate the properties of textile materials required for protective clothing

CO2: Recommend the textiles for construction of impact protective textile

CO3: Design and develop protective clothing for thermal and cold protection

CO4: Describe the application of textiles in chemical and radiation protection

CO5: Design protective garments for biological hazards

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1. Adanur S., "Wellington sears handbook of Industrial textiles" Technomic publishing co. inc., 1995, ISBN : 1 – 56676 – 340 – 1
2. Pushpa Bajaj and Sengupta A.K, "Protective clothing", the Textile Institute, 1992, ISBN 1- 870812 – 44-1
3. Chellamani K.P. and Chattopadhyay D., "Yarns and Technical Textiles", SITRA, 1999.
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## Course Articulation Matrix:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	2	1	2
CO2	3	1	3	2	2	2
CO3	3	1	3	2	2	2
CO4	3	1	3	2	2	2
CO5	3	1	3	2	2	2
<b>Overall CO</b>	2.8	1.2	3	2	1.8	2

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives**

To enable the students to learn about theory of coloration, coating techniques and substrate modification of the textile fabrics.

**Theory of Dyeing**

Dyeing equilibrium; dye-fibre interaction; adsorption isotherm; dye affinity; heat of dyeing; half dyeing time

**Ink Jet Printing**

Concept and methods of inkjet printing; colour separation; selection of dyes and developments in inks; techno-economical features

**Coating**

Coating polymers and auxiliaries, coating techniques and coated fabric assessment.

**Enzymes in Processing I**

Enzymes – classifications of enzymes and nomenclature of enzymes, synthesis of enzymes, enzyme kinetics

**Enzymes In Processing II**

Substrates and their structure, scaling of enzyme production, textile processing enzymes

**Outcomes:**

Upon completion of this course, the student can

- CO1: Comprehend the theories and concepts of dyeing
- CO2: Compare the various methods of printing and to study about the concepts of ink jet printing
- CO3: Categorize and evaluate the coated fabrics
- CO4: Classify various types of enzyme and to understand the process involved in synthesis of enzyme
- CO5: Distinguish the application of enzyme in wet processing

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**Course Articulation Matrix:**

<b>Course Outcomes</b>	<b>Program Outcomes</b>					
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
CO1	3	1	2	2	3	3
CO2	3	1	2	2	3	3
CO3	3	1	2	2	3	3
CO4	3	1	2	2	3	3
CO5	3	1	2	2	3	3
<b>Overall CO</b>	3	1	2	2	3	3

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives:**

To enable the students to

- Understand testing of yarn.
- Analyze the various reports generated during quality evaluation of fabrics and
- Interpret the results obtained through these reports for process and quality control.

**analysis of defects and mass variation**

Depiction of mass variation of textile strands in time and frequency domain; interpretation and significance of U% and CV% for textile strands; irregularity index; classification and analysis of yarn faults created by mass variation, their causes and remedies; yarn faults in fabrics - causes and remedies

**Variance Length Curve and Spectrogram**

Theory of construction of VL curve; analysis of variance length curves to understand and avoid the introduction of mass variation during the spinning operation determination of periodic mass variation in the form of spectrogram; determination of theoretical wave length from spectrum; comparison between normal and ideal spectrum; type of faults and their representation in spectrogram; interpretation of superimposed waves in spectrogram

**Evaluation of Yarn Tensile Properties and Fabric Comfort Properties**

Influence of testing factors on yarn tensile properties; measurement and application of yarn modulus; creep and stress relaxation of yarn; mechanical conditioning of yarn; fabric comfort related transmission properties- air permeability, moisture management, thermal conductivity, water vapor permeability and wicking; antistaticity

**Evaluation of Technical Textile I**

Performance evaluation and standard test methods of non woven; geotextiles – tensile strength, tear strength, water permeability, abrasion resistance, seam strength etc., medical textile – biocompatibility, antimicrobial, resistance to microbial penetration, liquid penetration, linting etc.

**Evaluation of Technical Textile II**

Performance evaluation and standard test methods of composite materials- tensile strength, flexural rigidity, impact strength, compression strength, interlaminar shear strength etc. test methods for coated textiles - tensile strength, bursting strength, abrasion resistance, hydrolysis resistance, resistance to UV and chemicals; accelerated ageing, high & low temperature exposure; evaluation and standard test method for bullet proof, UV resistant fabric, acoustic textiles, anti odour textile.

**Outcomes:**

On completion of this course, the students can

CO1: Analyze the yarn faults and apply knowledge in reducing yarn faults

CO2: Analyze the variance length curve and spectrogram

CO3: Assess yarn tensile properties and fabric comfort properties

CO4: Determine the performance of technical textile

CO5: Assess the properties of composite and other functional textiles

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2. B. P. Saville., "Physical testing of textiles", Woodhead publisher, 1999, ISBN: 978-1-85573-367-1.
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## Course Articulation Matrix:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	2	3	2
CO2	3	1	2	2	3	2
CO3	3	1	2	2	3	2
CO4	3	1	2	2	2	3
CO5	3	1	2	2	2	3
<b>Overall CO</b>	3	1	2	2	2.6	2.4

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives:**

To enable the students to learn about

- Characteristics of technical textile materials and their related models to describe their properties.
- Conducting of experiments to characterize technical textile.

