ODISHA UNIVERSITY OF TECHNOLOGY AND RESEARCH

Techno Campus, Mahalaxmi Vihar, Ghatikia, Bhubaneswar-751029.

Syllabus (Effective from 2023-24)

School/ Department: Department of Textile Engineering
Course: M.Tech., Programme: Textile Engineering (TE),
Duration: 2 years (Four Semesters)

Abbreviation used:

AC	Audit course	LC	Lab Course	PA	Practical Assessment
PC	Professional Core	PR	Project/ Practical/ Internship	L	Lecture
PE	Professional Elective	SE	Seminar/ Expert Lecture/ Etc.	T	Tutorial
OE	Open Elective	IA*	Internal Assessment	P	Practical
MC	Mandatory/ Common Course	EA	End-Semester Assessment		

Subject Code Format:

A1	A2	B3	C4	C5	C6
School/ Dept. (Offering) **BH:** Basic Sciences and Humanities **CS:** Computer Sciences **EE:** Electrical Sciences **EI:** Electronic Sciences **IP:** Infrastructure and Planning **MS:** Mechanical Sciences **BT:** Biotechnology **TE:** Textile Engineering		**Level** **1:** UG/ Int. Msc. (1st Year) **2:** UG/ Int. Msc. (2nd Year) **3:** UG/ Int. Msc. (3rd Year) **4:** UG/ Int. Msc. (4th Year) **5:** UG/ Int. Msc. (5th Year) **6:** PG (1st Year) **7:** PG (2nd Year) **8:** Ph.D.	**0:** AC **1:** PC **2:** PE **3:** OE **4:** MC **5:** LC **6:** PR **7:** SE **8:** **9:**	**Serial Number (01 to 99)** 01/ 03/…/ 19: Odd Sem. (TCP) 21/ 23/…/ 39: Odd Sem. (TE) 41/ 43/…/ 59: Odd Sem. (Prog-3) 61/ 63/…/ 79: Odd Sem. (Prog-4) 81/ 83/…/ 99: Odd Sem. (Prog-5) 02/ 04/…/ 20: Even Sem. (TCP) 22/ 24/…/ 40: Even Sem. (TE) 42/ 44/…/ 60: Even Sem. (Prog-3) 62/ 64/…/ 80: Even Sem. (Prog-4) 82/ 84/…/ 98: Even Sem. (Prog-5)	

1st Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC 1	TE6121	Advanced Yarn and Fabric Manufacturing System	3	0	0	3	40	60	-	100
2	PC 2	TE6123	Design and Manufacturing of Technical Textile-I	3	0	0	3	40	60	-	100
3	PE 1 (Any One)	TE6221	Design and Analysis of Experiments	3	0	0	3	40	60	-	100
		TE6223	Product Design and Development								
4	MC 1	BH6401	Mathematical Methods in Engineering	3	0	0	3	40	60	-	100
5	MC 2	MS6403	Research Methodology and IPR	2	0	0	2	40	60	-	100
6	LC 1	TE6521	Evaluation of Textile Materials	0	0	4	2	-	-	100	100
7	LC 2	TE6523	Computer-aided designing (CAD) in Textile	0	0	4	2	-	-	100	100
8	AC 1	Any One from the List of AC 1 (Appendix-I)		2	0	0	0	40	60	-	100
			Total	**16**	**0**	**8**	**18**	**240**	**360**	**200**	**800**

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2nd Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PC 3	TE6122	Advances in Knitting, Non-woven & Braiding	3	0	0	3	40	60	-	100
2	PC 4	TE6124	Design & Manufacturing of Technical Textile-II	3	0	0	3	40	60	-	100
3	PE 2 (Any One)	TE6222	High-Performance Fibers	3	0	0	3	40	60	-	100
		TE6224	Apparel Engineering								
4	PE 3 (Any One)	TE6226	Textile Reinforced Composites	3	0	0	3	40	60	-	100
		TE6228	Medical Textiles								
5	OE 1	Any One from the List of OE 1 (Appendix-I)		3	0	0	3	40	60	-	100
6	PR 1	TE6622	Project (Specialization Related)	0	0	4	2	-	-	100	100
7	LC 3	TE6522	Knitting, Non-woven and Braiding Lab	0	0	4	2	-	-	100	100
8	AC 2	Any One from the List of AC 2 (Appendix-I)		2	0	0	0	40	60	-	100
			Total	**17**	**0**	**8**	**19**	**240**	**360**	**200**	**800**

3rd Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PE 4* (Any One)	TE7221	Theory of Yarn and Fabric Structure	3	0	0	3	40	60	-	100
		TE7223	Nano and Smart Textile								
2	PR 2	TE7621	Dissertation (Phase-I)	0	0	24	12	-	-	100	100
			Total	**3**	**0**	**24**	**15**	**40**	**60**	**100**	**200**

* Virtual/Online Course either offered by OUTR or available in MOOCs platform (No physical class)

4th Semester

Sl. No.	Subject Type	Subject Code	Subject Name	Teaching Hours			Credit	Maximum Marks			
				L	T	P		IA	EA	PA	Total
1	PR 3	TE7622	Dissertation (Phase-II)	0	0	32	16	-	-	100	100
			Total	**0**	**0**	**32**	**16**	**-**	**-**	**100**	**100**

Credits and Maximum Marks

Sl. No.	Semester	Credits	Maximum Marks
1	1st	18	800
2	2nd	19	800
3	3rd	15	200
4	4th	16	100
Total		68	1900

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1st Semester

PC 1	TE6121	Advanced Yarn and Fabric Manufacturing System	3	0	0	3

Course Objective: The objective of teaching advanced yarn and fabric manufacturing is to equip students with in-depth knowledge and practical skills related to the latest developments, technologies, and techniques used in the production of yarns and fabrics.

Course Outcomes:

1. **Knowledge Acquisition and Comprehension**: Students will acquire an understanding of diverse advanced yarn and fabric manufacturing processes.
2. **Application and Synthesis**: Students will proficiently apply the acquired concepts to innovate and develop novel yarn and fabric structures.
3. **Evaluation and Critical Thinking**: Students will be adept at assessing newly created textile structures, judging their merits and limitations.
4. **Analysis and Interpretation**: Students will have the capability to systematically analyze evaluation data and extract meaningful interpretations from it.