**LIST OF EXPERIMENTS**

1. Evaluation of water absorbency and liquid transmission of healthcare and hygiene textiles
2. Evaluation of transverse and vertical wicking characteristics of technical textile
3. Evaluation of thermal insulation and water vapor permeability of fabrics
4. Determination of the mechanical properties of bullet proof fabric
5. Determination of fabric seam efficiency
6. Estimation of seam sealing tape performance (Water repellency, thickness, tensile strength, liquid and gas tight integrity)
7. Evaluation of fire-retardant fabric performance at different environmental condition
8. Evaluation of permeation rate and breakthrough time of chemical protective fabric
9. Evaluation of conductivity of fabrics
10. Evaluation of the geotextiles (water permeability, abrasion resistance, resistance to chemical, heat and microbes)
11. Determination of toxicity of the fabric
12. Determination of tensile, flexural and impact strength of composites

**OUTCOMES:**

Upon the completion of this course the student will be able to

CO1: Determine the liquid interaction with different technical textile material

CO2: Carryout confirmative tests to understand the properties of technical textile

CO3: Illustrate the principle of seam sealing and determine the performance different protective fabrics

**Course Articulation Matrix:**

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	2	2	3
CO2	3	1	2	2	2	3
CO3	3	1	2	2	2	3
<b>Overall CO</b>	3	1	2	2	2	3

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OBJECTIVES:**

To enable the students to learn about

- Characteristics of textile materials.

**LIST OF EXPERIMENTS**

1. Determination of residual formaldehyde in fabrics
2. Evaluation of filtration efficiency of different woven and non woven filter fabrics.
3. Evaluation of flame retardant finish
4. Evaluation of antimicrobial finish
5. Evaluation of water repellent finish
6. Evaluation of stain repellent finish
7. Determination of surface tension of liquids
8. Determination of contact angle for porous substrates
9. Evaluation of mechanical properties of non porous film fabric
10. Determination of UPF of fabrics

**OUTCOMES:**

Upon the completion of this course the student will be able to

CO1: Evaluate the functional properties of textile materials

CO2: Determine the performance of finished fabric

CO3: Characterize the porous and nonporous substrates

**Course Articulation Matrix:**

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
1	3	1	2	2	2	3
2	3	1	2	2	2	3
3	3	1	2	2	2	3
<b>Overall CO</b>	3	1	2	2	2	3

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OBJECTIVES:**

To enable the students to analyze the given product for reverse engineering.

**LIST OF EXPERIMENTS**

Reverse engineering of product including identification of fibre, yarn and fabric specifications, method of production, machine used for production, testing protocols and cost estimation – Four products for each student

**OUTCOMES:**

Upon the completion of this course the student can

CO1: Examine the product to identify the construction of product

CO2: Conduct confirmative tests to describe the raw materials used

CO3: Organize the procedure to produce the product

CO4: Estimate the cost of product

**Course Articulation Matrix:**

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	2	2
CO2	3	1	3	2	2	2
CO3	3	1	3	2	2	2
CO4	3	1	3	2	2	2
<b>Overall CO</b>	3	1	3	2	2	2

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OBJECTIVES:**

- To train the students in preparing project reports and to face reviews and viva-voce.
- To develop the structured methodology to solve the identified problem in textile industry.
- To consolidate and write reports on the findings of the project.

**LIST OF EXPERIMENTS**

The student individually works on a specific topic approved by faculty member who is familiar in this area of interest. The student can select any topic which is relevant to his/her specialization of the programme. The topic may be experimental or analytical or case studies. At the end of the semester, a detailed report on the work done should be submitted which contains clear definition of the identified problem, detailed literature review related to the area of work and methodology for carrying out the work.

**OUTCOMES:**

Upon the completion of this course the student shall be able to

CO1: Recognize the subject already studied

CO2: Review of literatures collected for the project

work CO3: Construct experimental plan based on

literature CO4: Demonstrate the process involved in the project

**Course Articulation Matrix:**

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2	3	2	2
CO2	1	2	1	1	1	2
CO3	3	1	1	3	2	3
CO4	1	1	3	3	2	2
<b>Overall CO</b>	2	1.75	1.75	2.5	1.75	2.25

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives:**

- To solve the identified problem based on the formulated methodology.
- To develop skills to analyze and discuss the test results, and make conclusions.

**List of Experiments:**

The student should continue the phase I work on the selected topic as per the formulated methodology. At the end of the semester, after completing the work to the satisfaction of the supervisor and review committee, a detailed report should be prepared and submitted to the head of the department. The students will be evaluated through based on the report and the viva-voce examination by a panel of examiners including one external examiner.

**Outcomes:**

Upon the completion of this course the student can

CO1: Analyse the process output by conducting the experiments

CO2: Evaluate the results obtained

CO3: Correlate the output with proposed experiments

CO4: Arrange the results in systematic orders

CO5: Prepare the report as per the norms

**Course Articulation Matrix:**

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	3	3	1
CO2	1	1	1	3	3	1
CO3	3	1	1	2	3	2
CO4	2	3	1	1	1	2
CO5	2	3	2	2	2	2
<b>Overall CO</b>	2.2	1.8	1.2	2.2	2.4	1.6

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives**

To enable the students to learn the production and applications of coated and laminated textile and their testing.

**Polymers for Coating And Lamination**

Natural latex & synthetic rubbers, synthetic polymers: polyurethanes, poly (vinyl chloride), polyacrylate elastomers, silicone elastomers, poly (Tetrafluoroethylene), polyethylene, chlorinated and chlorosulponated polyethylenes, foams for laminates; textile substrate for coating

**Coating and Laminating Methods**

Knife coating, roll coating, dip coating, transfer coating, gravure coating, rotary screen printing, calendaring, hot melt coating, foam coating, lamination by adhesives, welding

**Application Of Coated And Laminated Textile I**

Breathable textiles, microporous coatings and films, hydrophilic coatings, smart temperature responsive breathable coatings; synthetic leather, architectural textiles, fluid containers, tarpaulins, automotive applications, carpet backing, flocking, fusible interlinings

**Application Of Coated And Laminated Textile II**

Thermochromic fabrics, temperature adaptable fabrics, fabrics for chemical protection, camouflage nets, high visibility garments, intumescent coating, metal and conducting polymer coated fabrics, coating with hydrogel and shape memory polymers

**Characterization of Coated and Laminated Textiles**

Tensile strength, elongation, adhesion, tear resistance, flexing, ageing, weathering behavior, microbiological degradation, yellowing, testing standards

**OUTCOMES**

Upon completion of this course the student shall know

CO1: Different kinds of polymers used for coating and lamination

CO2: Different methods of coating and lamination

CO3: Application of coated and laminated textiles in automotive and architectural textiles

CO4: Application of coated and laminated textiles in protective textiles

CO5: Characterization of coated textiles

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**Course Articulation Matrix:**

<b>Course Outcomes</b>	<b>Program Outcomes</b>					
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
CO1	3	3	2	3	2	1
CO2	3	3	2	3	2	1
CO3	2	2	2	2	2	2
CO4	2	2	2	2	2	2
CO5	2	3	2	3	2	3
<b>Overall CO</b>	2.4	2.6	2	2.6	2	1.8

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives**

To enable the students to learn the concepts of sustainability and its importance in textile industry.

**Introduction to Sustainability**

Sustainability; Concepts and terminologies in sustainable approach; principles of sustainability; importance and application of sustainable approaches in textile industry

**Sustainability in Textile Industry**

Supply chain in textile industry; sustainable cotton, wool, and synthetic fibre production and processing; sustainability in non-production activities

**Sustainability in Processing**

Enzyme biotechnology, plasma technology in textiles; waterless dyeing technologies, low liquor dyeing

**Recycling**

Textile recycling: polymer, fibre, yarn and fabric; consumer perception of recycled textile products

**Eco Designing and Ecolabelling**

Eco-design, building eco-design through supply chain; sustainability for credit rating; environmental management systems; standards for labelling, textile labels and environmental labelling; life cycle analysis of textiles

**Outcomes**

Upon completion of this course the student shall be able to

CO1: Comprehend the concept of sustainability and its importance

CO2: Analyze the scope of sustainability in textile fibre production

CO3: Analyze the scope of sustainability in dyeing of textiles

CO4: Evaluate the importance of recycling in textile industry

CO5: Compare the various eco-labels in industry

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**Course Articulation Matrix:**

<b>Course Outcomes</b>	<b>Program Outcomes</b>					
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
CO1	3	2	2	1	3	2
CO2	3	2	2	1	3	2
CO3	3	2	2	1	3	2
CO4	3	2	2	1	3	2
CO5	3	2	2	1	3	2
<b>Overall CO</b>	3	2	2	1	3	2

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives**

To enable the students to learn about

- Reinforcements, matrices used for the composites.
- Manufacture and testing of composites and
- Mechanics of failure of composites.

**Reinforcements**

Introduction – composites –classification of reinforcements - matrices; selection of fibre for reinforcement and their properties; preparation of reinforced materials and quality evaluation; composite-design requirements and its application; preforms for various composites

**Matrices**

Properties and applications of matrices - natural, synthetic - thermoplastic and thermoset; mechanism of interaction of matrices and reinforcements; optimization of matrices

**Composite Manufacturing**

Classification; methods of composites manufacturing for both thermoplastics and thermosets- Hand layup, Filament Winding, Resin transfer moulding, prepregs and autoclave moulding, pultrusion, vacuum impregnation methods, compression moulding; post processing of composites

**Testing**

Fibre volume and weight fraction, specific gravity of composites, calculations; mechanical behavior of thermoset and thermoplastic composites; non impact testing of composite- ultrasonic C scan, vibrometry, infrared thermography, void analysis, internal damage.

**Mechanics**

Micro mechanics, macro mechanics of single layer, macro mechanics of laminate, classical lamination theory and its derivations, failure theories – maximum stress, maximum strain, Tsai-Hill and Hashin-Rotem analysis, prediction and derivations; prediction of inter laminar stresses.

**OUTCOMES**

Upon completion of this course, the student shall be able to

CO1: Elucidate the different types of textile reinforcements

CO2: Comprehend the different types of matrices

CO3: Describe the manufacturing of composites

CO4: Evaluate the properties of composite

CO5: Interpret the mechanics of composites failure

**REFERENCES:**

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3. George Lubin and Stanley T. Peters, "Handbook of Composites", Springer Publications, 1998.
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**Course Articulation Matrix:**

<b>Course Outcomes</b>	<b>Program Outcomes</b>					
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
CO1	3	3	2	1	2	2
CO2	3	3	2	1	2	2
CO3	3	3	3	2	1	2
CO4	3	3	3	2	2	2
CO5	3	3	3	2	2	2
<b>Overall CO</b>	3	3	2.6	1.6	1.8	2

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OBJECTIVES**

To enable the students to

- Recall the basics of dyes and their use in textile industry.
- Define functional dyes and recognize their use.
- Understand the application of functional dyes.
- Know the importance of toxicity and health aspects of dyes.