Module I:

Advances in Spinning Technologies :

Rotor Spinning: Design significance of various components of spinning unit in rotor spinning machine and modification in their design - developments in rotor drives –yarn monitoring. Automation in rotor spinning machines.

Airjet Spinning: Technical developments in air jet spinning, Evolution of vortex spinning, critical review of both systems.

Friction Spinning: Evolution of spinning technologies based on friction spinning system. Composite yarn spinning on friction spinning, Types of fibers used, Advantages and limitations of friction spinning.

Other Spinning Technologies : Production of yarn in PLYfil, self-twist, electrostatic, Bobtex spinning systems.Raw materials requirements of those spinning system. Structure & properties of the yarn produced on these system. Production of core and elastic yarns, sewing thread. melange yarn.

Module II:

Advances in Weaving Technologies :

Advancements in Shuttleless weaving systems with respect to productivity, yarn characteristics and fabric quality, energy requirement, design flexibility, applications and limitations.

3D weaving: Multi-layerweaving, Orthogonal weaving,Spacer weaving, principle of hollow, shell and nodal fabric formations – fabric structure abdapplication, Polar and spiral fabric, Circular Weaving, Narrow fabric,Honeycomb weaving, Denim manufacturing.

Module III: (10 Hours)

Multiaxial weaving, Multiphase weaving, Terry weaving, Leno Weaving, Filament Weaving, Properties and applications of fabrics produced in these systems.

Introduction to auxetic materials– polymer, fiber and yarn; woven auxetic fabric structure; principle , production and application.

Reference Book:

1. New Spinning Systems, Vol.-5 (The Textile Institute), W. Klein
2. Fundamentals of Spun Yarn Technology (CRC Press), Carl A. Lawrence
3. Open-end Spinning (Elsevier Science), V. Rohlena
4. "Advances in yarn spinning technology" Lawrence C. A., Wood head publishing, 2010, ISBN-13: 978 1 84569 444 9.
5. Series publications of NCUTE Training Programs 6 Textile Progress Series by Textile Institute, Manchester
6. New spinning technologies – Dr. S. M. Ishtiaque – Advances in yarn manufacturing technology – IIT publication.
7. Weaving Technology and Operations, Allaan Ormerod and Walter S. Sondhelm, The Textile Institute, 1995
8. Xiaogang Chen, " Advances in 3 D Textiles" Woodhead Publishing Limited, 2015
9. Adanur.S, "Handbook of Weaving", Textile Institute, 2000.
10. Savvas Vassiliadis, Advances in Modern Woven Fabrics Technology, InTech publications, 2011
11. Yordan Kyosev, Recent Developments in Braiding and Narrow Weaving, Springer, 2016

12. Ormerod .A and Sondhelm.W.S, "Weaving Technology & Operations", Textile Institute Publication, 1995.
13. Research Papers on basics and advances in Technology.
14. "Weaving – Machine, Mechanism and Management", by Talukdar M K, Srirammulu P K and Ajgaokar D B, Mahajan Publisher Private Ltd., Ahmedabad, India,1998.
15. Principles of Woven Fabric Manufacturing, by Abhijit Majumdar, CRC Press
16. Specialist yarn and fabric structures Development and Applications Edited by R. H. Gong
17. Woven Textile Stucture Theory and Applications, By B. K. Behera and P. K. Hari

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PC 2	TE6123	Design and Manufacturing of Technical Textile-I	3	0	0	3

Course Objective: The objective of teaching advanced yarn and fabric manufacturing is to equip students with in-depth knowledge and practical skills related to the latest developments, technologies, and techniques used in the production of Technical Textile materials in the field of automotive, protective clothing, sports, civil engineering, and filtration.

Course outcome:

1. **Knowledge:** Students will recall and explain textile concepts in varied fields, including automotive, filtration, protection, civil engineering, sports, and home textiles.
2. **Comprehension:** Students will understand textile materials, designs, and applications in contexts like filtration, protection, sports, and home use.
3. **Application:** Students will apply knowledge to analyze real-world cases and propose suitable textile solutions in automotive, filtration, protection, sports, and home settings.
4. **Synthesis:** Students will creatively combine material understanding, design techniques, and functional needs to innovate textile solutions across disciplines.

Module I:

Textile in Automotives: Introduction to Textiles in Automotives; Materials and their sources used for automotive; Designing and engineering of the products such as seats, headliners, door casing, etc. Quality assurance, performance, and testing of products.

Textile in Filtration: Introduction to textiles in filtration; Material requirements and designing of textiles for filtration; Products and area of application such as dust collection, solid liquid separation, etc.; Nanofibers in filtration; Testing procedure and assessment of product quality; Future trends and development opportunities.

Module II:

Protection clothing: Introduction to protective textiles; Classification of protective clothing. Textiles for thermal protection, Textiles for UV Protection, Chemical, and biological protection, ballistic protection, and Military application. Materials and their sources with Standards and selection criteria for protective textiles; Surface treatment for protective textiles; quality assurance, performance, and testing of products, Future trends, new developments, and opportunities.

Module III:

Textiles In Civil Engineering: Introduction to the Application of Textile in Civil Engineering, Testing, Mechanical Behaviour, and Durability Aspects of Textile Fibre Composites Used in Structural and Civil Engineering; Textile Reinforced Concrete: Structural Behaviour & Design; Geotextiles; Case Studies related to the application of Textile in civil engineering.

Sports Textiles: Introduction to sports textiles; Material requirements and designing of textiles for sports; smart and intelligent textiles for sports, coated and laminated textiles for sports, Assessment of comfort and performance for sportswear; other special applications; Future trends, new developments, and opportunities

Home Textiles: Introduction to home textiles, Fibres and Fabrics used in home textiles, Performance specification of different home textiles, Evaluation of home textiles, Finishes used in home textiles, Eco-friendly aspect of home textiles.

Reference Book:

1. Handbook of Technical Textiles, Volume 2: Technical Textile Applications Edited by A. Richard Horrocks and Subhash C. Anand
2. Textiles in automotive engineering by Walter Fung and Mike Hardcastle
3. Textiles for Protection Edited by Richard A. Scott
4. Textiles in Sports Edited by R. Shishoo
5. Textile Fibre Composites in Civil Engineering Edited by T.C. Triantafillou

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PE 1	TE6221	Design and Analysis of Experiments	3	0	0	3

Course Objective

The objective of this course is to impart students a holistic view of the fundamentals of experimental designs, analysis tools and techniques, interpretation and applications. Upon completion of this course, the students will know (i) the fundamentals of experiments and its uses, (ii) basic statistics including ANOVA and Regression, (iii) experimental designs such as RCBD, BIBD, Latin Square, factorial and fractional factorial designs, (iv) application of statistical models in analysing experimental data (v) RSM to optimize response of interest from an experiment, and (vi) use of software such as Minitab.

Module I :

Introduction to Experimental Design

Importance of experiments, experimental strategies, basic principles of design, terminology, ANOVA, steps in experimentation, sample size, Data collection methods and measurement techniques, Data management and documentation,normal probability plot, Linear Regression model. Formulating research questions and hypotheses, Defining experimental variables and levels, Determining sample size and power analysis, Randomization procedures and techniques, Blocking and Stratification in experimental design.

Module II :

Planning and Conducting Experiments

Basic concepts and principles of experimental design.Types of experimental designs (completely randomized design, randomized block design, factorial design, etc.) Randomization and Replication in experimental design Control and treatment groups. Simple Designs of ANOVA, Complete Factorials Experiments and Experimental designs with at least one random factor. Split plot design, Ethics in Experimental Design, and Human Subject research.

Module III:

Statistical Analysis of Experimental Data

Exploratory data analysis and graphical techniques, Analysis of Variance (ANOVA) and its assumptions,Test of hypothesis, Z-Test, T-test, and F-test. Designing and analyzing factorial experiments, Response surface methodology, Non-parametric methods for experimental data analysis, regression, and correlation, the test of significance .

Text books:

1. Design and Analysis of experiments, D.C.Montgomery, John Wiley and Sons, 2003.
2. Textile Engineering: Statistical Techniques, Design of Experiments and Stochastic Modeling, Anindya Ghosh, Bapi Saha, Prithwiraj Mal, 1st Edition, CRC Press. https://doi.org/10.1201/9781003081234

Reference Books

1. Experimental Designs by William G. Cochran & Gertrude M. Cox.
2. Modern Elementary Statistics by John E. Freund, Benjamin M. Perles 12th Edition, Pearson New International Edition, 2014.
3. J. R. Nagla, Statistics for Textile Engineers‖, Woodhead Publishing India Pvt. Ltd., 2014.

Course Outcomes:

CO1: Modeling of experimental design analysis and data management.

CO2: Demonstrate the planning and conducting of experiments.

CO3: Illustration of suitable methods for statistical analysis of experimental data such as ANOVA and regression and testing of hypothesis.

CO4: Solution of real life problems for design analysis.

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PE 1	TE6223	Product Design and Development	3	0	0	3

Course Objective: The course aims to equip students with a holistic understanding of textile product development by covering fundamental concepts, design methodologies, and material selection principles. By the end of the course, students will possess the skills to effectively identify customer needs, create innovative design concepts, select appropriate materials, and apply various tools to enhance product properties and functionality.

Course Outcomes

1. **Knowledge:** Understand the sequential phases of the textile product development process, including customer needs analysis, concept generation, material selection, and prototype creation.
2. **Application:** Utilise 3D computer modeling tools to visualize and assess the design elements of textile products.
3. **Analysis:** Analyse the impact of material selection on the performance attributes of textile products, considering factors such as durability, comfort, and technical functionality.
4. **Evaluation:** Evaluating the Properties of Fibre Properties, Yarn Construction, Fabric Characteristics, and Functionality of Various Textile Products

Module I:

Introduction to Textile Product Development

Overview of the product development process and its relevance in the textile industry, Distinguishing features of textile products and their classification based on applications, Understanding the generic product development process, from identifying customer needs to specification development, Material selection, performance characteristics of apparel, home textile and technical products, criterion for material selection. Role of fiber, yarn, and fabric and finishing process on product performance. Industrial design, ergonomics, aesthetics, Product architecture, Anthropometric principles, fit.

Module II:

Concept Generation, Material Selection, and Design Principles

Methodologies for generating innovative concepts in textile product development, Material selection criteria and their impact on product attributes, Integrating industrial design, ergonomics, and aesthetics to enhance product performance, Exploring the role of fiber, yarn, fabric, and finishing processes in achieving desired product properties.

Module III:

Prototyping, Analysis, and Product Enhancement

Principles of prototyping and its significance in refining product designs, Utilizing 3D computer modeling for visualization and analysis, Design options for improving the properties and functional attributes of different textile products, Applying design logic to develop selected products, calculating design parameters, and creating detailed specifications.

Reference Book

1. Textiles: Fibre to Fabric" by Bernard P. Corbman and S. Harold Carr
2. "Fashion Design: Process, Innovation, and Practise" by Kathryn McKelvey and Janine Munslow
3. "Product Design and Development" by Karl T. Ulrich and Steven D. Eppinger
4. "Materials Selection in Mechanical Design" by Michael F. Ashby
5. "Design of Clothing Manufacturing Processes: A Systematic Approach to Planning, Scheduling, and Control" by J. Marcus Castro
6. "Design Thinking for Visual Communication" by Gavin Doughtie and Wendy Jedlicka
7. "Introduction to Ergonomics" by R.S. Bridger
8. "Product Design for Manufacture and Assembly" by Geoffrey Boothroyd, Peter Dewhurst, and Winston Knight
9. "3D Printing and Additive Manufacturing Principles and Applications" by Chee Kai Chua, Kah Fai Leong, and Chu Sing Lim

MC 1	BH6401	Mathematical Methods in Engineering	3	0	0	3

Refer Appendix-I for detailed Syllabus.

MC 2	MS6403	Research Methodology and IPR	2	0	0	2

Refer Appendix-I for detailed Syllabus.