**Basics of Dyes**

General survey of dyes; chemical structure of dyes, general properties of dyes, chromophores and dye classes for textile application

**Dyes Used In Textiles**

Dyeing technology; standardization of textile dyes: dyes for cellulosic fibres, polyamides, polyesters and acrylic fibres; optical brightening agents: chemistry and evaluation of OBA

**Functional Dyes**

Functional dyes: dyes for leather; fur; paper; hair; food and inks – introduction, chemical structure and requirements

**Application of Functional Dyes**

Dyes used for imaging, invisible imaging, displays, electronic materials and biomedical applications; solar cells

**Toxicology and Health Aspects**

Toxicity and environmental assessment; regulatory and legislative aspects

**Outcomes**

Upon completion of this course the student shall be able to

CO1: Comprehend the chemical structure and properties of dyes

CO2: Recognize about the various dyes used in processing house

CO3: Compare the role of functional dyes on textile and other substrates

CO4: Describe the applications of the functional dyes in different industries

CO5: Examine toxicity and health issues with functional dyes

**References**

1. Choudhury A. K. R., "Modern Concepts of Colour and Appearance", Oxford and IBH Publishing Ltd, 2000.
2. G. Buxbaum (Ed.) Industrial Inorganic Pigments, Second, Completely Revised Edition, 1998 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.
3. Willy Herbst, Klaus Hunger, Industrial Organic Pigments- Production, Properties, Applications Third, Completely Revised Edition (With Contributions by Gerhard Wilker, Heinfred Ohleier and Rainer Winter) 2004 WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim.
4. Advances in Color Chemistry – Vol I, Peters A. T.
5. Advances in Color Chemistry – Vol II, Peters A. T.
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**Course Articulation Matrix:**

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	1	2	2
CO2	3	2	2	1	2	2
CO3	3	2	2	1	2	2
CO4	3	2	2	1	2	2
CO5	3	2	2	1	2	2
<b>Overall CO</b>	3	2	2	1	2	2

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OBJECTIVES**

To enable the students to learn the

- Theory of yarn formation by rotor, friction, two nozzle air-jet, air vortex and other spinning systems and
- Effect of process parameters used in the spinning system on yarn quality and production.

**Rotor Spinning I**

Principle of open end spinning; description of the working of the rotor spinning; requirements of the raw materials; preparation of the sliver for rotor spinning; yarn formation and its structure; yarn withdrawal and winding

**Rotor Spinning II**

Design of rotor, opening roller, transport tube, navel and their implications on production and yarn quality; developments in rotor spinning machine; production limits; process control; techno economic comparison with ring spinning; structure vs. property relationship

**Friction Spinning**

Principle of yarn formation - DREF2, DREF3 spinning systems; developments in friction spinning systems, raw material requirement, theory of yarn formation, effect of process variables on yarn quality, application of these machines for different end products, economics; technological limitations; structure vs. property relationship

**Two Nozzle Air-Jet And Air Vortex Spinning**

Description of yarn production in two nozzle air-jet spinning machine; raw materials requirement, process variables, structure and quality of the air-jet spun yarn; theory of yarn formation by Air vortex system, raw material requirement and structure; structure vs. property relationship

**Other Spinning Technologies**

Production of yarn in PLYfil, self-twist, electrostatic, Bobtex spinning systems; working details of production of double-rove yarns, wrap yarns and core spun yarns; raw material requirement in these systems; economics of these methods of yarn production; yarn characteristics and their applications; structure property relationship

**OUTCOMES**

Upon completion of this course, the student can

- CO1: Explain the theory of yarn formation in open end spinning and demonstrate production of yarn in rotor spinning system
- CO2: Design of important elements of rotor spinning machine
- CO3: Explain the theory of yarn formation in friction spinning system and relate the structure of yarn with property of yarn
- CO4: Explain the theory of yarn formation in two nozzle air-jet and Air vortex spinning system and relate the structure of yarns with property of yarn
- CO5: Describe the principle of yarn production by other spinning systems and relate the structure of yarns with property of yarn

## References

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2. Klein W., "New Spinning Methods ", The Textile Institute, Manchester, 1993.
3. Dyson E., "Rotor Spinning, Technical and Economics Aspects ", Textile Trade Press, New Mills, Stock Port, 1975.
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## Course Articulation Matrix:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	2	2
CO2	2	1	3	3	2	3
CO3	2	1	3	2	2	2
CO4	2	1	3	2	2	2
CO5	2	1	3	2	2	2
<b>Overall CO</b>	2	1	3	2.2	2	2.2

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives:**

To enable the students to understand and apply process and quality control measures during spinning of yarn to optimize the productivity and quality.

**Levelling**

Quality measures and control of intermediate products to achieve required yarn count with minimum dispersion; different levelling methods adopted in the pre-spinning machines; assessment and control of auto levelling; importance of fibre-mix homogeneity on yarn quality; types and levels of mixing in the preparatory processes; assessment of fibre-blend variations, effect of blend variation on fabric quality

**Nep and Hook Removal**

Causes of nep and hook formation, control measures; measurement of neps and hooks; factors influencing the removal of neps in the carding and combing machines; fibre hook straightening during the preparatory operations, factors

**Waste Control**

Waste determination and cleaning efficiency; control of waste in blowroom, card and combers; influence of machine and processing parameters on waste removal; controlling the lint content in waste; control of pneumafil waste, hard waste in ring frame; determination of yarn realization; centralized waste collection system

**Production Control**

Balancing of machinery; factors affecting the production limits of the spinning machinery; new concepts in achieving higher production in the spinning machinery; computation of the productivity indices; automation, improving production and labour efficiency

**Humidity Control and Machinery Maintenance**

Effect of humidity, temperature and maintenance of machinery on production and quality of yarn, optimizing ambiance and humidity control; process conditions required for producing polyester, viscose and blended yarns; yarn defects – causes and remedies