LC 1	TE6521	Evaluation of Textile Materials	0	0	4	2

List of Experiments

1. Analysis of microscopic view of different natural and man-made fibres.
2. Determination and analysis of the chracteristicsof different cotton fibres using HVI.
3. Analysis of chemical structure of textile fibres.
4. Birefringence measurement of fibres
5. Creep and Stress relaxation of filament
6. Measurement of U% of sliver, roving and yarn, Imperfections and hairiness of yarn.
7. Determination of periodic mass variation in yarn in the form of spectrogram, Analysis and interpretation spectrogram in finding faulty machine elements
8. Measurement of Tensile properties of yarn , creep and stress relaxation.
9. Analysis of yarn defects.
10. Measurement and analysis of air permeability, filtration efficiency of fabrics
11. Measurement and analysis of tensile and flexural properties of textile materials
12. Measurement and analysis of water vapour permeability and thermal conductivity characteristics
13. Testing of knitted fabric (Tightness factor, spirality, Robbing back).
14. Defect analysis of fabrics.
15. Sewability test of fabric(Seam strength, Seam Pucker, Seam slippage, Needle cutting) index.

LC 2	TE6523	Computer-aided designing (CAD) in Textile	0	0	4	2

1. Development of different designs of woven, Knitted fabrics
2. Development of Apparel design for Men, women, and kid's wear
3. Pattern making of Garments

AC 1	Any One from the List of AC 1 (Appendix-I)	2	0	0	0

Refer Appendix-I for detailed Syllabus.

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2nd Semester

PC 3	TE6122	Advances in Knitting, Non-woven & Braiding	3	0	0	3

Course Objective: Enhance students' knowledge and expertise in advanced knitting, nonwoven technology, and braiding methods for diverse technical applications.

Course Outcomes:

1. **Remembering and Understanding**: Recall, explain, and categorize advanced knitting, nonwoven, and braiding methods for technical fabrics.
2. **Applying and Analysing**: Apply concepts to create technical fabrics, analyze real-world cases, and assess their suitability.
3. **Synthesizing and Evaluating**: Integrate knowledge of emerging trends like 3D nonwovens, electrospinning, and nonwoven composites and critically evaluate braided fabrics.
4. **Creating and Innovating**: Design original technical fabric structures using diverse techniques and propose innovative solutions for industrial applications.

Module I:

Advanced Knitting Technology: Introduction to Weft and Warp Knitted Structures, Technical Applications of Weft Knitted Fabrics, Technical Applications of Warp Knitted Fabrics, Spacer Knitted Structures: Design and Characteristics, Applications of Spacer Knitted Fabrics in Various Industries, Case Studies: Real-world Examples of Technical Applications

Module II:

Developments in Nonwoven Technology: Overview of Nonwoven Technologies and Processes, Spunmelt Processes: Spunbonding and Meltblowing Techniques, Characteristics and properties of spun-bonded and melt-blown nonwoven fabrics, Nonwoven Wipes: Types, Manufacturing, and Applications, Thermal and chemical bonding techniques for non-woven manufacturing. Testing(Fibre orientation, porosity, pore size distribution, tensile, permeability, thermal conductivity, liquid adsorption, Capillary wicking,) and modeling of non-woven fabrics. Stitch Bonding Methods in Nonwoven Fabrication; Nonwoven Composite Fabrics: Reinforcement and Hybrid Structures; Electrospinning: Nanofiber Production and Applications 3D Nonwovens: Production Methods and Innovative Applications;

Module III:

Advanced Braiding Techniques: Biaxial and Triaxial Braided fabrics; Structure, Properties, and Applications of Braided Fabrics. 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.braided auxetic fabrics; applications

Reference Books:

1. "Knitting Technology: A Comprehensive Handbook and Practical Guide" by David J. Spencer
2. "Advances in Knitting Technology" by K. F. Au
3. "Nonwoven Fabrics: Raw Materials, Manufacture, Applications, Characteristics, and Testing Processes" by Han Cao
4. "Textile Composites and Inflatable Structures" by Eugenio Oñate, B. Kröplin, J. Oliver, M. Cervera
5. "Braiding Technology for Textiles: Principles, Design and Processes" by Yordan Kyosev
6. "Nonwoven Textiles" by Deniz Duran, Omur Akyildiz
7. "Nonwoven Fabrics: Theory and Applications" by T. Karthik, M. R. Sethurajan, G. Thilagavathi
8. Fundamentals and advances in knitting technology. By S. C. Ray, Woodhead Publishing India Pvt. Ltd
9. Lunenschloss J and Albrecht W, ―Non-Woven Bonded Fabric‖, Ellis and Horwood Ltd., UK, 1985.
10. Russell, S. J. (2006). Handbook of nonwovens. Woodhead Publishing.
11. Kellie, G. (Ed.). (2016). Advances in technical nonwovens. Woodhead Publishing.
12. Advances in Braiding Technology, Specialized Techniques and Applications, By Yordan Kyosev, Woodhead Publishing.

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PC 4	TE6124	Design & Manufacturing of Technical Textile-II	3	0	0	3

Course Objectives:The course aims to provide a comprehensive understanding of diverse textile applications. Students will learn about geosynthetics, packaging textiles, agro textiles, and medical textiles, covering materials, standards, testing, and future trends. By the end of the course, students will be equipped to analyze, design, and innovate textiles for various applications.

Course Outcome:

1. **Recall and Comprehension**: Recall key concepts and understand the properties and applications of geosynthetics, packaging textiles, agro textiles, and medical textiles.
2. **Application and Analysis**: Apply knowledge to design geosynthetic solutions, assess packaging materials, evaluate agro-textile effectiveness, and create medical products.
3. **Synthesis and Evaluation**: Predict future trends, evaluate ecological impact, assess agro-textile performance, and critically appraise medical textile attributes.
4. **Innovation and Creation**: Design inventive solutions for engineering challenges, innovate in packaging textiles, and agro-textile enhancements, and create novel medical textile products.

Module I:

Geosynthetics: Introduction to Geosynthetics; Concepts, Design, Properties, Applications, and Test Methods of Geotextiles, Geogrids, Geonets, Geomembranes, Geosynthetic Clay Liners, Geopipes, Geofoams, and Geocomposites; Future Trends and Development Opportunities

Module II:

Medical Textile: Introduction to Medical Textiles; Materials and Their Sources; Standards and Selection Criteria for Medical Textiles; Case studies for different medical textile products non-implantable, implantable, extracorporeal, and for hygiene and health care purposes Textiles for hospital sheeting: surgical cotton, bandages, and gauze; face masks and nose masks; surgical threads and sutures; cervical collars; towels; swaps; napkins; wipers; mops; pads; etc.

Module III:

Agro Textiles: Introduction to Agro Textiles; Classification of Agro Textiles; Materials and Their Sources with Standards and Selection Criteria for Agro Textiles; Testing and Evaluation of Agro Textiles; Area of application; Future Trends.

Pack Textiles: AnIntroduction to Pack textiles**;** Packaging materials used for different functions Bulk container packaging, packaging profile, low volume/low capacity packaging Product criteria and case studies for textiles used in packaging for different industrial products and agricultural commodities—norms, specifications, testing, and ecological factors Uses of jute, cotton, and nylon fabrics for packaging Future trends and the development of food-grade packaging

Reference Books:

1. Handbook of Technical Textiles, Volume 2: Technical Textile Applications Edited by A. Richard Horrocks and Subhash C. Anand
2. Designing with Geosynthetics by Robert M. Koerner
3. Geotextiles from design to application Edited by Robert M. Koerner
4. Handbook of Industrial Textiles by Wellington
5. Agro Textiles and its Application by Dr. S. Grace Annapoorani
6. Medical Textiles 96, Conference Proceeding, edited by Prof. Subhas Anand, Woodhead Publishing Ltd.
7. Medical and Hygiene Textile Production by Mathews, Allison, and Hardingham

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PE 2	TE6222	High-Performance Fibers	3	0	0	3

Course Objective:This course explores high-performance and specialty fibers, encompassing classifications, manufacturing, and properties. It includes polymer conductivity, glass, ceramic, basalt, optical, and superabsorbent fibers. The course further examines micro-denier fibers, advanced polymers, hybrids, and nanocomposites, providing students with insights into diverse fiber types and their applications.

Course Outcomes:

1. **Remembering**: Recall the definitions and classifications of high-performance fibers and list their structural requirements.
2. **Understanding**: Explain the polymerization and spinning processes used in creating aramids, aromatic polyesters, rigid rods, and ladder polymers.
3. **Applying**: Apply knowledge of carbon fiber production from polyacrylonitrile and describe the concept of gel spinning and the properties of UHMWPE fibers.
4. **Analyzing**: Analyse the structural aspects and properties of UHMWPE fibers and compare different high-performance fiber types based on their characteristics.

Module I:

Definition, classification, and structural requirements of high-performance and specialty fibers,Polymerization, spinning, and properties of aramids, aromatic polyesters, rigid rod and ladder polymers such as PBZT, PBO, PBI, PIPD, Manufacture of carbon fibers from polyacrylonitrile, Concept of gel spinning and spinning of UHMPE fibers, structure, and properties for UHMWPE fiber.

Module II:

Conducting fibers: Polymer conductivity, processing of conducting polymers into fibers and fiber coatings.Spinning and properties of polyaniline (PANI) fiber.Glass and ceramic fiber: manufacturing process and applications. Methods of synthesis, production, and properties of glass and ceramic fibers.Basalt fibers and their applications. Specialty fibers: profile fibers, optical fibers, bicomponentfibers and hybrid fibers, Superabsorbent polymers, and fibers.

Module III:

Polyvinyl alcohol-based fibers, Ultra-fine fibers: definition, manufacturing, characteristics, and applications of micro-denier fibers, Specialty fibers from new polymers, hybrid fibers, nano-composite fibers, Other specialty fibers: absorbent fibers, hollow fibers, and profile fibers, bi-component fibers, optical fibers.

References Books:

1. Salem David R., Structure Formation in Polymeric Fibres, First edition, Hanser Publishers,2000.
2. Ward I M, Developments in Oriented Polymers, Elsevier Applied Science,1987
3. Yang H H, Kevlar aramid fiber, John Wiley & Sons, Chichester, 1993.
4. Mukhopadhyay S K, 'High-performance fibers', *Textile Progress*, 1993, 25, 1–85.
5. Ozawa S and Matsuda K, High Technology Fibers Part B, edited by Lewin M and Preston J, Marcel Dekker, New York, 1989.
6. V. K. Kothari, Textile fibres: Developments and Innovations, First edition, IAFL publications,2000

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Syllabus (Effective from 2023-24)

School/ Department: Department of Textile Engineering
Course: M.Tech., Programme: Textile Engineering (TE),
Duration: 2 years (Four Semesters)

PE 2	TE6224	Apparel Engineering	3	0	0	3

Course Objective: This course provides a comprehensive understanding of apparel engineering, including garment construction, manufacturing, and advanced concepts. Students will acquire the knowledge and skills necessary to design, manufacture, and innovate sustainable apparel, as well as an awareness of emerging technological and industry trends.

Course Outcomes:

1. **Knowledge:** Understand the fundamental principles of apparel engineering, including garment components, fabric properties, and pattern-making techniques.
2. **Application:** Apply pattern-making and grading skills to develop well-fitting garment patterns tailored to different body types.
3. **Analysis:** Analyse the impact of fabric properties on garment performance and design, considering factors such as comfort and durability.
4. **Evaluating:** Evaluate the suitability of different manufacturing processes for specific garment types and identify opportunities for process improvement.