**Outcomes:**

Upon completion of this course, the student shall be able to

CO1: Explain the quality control measures in terms of levelling of material

CO2: Analyse the causes for the formation of neps and hooks and their removal

CO3: Appraise the factors influencing the waste removal in the spinning machinery

CO4: Analyse the factors and explore new concepts to increase the production rate

CO5: Enumerate and analyze the measures to be taken while processing manmade fibres in the spinning machinery

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1. Lord P.R., "Handbook of Yarn Production; Science, Technology and Economics", Woodhead Publishing, 2003, ISBN: 1855736969 | ISBN-13: 9781855736962.
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## Course Articulation Matrix:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	3
CO2	3	2	2	3	3	3
CO3	3	2	2	3	3	3
CO4	3	2	3	3	3	3
CO5	3	2	2	3	3	3
<b>Overall CO</b>	3	2	2.2	3	2.8	3

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OBJECTIVES**

To enable the students to learn about

- Enzymes, types and kinetics of enzyme reaction on textile fibres.
- Application of enzymes on different fibres.

**Enzymes**

Nomenclature and classification of enzymes; characteristic features of enzymes; modifiers of enzyme activity - activators and inhibitors; specificity of enzyme action; extraction and purifications of enzymes

**Enzyme Kinetics**

Kinetics of single-substrate enzyme-catalyzed reactions; basics of kinetics of multi-substrate enzyme-catalyzed reactions

**Enzymes for Cotton Fibre**

Chemistry and structure of cotton fibre; enzymes in pretreatment of cotton substrates – desizing, scouring, bleaching and bio finishes

**Enzymes for Other Fibers**

Enzymes for processing and functionalizing protein fibres; enzymatic modification of polyester, polyamide, polyacrylonitrile and cellulose acetate fibres

**Enzymes in Effluent Treatment**

Enzyme technology and biological remediation, enzyme decolourisation and decolouration by bio sorption and enrichment cultures

**OUTCOMES**

Upon completion of this course, the student shall be able to

- CO1: Classify various types of enzymes and study the characteristics and activity of enzymes
- CO2: Analyze the efficiency of enzymatic process through kinetic studies of single and multi- substrate enzyme
- CO3: Explain the activity of enzyme on cotton fibres
- CO4: Differentiate the activity of enzyme on protein and synthetic fibres
- CO5: Appraise the application of enzymes for effluent treatment

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**Course Articulation Matrix:**

<b>Course Outcomes</b>	<b>Program Outcomes</b>					
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
CO1	2	2	3	2	2	2
CO2	2	2	3	2	2	2
CO3	2	2	3	2	2	2
CO4	2	2	3	2	2	2
CO5	2	2	3	2	2	2
<b>Overall CO</b>	2	2	3	2	2	2

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives**

To enable the students to learn about advanced spinning technology for manufacturing high performance fibres, their properties and applications.

**Aromatic Polyamides**

Fundamentals of high performance fibres; comparison of regular and high performance fibres; fibre forming process; manufacturing, properties and applications - aramid fibres, high performance polyethylene

**Organic and Inorganic Fibres**

Manufacturing, properties and applications - glass fibres, basalt fibres; carbon fibres, ceramic fibres

**Natural and Regenerated Fibres**

Manufacturing, properties and applications - alginate fibres; chitosan fibres; regenerated protein fibres – silk, wool, casein, soy bean fibre; synthetic biodegradable fibres

**Chemical and Thermal Resistant Fibres**

Manufacturing, properties and applications of chemical resistance fibres – chlorinated fibres, fluorinated fibres, PPS, PEEK and PEI; thermal resistant fibres – semi carbon fibres, PBI, PBO

**Speciality Fibres**

Manufacturing, properties and applications - hollow fibres, profile fibres blended and bi-component fibres, hybrid fibres; functionalization of fibres – methods and applications

**OUTCOMES**

Upon completion of this course, the student shall be able to

CO1: Produce aromatic polyamide fibres

CO2: Synthesize and manufacture of organic and inorganic fibres

CO3: Illustrate the manufacturing of natural and regenerated fibres

CO4: Construct and analyze the chemical and thermal resistant fibres CO5:

Compare the properties of specialty fibres over other fibres

**REFERENCES**

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3. Hongu T. and Phillips G.O., "New Fibres", Woodhead Publishing Ltd., England, 1997.
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**Course Articulation Matrix:**

<b>Course Outcomes</b>	<b>Program Outcomes</b>					
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
CO1	3	1	2	3	2	3
CO2	3	1	2	3	2	3
CO3	3	1	2	3	2	3
CO4	3	1	2	3	2	3
CO5	3	2	3	3	2	3
<b>Overall CO</b>	3	1.2	2.2	3	2	3

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives**

To enable the students to learn about the principles of filtration and design of textile materials used for filtration process.