Module I:

Fundamentals of Apparel Engineering

Introduction to apparel engineering and its role in the fashion industry, Understanding garment components, construction techniques, and terminologies, Fabric properties and their impact on garment performance and design, Principles of pattern making, grading, and marker making for efficient garment production, Overview of sewing machine types, functions, and maintenance

Module II:

Apparel Manufacturing Processes and Automation

Exploration of various apparel manufacturing processes, from cutting to finishing, Analysis of assembly line operations, workflow optimization, and time study techniques, Introduction to lean manufacturing principles and their application in apparel production, Automation, and technology trends in apparel manufacturing, including robotics and computer-aided production,Quality control and inspection methods for ensuring product consistency and standards

Module III:

Product Development and Advanced Concepts

Phases of product development: concept ideation, design, prototyping, and commercialization, Understanding sustainable practices in apparel engineering, including eco-friendly materials and production methods,Specialized areas in apparel engineering, such as activewear, technical textiles, and performance apparel, Integration of smart textiles, wearable technology, and innovative materials in garment design.Case studies of successful apparel engineering projects and their impact on the industry

Reference Books

1. Apparel Manufacturing: Sewn Product Analysis" by Ruth E. Glock and Grace I. Kunz
2. "Patternmaking for Fashion Design" by Helen Joseph-Armstrong
3. "Quality Control for the Apparel Industry" by Pradip V. Mehta and Priyanka G. Mehta
4. "Lean Apparel Manufacturing: Theory and Practise" by Sandeep K. Agarwal and Sureshchandra R. Gupta
5. "Technology of Clothing Manufacture" by Dilys Williams and Ian King
6. "Apparel Production Terms and Processes" by Janice E. Bubonia-Clarke
7. "Fashion Technology: Design and Production" by Peter Evans and Fiona Stirling
8. "Apparel Merchandising: The Line Starts Here" by Jeremy A. Rosenau and David L. Wilson

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Syllabus (Effective from 2023-24)

School/ Department: Department of Textile Engineering
Course: M.Tech., Programme: Textile Engineering (TE),
Duration: 2 years (Four Semesters)

PE 3	TE6226	Textile Reinforced Composites	3	0	0	3

Course Objective: The Textile-Reinforced Composites course focuses on understanding the integration of textiles and polymers to create advanced materials. It covers mechanical behavior, design principles, and real-world applications in industries like aerospace and automotive.

Course Outcomes:

1. **Remember**: Recall fundamental concepts related to textile-reinforced composites, including their manufacturing processes and key terminology.
2. **Understand:** Grasp the mechanical behavior of textile-reinforced composites, comprehend design considerations, and recognize their applications in various industries.
3. **Analyze**: Break down complex composite structures into their constituent components, assess their interactions, and predict mechanical properties.
4. **Evaluate:** Formulate informed judgments about the suitability of different textile-reinforced composites for specific applications based on performance requirements.

Module I:

Definition, classification, and materials used in composites

Definition of composites, textile composites, and textile structural composites, Materials for composites, Fiber: glass, carbon, aramid, boron, ceramic and natural fibers, Matrices, classification, properties and selection of matrices, Polymer matrix, Thermoset matrix – epoxy, polyester, vinyl ester, etc, Thermoplastic matrix – polyether ether ketone, polyphenylene sulfide, polysulfone, Metal matrix and Ceramic matrix, Carbon-Carbon Composites, Recycling Fiber-Reinforced Composites

Textile structures used in composites

Reinforcement structures, Classification of Textile Reinforced Structures based on axis and dimension; non-axial, mono-axial, biaxial, triaxial, and multiaxial structures, UD, 2D,3D structures, Structural anisotropy, parallel arrangement and series arrangement of components, Chopped strand, and Milled fibers, Hybrid fabrics, Non-crimp fabrics, Laminates, Stitched structure, Embroidery structures, Composite Rope, Braided structures

Module II:

Manufacturing Methods

Methods of composite processing, Hand and machine lay-up, spray-up molding, vacuum-bag and pressure-bag moulding, autoclave, compression moulding, liquid resin molding, resin transfer moulding, Poltrusion, filament winding, injection moulding, thermoplastic processing, automated tape laying.

Characterization of Composites

Characterization of Composites, Mechanical Analysis, Tensile, bending, compression, impact, fatigue behavior, DMA, Thermal properties Internal Geometry of reinforcement structures, Fibre volume fraction and surface geometry, Morphological characterization of composites reinforced by various textile structures, the study of fiber-matrix behavior at the interface, Damage analysis,Failure mechanisms, matrix cracking, fiber fracture, debonding, delamination, fiber pullout, micro-buckling, kink bands, Fractography, Failure criteria, Non-Destructive Testing, electromagnetic, chemical spectroscopy.

Module III:

Theory of Composites

Theory of composites, Composite concepts, and theory, Rule of the mixture, the synergy effect, Logarithmic mixing rule, Geometry of reinforcement - Particular, granular, fibrillar, lamellar, Properties of components, properties of the interface, mechanism of adhesion, Fibre volume fraction calculation.

Applications of Textile structural composites

Automotives, marine, aerospace, sports, protection systems, wind energy, machine components, construction engineering

Suggested texts and reference materials:

1. Textile structural composites by Tsu Wei Chou and Frank K. Ko, ELSEVIER, 1989
2. 3D Fibrous assemblies, by Jinlian Hu, WOODHEAD, 2009
3. High-performance fiber composites, by J G Morley, Harcourt Brace Jovanovinch, 1987
4. Textile structural composites, by S Advani, Conference proceedings, 2007
5. Design and Manufacturing of Textile structural composites by *A Long, WOODHEAD*

Books Recommended

1. Fibre-reinforced composites by P.K.Mallick CRC press.
2. HANDBOOK OF TECHNICAL TEXTILES *Edited by* A R Horrocks and S C Anand.

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Syllabus (Effective from 2023-24)

School/ Department: Department of Textile Engineering
Course: M.Tech., Programme: Textile Engineering (TE),
Duration: 2 years (Four Semesters)

PE 3	TE6228	Medical Textiles	3	0	0	3

Course Objectives:

This course aims to comprehend the medical functions of polymers, investigate advanced healthcare textile applications, and examine cell-polymer interactions alongside ethical considerations.

Course Outcomes:

1. **Remembering**: Recall and describe the roles of natural and synthetic polymers in medical contexts.
2. **Understanding**: Explain the significance of the fibrous extracellular matrix in the human body.
3. **Applying**: Utilize textile techniques to design wound dressings and scaffold structures.
4. **Analyzing**: Analyze the advantages and limitations of different non-implantable medical textiles, Examine ethical and legal issues related to medical textile materials.