**Basic Principles**

Aerosol- types, specifications; filtration – theory, models; theory of liquid-solid filtration

**Design of Hepa And Room Filters**

HEPA and ULPA filters – types, functional requirements, raw material selection, design of filters; evaluation of filters - standards

**Design of Mask and Respirator**

Mask and respirator - types, functional requirements, raw material selection, design and production; evaluation of masks and respirators – standards

**Liquid-Liquid and Liquid-Solid Separators**

Water filters, oil-water separators, oil cleaning filters – types, requirements, raw material selection, theory of separation; design and production methods; evaluation and standards

**Gas Separators**

Theory of separation of pure gases from air; different methods of production of pure oxygen, nitrogen, hydrogen and other pure gases from air; estimation of purity; applications

**Outcomes;**

Upon completion of this course, the student can

CO1: Describe the principles of aerosol and liquid filtration

CO2: Design the filters used for room, clean room

CO3: Design the masks and respirators

CO4: Explain the concepts of solid- liquid and liquid-liquid separation and design such filters

CO5: Explain the process of separation of pure gases from air and design the process

**References**

1. Horrocks A R and Anand S C, "Handbook of Technical Textiles", Woodhead publication and Textile Institute, England, 2000.
2. Ken Sutherland, "Filters and Filtration Handbook", Butterworth-Heinemann Elsevier, Burlington, 2008.
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**Course Articulation Matrix:**

<b>Course Outcomes</b>	<b>Program Outcomes</b>					
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
CO1	3	1	3	3	2	3
CO2	3	1	3	3	2	3
CO3	3	1	3	3	2	3
CO4	2	1	3	3	2	3
CO5	3	1	3	3	2	3
<b>Overall CO</b>	2.8	1	3	3	2	3

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives**

To enable the students to learn about the

- Important characteristics of fabric that are responsible for its comfort properties
- Different phenomena which take place in the fabric related to the comfort properties of the fabric.

**Fabric Hand**

Definition and concept of fabric hand; elements relating to fabric hand; development of fabric hand evaluation - subjective evaluation of fabric hand; objective evaluation of fabric hand - The El Mogahzy–Kilinc hand method; effects of fibre and yarn properties on fabric hand

**Characteristics of Porous Materials**

Geometrical characterization of single fibres; structural analysis of fibrous materials with fibre orientations; determination of the fibre orientation; characterization of porous fibrous materials; pore distribution in a fibrous material

**Moisture Vapour Transfer and Interactions**

Mass transfer by diffusion; moisture vapour transfer – principle of moisture diffusion, methods of measurement of moisture vapour transfer; concept of moisture management tester; effect of fibre, yarn and fabric parameters on moisture vapour transfer

**Heat Transfer and Interactions**

Thermal conduction in fibrous materials – thermal conduction analysis; Effective thermal conductivity (ETC) for fibrous materials; prediction of ETC by thermal resistance networks, volume averaging method and homogenization method; structure of plain weave woven fabric composites and the corresponding unit cell

**Physiological Comfort**

Neuro physiological comfort – basis of sensory perceptions, measurement techniques – mechanical stimuli and thermal stimuli; fabric tactile and mechanical properties – fabric prickliness, itchiness, stiffness, softness, smoothness, roughness, and scratchiness; predictability of clothing comfort performance

**Outcomes**

Upon completion of this course, the student shall be able to

- CO1: Analyse the fabric hand and its comfort parameters
- CO2: Demonstrate the permeability and porous nature of fibrous assemblies
- CO3: Explain the Moisture vapour transfer phenomenon
- CO4: Explicate the phenomenon of Heat transfer
- CO5: Interpret the Fabric properties with respect to comfort and correlate the property of the fabric with comfort to the wearer.

## References

2. Hassan M. Behery, "Effect of Mechanical and Physical Properties on Fabric Hand", Wood head Publishing Ltd., ISBN 0-8493-3479-9.
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## Course Articulation Matrix:

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	2	2	2
CO2	3	2	2	2	2	2
CO3	3	2	2	2	2	2
CO4	3	2	2	2	2	2
CO5	3	2	2	2	2	2
<b>Overall CO</b>	3	2	2	2	2	2

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives**

To enable the students to appreciate

- The methodology of various surface modification techniques.
- The basic concepts of coating.
- The physical and chemical aspects of coating, nano material and plasma treatment.
- The advancement in textiles by surface modifications.

**Surface Modification Using Chemicals**

Mechanisms and chemistries of textile surface modifications- acid, alkali, oxidation agent, and reducing agent; merits and demerits of surface modification using chemicals; applications of surface modification of textiles by aqueous and ionic solutions

**Grafting**

Techniques of surface grafting- chemical grafting, radiation, plasma and light induced grafting; properties and applications surface grafted textile; merits and demerits of surface grafting

**Surface Modification Using Plasma**

Nature of plasma, Plasma generation-low-pressure plasmas, atmospheric-pressure plasmas, corona discharge, dielectric barrier discharge, merits and demerits of plasma treatment, characterization of plasma-treated textile surfaces, modifications to natural and synthetic textile surfaces using plasma, applications of plasma treated textiles

**Advanced Coating**

Working principles of physical vapor deposition and its finishing process on textiles; working methods for chemical vapour deposition on textiles; electroless coating; electrophoretic deposition; nano coating- sol gel, layer by layer deposition technique; applications of advanced coated textiles

**Applications of Surface Modified Textiles**

Super absorbent; solar cells; filters; composites; thermochromic textile; thermal and electrically conductive textile; antimicrobial and anti-fouling; self-cleaning

**Outcomes**

Upon completion of this course the student shall be to

- CO1: Explain and distinguish about surface modification of textile using various chemicals
- CO2: Recognize about various surface grafting techniques
- CO3: Analyze the effect of plasma and create desired effect on textile substrate
- CO4: Explain about various advanced coating technique
- CO5: Analyze about various applications of surface treated textiles

**References**

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**Course Articulation Matrix:**

<b>Course Outcomes</b>	<b>Program Outcomes</b>					
	<b>PO1</b>	<b>PO2</b>	<b>PO3</b>	<b>PO4</b>	<b>PO5</b>	<b>PO6</b>
CO1	3	2	3	1	1	2
CO2	3	2	3	1	1	2
CO3	3	2	3	1	1	2
CO4	3	2	3	1	1	2
CO5	3	2	3	1	1	2
<b>Overall CO</b>	3	2	3	1	1	2

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

**Objectives**

To enable the students to learn about

- Basic of sports textiles.
- Textiles in sports equipment.
- Applications of agro textile.

**Sports Textile**

Introduction to sports textile; high performance, high functional and smart fibers, yarns and fabrics – development, properties and applications

**Manufacturing of Sports Apparel**

Design and development - aerobic clothing, athletic clothing, football clothing, cricket clothing, games shorts, gloves, jackets, pants, shirts, shorts, socks, sweatshirts, swimwear and tennis clothing

**Textile in Sports Equipments**

Raw materials and applications of textiles in sports footwear, protective gears, football, hockey equipment, tennis, baseball; textile material and structure for camping purpose; textile in sports surface; standards and test methods for sports textiles

**Agro Apparels**

Agro apparels - introduction and types; properties and design requirements for agro apparels - apron, gloves, head scarf, face mask and cap; standards and test methods for agro apparels

**Agro Non Apparels**

Introduction to agro non apparels; design and development of sunscreen, fence, protection net, ropes, crop cover, weed barrier, wind shield, insect mesh, mulch mat, cold and frost control fabrics

**Outcomes**

Upon completion of this course the student shall be able to

CO1: Explain the requirements of sports textile

CO2: Demonstrate and outline the manufacturing of sports textile

CO3: Recognize the application of textile in sports equipments

CO4: Summarize and comprehend the application of textiles in agro apparels

CO5: Design and develop agro non apparels

**References**

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2. Ghosh. S. K., "Functional Coatings", Wiley-VCH Verlag, GmbH & Co. KGaA, Weinheim, 2006, ISBN:3-527-31296-X.
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**Course Articulation Matrix:**

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	2	2	3	2	2
CO2	3	2	2	3	2	2
CO3	3	2	2	3	2	2
CO4	3	2	2	2	2	2
CO5	3	2	2	2	2	2
<b>Overall CO</b>	3	2	2	2.6	2	2

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OBJECTIVES**

To enable the students to

- Acquire knowledge about the fundamentals of nanotechnology.
- Demonstrate the basic concepts in synthesis of nanomaterials.
- Know the manufacturing techniques and applications of nanotechnology in textile engineering.

**Fundamentals of Nanoscience and Nanotechnology**

Fundamental concepts of nanoscience and nanotechnology; synthesis and fabrication of nanomaterials, basic approaches: bottom-up and top down; basic physical and chemical techniques of synthesis of nanomaterial; application in different fields of science and technology

**Properties of Nanomaterials**

Size, structure and surface dependence of physical and chemical properties; nanomaterials - conductivity, mechanical, optical and electrical properties; bonding and bond structure in nanoparticles, quantum confinement, surface plasmon resonance

**Nanofibres and Nanocomposite**

Electrospinning of nanofibres; factors influencing nanofibre morphology; polymer requirements, process parameters for various polymers, applications; basic concepts, definition, types, nano vs macrocomposites, synthesis routes: in situ, solution and melt; concept of hybrid nanocomposites; application of nanocomposite in textile

**Nanotechnology in Textiles**

Synthesis and applications of nanomaterials – fibres, yarn and fabric; functionalization of textile materials with nanomaterials-antimicrobial, UV, flame retardant, soil release, water repellency, conductivity, filtration, electromagnetic shielding and medical application

**Evaluation of Nanomaterials**

Nanomaterials - particle size and its distribution, porosity, surface morphology-SEM, TEM, crystallinity; surface characteristics of nanomaterials coated fabrics

**Outcomes**

Upon completion of this course the student can

CO1: Outline the fundamental of nanotechnology

CO2: Illustrate the properties of nanomaterials

CO3: Demonstrate and summarize the concepts of nanofibre and nanocomposite

CO4: Explain the application of nanotechnology in textile

CO5: Analyse the properties of nanomaterials and coated fabric

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10. Zhen Guo, Li Tan, Fundamentals and Applications of Nanomaterials, (Artech House) London (2009)
11. Hari Singh Nalwa, Encyclopedia of Nanoscience and Nanotechnology, American Scientific Publishers, 10 Volumes Set (2004)

**Course Articulation Matrix:**

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	3	3
CO2	2	2	2	3	3	3
CO3	2	2	2	3	3	3
CO4	3	2	2	3	3	3
CO5	2	2	2	3	3	3
<b>Overall CO</b>	2.2	2	2	3	3	3

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**OBJECTIVES**

To enable the students to

- Understand the fundamentals of electrically conductive textiles.
- Know the properties of conductive polymers.
- Analyze the properties of electronic textiles.

**Electrical Property of Textiles**

Introduction-conductor, semiconductor and insulator; dielectric property of fibres, electrical resistance, electrical surface resistance, volume resistivity, methods of measuring; factors influencing; types of electrical conductive textiles.