Module I:

Fundamentals of Medical Textile Polymers

Natural and synthetic polymers, textile-based techniques used for medical applications, The fibrous extracellular matrix of the human body and its characteristic features Cell-Polymer interaction,

Module II:

Advanced Applications of Medical Textiles

Non-implantable materials (Wound-dressing, related hydrogel, and composite products; bandages; Gauges); Implantable biomedical devices (Vascular grafts, Sutures, Heart valves), Extra-corporeal materials (Scaffolds for Tissue engineering, Rapid prototyping, Cartilage, Liver, Blood vessels, Kidney, Urinary bladder, tendon, Ligaments, Cornea),

Module III:

Design and Ethics in Medical Textiles

Healthcare and hygiene products (Surgical Gowns, masks, wipes, Antibacterial Textiles, Super absorbent polymers, Dialysis, Soluble factor release), Safety, legal, and ethical issues involved in medical textile materials

Suggested Books

1. "Introduction to Medical Textiles" by V. S. Kothari and C. Vigneswaran
2. "Medical Textile Materials" by Yimin Qin and Grace X. Gu
3. "Medical and Healthcare Textiles" by S. Rajendran
4. "Smart Textiles and Their Applications" by Vladan Koncar
5. "Textiles in Sport" by Roshan Shishoo
6. "Textiles for Sportswear" by Roshan Shishoo
7. "Handbook of Technical Textiles," edited by A. Richard Horrocks and Subhash C. Anand
8. "Biomaterials and Medical Devices: Associated Infections" by L. Barnes, I. R. Cooper, and M. M. Kendall
9. "Polymers for Medical and Biomedical Applications" by T. Nebe and K. L. Nebe
10. "Biodegradable Polymers in Clinical Use and Clinical Development" by A. J. Domb, J. Kost, and D. Wiseman
11. "Medical Textiles and Biomaterials for Healthcare" by S. C. Anand and J. F. Kennedy

OE 1	Any One from the List of OE 1 (Appendix-I)	3	0	0	3

Refer Appendix-I for detailed Syllabus.

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Syllabus (Effective from 2023-24)

School/ Department: Department of Textile Engineering
Course: M.Tech., Programme: Textile Engineering (TE),
Duration: 2 years (Four Semesters)

PR 1	TE6622	Project (Specialization Related)	0	0	4	2

Course Objectives:

1. To identify the problem /idea and review and summarize the literature for the topic of the identified problem & to provide a platform to students to enhance their practical knowledge and skills
2. To describe the process flow for undertaking the research/survey trials with appropriate standards and process variables
3. To design, development, construction, and fabrication of innovative product/system for the final submission
4. To explain various tools of testing and statistical analysis for the data in order to draw relevant conclusions

Contents:

Students will select a topic which addresses some textile industry problem, or other product developments in textiles based on development/fabrication of innovative product/system/solution.This is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills. Execution of mini project should be carried out by students only under guidance of a faculty. Each student must keep a project notebook The notebooks will be checked periodically throughout the semester by the guide

LC 3	TE6522	Knitting, Non-woven and Braiding Lab	0	0	4	2

1. Studies of the effect of machine gauge, cam setting, yarn tension, and other yarn and process parameters on the structural parameters of the knitted fabric.
2. Find the Actual loop length and theoretical loop length in hand knitting machine
3. Measurement of Spirality angle
4. Evaluate the robing back percentage of knitted fabrics
5. Analysis of Nonwoven Fabrics for different applications
6. Determination of braid angle and cover factors
7. Relationship between braid angle and tensile modulus

AC 2	Any One from the List of AC 2 (Appendix-I)	2	0	0	0

Refer Appendix-I for detailed Syllabus.

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Syllabus (Effective from 2023-24)

School/ Department: Department of Textile Engineering
Course: M.Tech., Programme: Textile Engineering (TE),
Duration: 2 years (Four Semesters)

3rd Semester

PE 4	TE7221	Theory of Yarn and Fabric Structure	3	0	0	3

Course Outcomes:

After successful completion of this course, the students should be able to;

- Understand fiber migration and packing in yarn.
- Articulate the tensile behavior of different types of yarn.
- Analyse the effect of different parameters affecting the structure of yarn and fabric on its properties.
- Illustrate structural characteristics of knitted, braided and nonwovens and design the fabric to get the desired property.

Module I

Packing of fibers in yarn: Idealized packing; measurement of packing density and radial packing density of yarn; Packing in actual yarns; Specific volume of yarns; Equation of yarn diameter.

Fibre Migration: Ideal migration, tracer fiber technique, characterization of migration behavior, migration in spun yarns, mechanisms of migration, and the effect of various parameters on migration behavior.

Module II

Structural Mechanics: Translation of fiber properties into yarn properties; Extension of continuous filament yarn for small strains and large strains; Prediction of breakage, Nature of rupture for continuous filament yarn. Extension and breakage of spun yarn, Blended yarn structure, Structure-property relationship of ring, rotor, air-jet, friction spun yarn, Extension of continuous filament yarn. Theoretical treatments of yarn tensile strength, Strength-comfort-twist relationship, Practical aspects of yarn strength

Module III

Structural mechanics of woven fabric: Tensile, Bending, Compression, shear, and buckling; Fabric shrinkage, low-stress fabric mechanical properties, and fabric handle.

The geometry of weft and warp knitted structures. Structure and mechanics of knitted fabrics, Structural properties of knitted fabrics, Tensile, Bending and Shear properties of knitted fabrics.

Mechanics of braided structure: Braid angle, cover factor, and fiber volume fraction.

Structure and mechanics of nonwovens, Structure property relationships, Modeling nonwoven fabric mechanics: thermally bonded nonwovens

Books Recommended:

1. Hearle J. W. S., “Structural Mechanics of Fibers, Yarns, and Fabrics”, Wiley-Interscience, NewYork,1969.
2. Goswami B. C., “Textile Yarns: Technology, Structure, and Applications”, Wiley- Interscience, NewYork, 1977.
3. Jinlian Hu., “Structure and Mechanics of Woven Fabrics”, Woodhead Publishing Ltd., 2004.
4. Hearle J. W. S., John J., Thwaites. andJafargholiAmirbayat., “Mechanics of Flexible FibreAssemblies”, Sijthoff and Noordhoff,1980.
5. Hassan M. Berery., “Effect of Mechanical and Physical Properties on Fabrics Hand”, Wood head Publishing Ltd.,2005.
6. Behera BK, Hari PK, “Woven Textile Structure: Theory and Applications”. Woodhead publishing.