**Metallic Electrical Conductive Textiles**

Introduction; metal fibres-types, applications, property; metal yarn-filament, spun yarn; spinning system, core yarn; weaving and knitting

**Conductive Polymer Based Textiles**

Introduction; conjugated polymers - chemical structure and electrical conduction; classification- polyaniline, polypyrrole, poly (3, 4-ethylenedioxythiophene) etc, conductive polymers- synthesis, properties and applications

**Carbon Based Electrical Textiles**

Introduction, carbon-atomic structure and its electrical conduction; classification- carbon, fullerene, graphite, graphene, SWCT, MWCT; carbon nanofoams and its applications

**Wearable Electronic Textiles**

Introduction, classification - active, passive and very smart; design and applications of smart wearable in military, sportswear, fashion, health care and medical

**Outcomes**

Upon completion of this course the student can

CO1: Explain the electrical property of textiles

CO2: Comprehend and Outline the characteristics of metallic conductive textiles

CO3: Summarize the available conductive polymer based textiles

CO4: Illustrate the overview of carbon based electrical textiles

CO5: Apply the concepts of wearable electronics in textile

**References**

1. Sandra Varnaite-Zuravliova, "The types, properties and applications of conductive textiles, Cambridge scholar publishing, 2020, ISBN 9781527542822.
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**Course Articulation Matrix:**

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	3	2	2
CO2	3	3	3	3	2	2
CO3	3	3	2	3	2	2
CO4	3	3	2	3	2	2
CO5	3	3	2	3	2	2
<b>Overall CO</b>	3	3	2.4	3	2	2

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives**

To enable the students to learn about

- Different types of biomaterials and
- Biomedical application of textile products.

**Biomaterials**

Biomaterials—introduction, types; natural, polymeric and biological materials; metals and metal oxides

**Non Implantable Medical Textiles**

Bandages and pressure garments - elastic and non-elastic compression bandages, support and retention bandages, testing of bandages; wound – types, stages of healing; requirements of wound dressing; wound care materials – types, advantages and limitations; testing of wound dressings; advanced wound dressings; wound healing performance

**Implantable Textiles**

Implantable products – functional requirement, different applications; sutures – requirements, classifications, specifications, materials, production and their applications, testing; vascular grafts, artificial ligaments, artificial tendons-material and design; scaffolds for tissue engineering – material, design and testing of essential properties

**Hygiene Textiles**

Textile based healthcare and hygiene products – bed spreads, gowns, gloves, respirators, functional requirement, engineering of product, evaluation-standards

**Regularity and Ethical Issues**

Application of nano technology in medical hygiene textiles, toxicity; advanced textile materials in healthcare; Ethical issues and regularities for conducting pre-clinical and clinical trials; regulations regarding disposal of medical wastes

**Outcomes**

Upon completion of this course, the student can

CO1: Discuss about biomaterials and biomedical applications

CO2: Design bandages and wound dressing and appraise their performance

CO3: Demonstrate the textiles for implantable applications

CO4: Explain the functional requirements of hygiene textiles and design the product

CO5: Explain the regularity and ethical issues in conducting *in-vivo* experiments and disposal of medical wastes

**References:**

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**Course Articulation Matrix:**

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	3	2	3
CO2	2	1	3	3	3	3
CO3	2	1	3	3	2	3
CO4	2	1	3	3	3	3
CO5	2	1	3	2	2	3
<b>Overall CO</b>	2	1	3	2.8	2.4	3

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively

**Objectives**

To enable the students to learn about the scope of recycling in textiles.

**Overview of Recycling**

Recycling -Introduction, importance and challenges in recycling of textiles; Recycling – Upcycling and downcycling; An approach to circular economy -Cradle to Cradle process in textiles; Importance of 3R principles - Reduce, Reuse and Recycle in textile waste management; market scenario of upcycled and downcycled textile, fashion garments; Pre consumer and post-consumer waste; textile waste collection models and sorting technologies

**Recycling of Fibres And Polymers**

Fibre recycling categories – reuse, product recycling, material recycling and thermal recycling methods; Fibre and polymer recycling routes-Primary, Secondary and tertiary recycling; Cotton waste separation and reclamation techniques; Mechanical recycling – shredding mechanism, factors influencing the quality of the shredded fibres; Chemical recycling - Solvolysis, Depolymerisation techniques for different polymers; PET Depolymerisation techniques- Glycolysis, methanolysis and hydrolysis, Total depolymerisation back to its monomers, partial depolymerisation back to its oligomers

**Recycling of Dyes And Chemicals**

Recycling and reuse of textile chemicals- Recovery of sizing compounds, thickeners, lubricants, waxes and enzymes; Recovery of chemicals from scouring, bleaching and mercerization liquors; Recovery of dyes and pigments from liquors; recycling waste water from textile production, waste water treatments and recycling using membrane technology

**Recycled Product Development**

Manufacturing of woven, non-woven and Textile composites using recycled fibres; Waste minimization in technical design of clothing for facilitating recycling- recycle-friendly garment construction, technical aspects of garment design and automated disassembly of garments; Upcycling

**Characterisation**

Sustainability performance indicators (SPIs); evaluation and characterization of recycled textiles based on its applications; Comparison of Mechanical and chemical behavior of recycled materials to that of virgin textile materials

**Outcomes**

Upon completion of this course the student can be able to

CO1: Comprehend the overview of recycling and its techniques

CO2: Execute and select right type of process for recycling of fibres and polymers

CO3: Execute and select right type of process for recovery of water, dyes and auxiliaries

CO4: Apply and design textile product using recycled fibre

CO5: Evaluate the performance of recycled materials to that of virgin materials

**References:**

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**Course Articulation Matrix:**

Course Outcomes	Program Outcomes					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	3	1	3	3
CO2	2	2	3	1	3	3
CO3	2	2	3	1	3	3
CO4	2	2	3	1	3	3
CO5	2	2	3	1	3	3
<b>Overall CO</b>	2	2	3	1	3	3

1, 2 and 3 are correlation levels with weightages as Slight (Low), Moderate (Medium) and Substantial (High) respectively