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Syllabus (Effective from 2023-24)

School/ Department: Department of Textile Engineering
Course: M.Tech., Programme: Textile Engineering (TE),
Duration: 2 years (Four Semesters)

PE 4	TE7223	Nano and Smart Textile	3	0	0	3

Course Objectives:The course covers the fundamentals of Nanoscience and Nanotechnology in textiles, as well as the properties and synthesis of nanomaterials. It explores applications, such as nanocomposites, nanofibers, coatings, and smart textiles, as well as passive and active functionalities, such as wearable electronics and intelligent materials.

Course Outcomes:

1. **Remember**: Recall key principles of nanoscience and nanotechnology, including the classification of nanomaterials and their distinct physical and chemical properties.
2. **Apply synthesis**: Apply synthesis techniques to create nanomaterials for textiles, such as metal nanoparticles and nano-oxides, and demonstrate their surface functionalization and dispersion.
3. **Analyze**: Analyze the impact of nanomaterial integration in textiles, employing characterization methods like XRD, AFM, SEM/TEM, and DLS to assess their properties and behavior.
4. **Evaluate:** Think about the different ways nanotechnology can be used in textiles. Think about the pros and cons of nanocomposites, nanofibers, coatings, and smart textiles in terms of how they improve functionality and how they can be used in real life.

Module I:

Introduction to Nanoscience and Nanotechnology; Classification of nanomaterials, Size and surface dependence of their physical and chemical properties such as mechanical, thermodynamical, electronic, catalysis, etc; Synthesis of Nanomaterials used in Textiles such as carbon nanotube, fullerenes, metal and metal oxide nanoparticles i.e. nano silver, nano silica, nano titania, nano zinc oxide, nano magnesium oxide, etc.; Surface functionalization and Dispersion of nanomaterials; Nanotoxicity, Characterization techniques i.e. XRD, AFM, SEM/ TEM, DLS, etc.; Nanomaterial applications in textiles and polymers;

Module II:

Nanocomposites: definition types, synthesis routes; nanocomposite fibers and coatings e.g. gas barrier, antimicrobial, conducting etc.; Nanofibres: preparation, properties, and applications i.e. filtration, tissue engineering etc.; Nanofinishing: self-cleaning, antimicrobial, UV protective etc.; Nanocoating on textile substrates: Plasma Polymerisation, Layer-by-layer Self Assembly, Sol-Gel coating etc.

Module III:

Definition and Classification of Smart Textiles; Coated and laminated Textiles: materials, formulations, techniques, and applications, Smart and Intelligent Textiles: Passive and Active functionality, stimuli sensitive textiles, Electronic Textiles: wearable computers, flexible electronics. Heat-storage, thermo-regulated and thermally sensitive textiles, Clothing, Multifunctional and multi-use intelligent materials, Stimuli-responsive interpenetrating polymer network, Adaptive and responsive, textile structures, Optical fibers, and fiber optic sensors, Embroidery for technical applications, Hollow fiber membranes for gas separation, Smart medical textiles,Tailor-made intelligent polymers for biomedical, Applications, Textile scaffolds in tissue engineering

Reference Books:

1. "Introduction to Nanotechnology" by Charles P. Poole Jr. and Frank J. Owens
2. "Nanomaterials: Synthesis, Properties, and Applications" by A. S. Edelstein and R. C. Cammarata
3. "Nanotechnology in Textiles" by Mangala Joshi
4. "Smart Textiles and Their Applications" by Vladan Koncar
5. "Nanotechnology: Basic Science and Emerging Technologies" by Mick Wilson and Kamali Kannangara
6. "Nanotechnology: Principles and Applications" by Sulabha K. Kulkarni and M. A. Shah
7. "Nanostructures and Nanomaterials: Synthesis, Properties, and Applications" by Guozhong Cao
8. "Introduction to Nanoscience" by Stuart Lindsay
9. "Nanotechnology in Clothing" by Shahid ul-Islam and Mohammad Jawaid
10. "Functional Nanomaterials and Devices for Electronics, Sensors, and Energy Harvesting" by Wojtek Wlodarski and Adam D. G. Calleja

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Syllabus (Effective from 2023-24)

School/ Department: Department of Textile Engineering
Course: M.Tech., Programme: Textile Engineering (TE),
Duration: 2 years (Four Semesters)

PR 2	TE7621	Dissertation (Phase-I)	0	0	24	12

Course Objectives:

1. To enable the students to identify the problem /idea and review and summarize the literature for the topic of the identified problem & to provide a platform to students to enhance their practical knowledge and skills
2. To enable the students to understand and describe the process flow for undertaking the research/survey trials with appropriate standards and process variables
3. To enhance the knowledge and skill of the students in designdevelopment, construction, and fabrication of innovative product/system .
4. To learn various tools of testing and statistical analysis for the data in order to draw **relevant** conclusions.

Course Contents :

Students will carry out the Dissertation work with the guidance of a faculty in 2 phases. Phase - 1 will be carried out in 3rd Semester that will involve the finalization of topic of project, Literature survey, Plan of action and at least half of the project trials (50%) should be completed in Phase - I. The project will be chosen with reference to design, development, construction, and fabrication of innovative product/system approved by the Guide and department .Each student must keep a project notebook The notebooks will be checked periodically throughout the semester by the guide.

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Syllabus (Effective from 2023-24)

School/ Department: Department of Textile Engineering
Course: M.Tech., Programme: Textile Engineering (TE),
Duration: 2 years (Four Semesters)

4th Semester

PR 3	TE7622	Dissertation (Phase-II)	0	0	32	16

The Dissertation work of Phase II is mainly the completion of the remaining 50% of the project work. This includes the compilation of experimental works, results & discussions and conclusions.

Guidelines for students :

1) Students should complete and compile the experimental work and testing of the work assigned to them.
2) Students should complete thesis writing with given guidelines in consultation with guideand submit.
3) Students will be ready for the internal Viva with synopsis, objectives, plan of work and results and discussion.
4) The results and discussion will be as per in line with the plan of work. No deviation is allowed.
5) The students have to present their work in front of the dissertation evaluation committee.