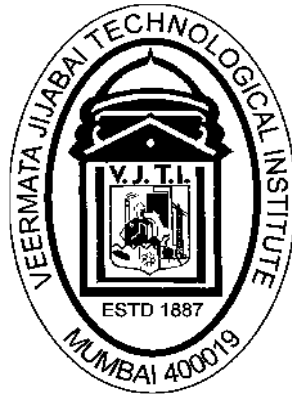


VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE
(VJTI)
MATUNGA, MUMBAI 400 019

(Autonomous Institute affiliated to University of Mumbai)



Curriculum

(Scheme of Instruction & Evaluation and Course contents)

(Revision 2018)

For

Final Year

of

Four Year Undergraduate Programmes Leading to
Bachelor of Technology (B Tech) Degree in Textile Technology

Implemented from the batch admitted in Academic Year 2018-19

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

(Autonomous Institute affiliated to University of Mumbai)

Curriculum

(Scheme of Instruction & Evaluation and Course contents)

For

Final Year

of

Four Year Undergraduate Programme Leading to

Bachelor of Technology (B Tech)

In

Textile Technology

VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

Textile Manufactures Department

VISION

To develop competent professionals and leaders for the global textile community, through quality education, innovation and research.

MISSION

- To provide comprehensive knowledge of textile technology through structured course delivery and active participation in innovative and collaborative research work.
- To foster stronger interface with industry, alumni and research organizations in India and abroad.
- To kindle a sense of social and environmental responsibility and inculcate the ability to perform well in team based projects in the professional sphere.

Bachelor of Technology in Textiles

Program Educational Objectives (PEOs)

The undergraduate programme of textile technology is designed:

1. To impart in-depth knowledge in the field of textile products, processes and quality assurance aspects.
2. To impart leadership and problem solving skills to enable the graduates excel in challenging work environments in textile domain and assume positions of higher responsibility in their professional career.
3. To motivate the graduates towards continuous learning of new products and processes in the field of textile manufacturing.
4. To instill the spirit of professionalism, ethical conduct, effective communication and team work within the individual.

Program Outcomes (POs)

On successful completion of the programme, graduates will be able to:

1. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems (**Engineering knowledge**).
2. Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences (**Problem analysis**)
3. Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations (**Design/development of solutions**).
4. Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions (**Conduct investigations of complex problems**).

5. Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations (**Modern tool usage**).
6. Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice (**The engineer and society**).
7. Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development (**Environment and sustainability**).
8. Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice (**Ethics**).
9. Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings (**Individual and team work**).
10. Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions (**Communication**).
11. Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments (**Project management and finance**).
12. Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change (**Life-long learning**).

Program Specific Outcomes (PSOs)

On successful completion of the programme, graduates will be able to:

1. Apply knowledge of textile products and processes, statistical, analytical and computational skills to investigate technical problems in textile and allied industries.
2. Demonstrate knowledge in textiles and management principles effectively in the workplace and manage projects in multidisciplinary environments.
3. Understand the impact of the textile processes in societal and environmental contexts and demonstrate the knowledge and need for sustainable development.

SEM – VII

Scheme of Instructions					Scheme of Evaluation				
Course Code	Course Name	L	T	P	Credits	TA	MST	ESE	ESE hours
R4TT3010T	Process Control in Textile Manufacturing	3	1	0	4	20	20	60	3
R4TT3010P	Process Control in Textile Manufacturing Lab	0	0	2	1	60	-	40	
R4TT3011T	Advanced Textile Materials	3	0	0	3	20	20	60	3
R4TT3012T	Textile Composites	3	0	0	3	20	20	60	3
R4TT3012P	Textile Composites Lab	0	0	2	1	60	-	40	
	Program Elective II Theory	3	0	0	3	20	20	60	3
	Program Elective II Lab	0	0	2	1	60	-	40	
	Open Elective II	3	0	0	3	20	20	60	3
R4TT3013D	Project – I	0	0	4	2	60	-	40	
R4TT3014D	Presentation on work carried out on Internship	0	0	4	2	60	-	40	
		15	1	14	23				

Abbreviations: **L**: Lecture, **T**: Tutorial, **P**: Practical, **TA**: Teacher Assessment / Term work Assessment, **MST**: Mid Semester Tests, **ESE**: End Semester Written Examination, **CIE**: Continuous In-semester Evaluation

Semester VII List of Program Elective II

Theory Course(s)		Laboratory Course(s)	
R4TT3105T	CAD/CAM application in clothing	R4TT3105P	CAD/CAM application in clothing Lab
R4TT3106T	Coated & Laminated Textiles	R4TT3106P	Coated & Laminated Textiles Lab
R4TT3107T	Processing of Fibers & Blends	R4TT3107P	Processing of Fibers & Blends Lab
R4TT3108T	Post Spinning of Man Made Fibres	R4TT3108P	Post Spinning of Man Made Fibres Lab

Semester VII List of Open Elective II

Code	Title
R4TT3602T	Structural Composites

SEM – VIII

Scheme of Instructions					Scheme of Evaluation				
Course Code	Course Name	L	T	P	Credits	TA	MST	ESE	ESE hours
R4TT3015T	Textile Management	3	1	0	4	20	20	60	3
R4TT3016T	Sustainable Textile Manufacturing	3	1	0	4	20	20	60	3
	Program Elective III	3	0	0	3	20	20	60	3
	Program Elective III Lab	0	0	2	1	60	-	40	
	Program Elective IV	3	1	0	4	20	20	60	3
R4TT3017D	Project – II	0	0	8	4	60	-	40	
		12	3	10	20				

Abbreviations: **L**: Lecture, **T**: Tutorial, **P**: Practical, **TA**: Teacher Assessment / Term work Assessment, **MST**: Mid Semester Tests, **ESE**: End Semester Written Examination, **CIE**: Continuous In-semester Evaluation

Semester VIII List of Program Elective III

Theory Course(s)		Laboratory Course(s)	
Code	Title	Code	Title
R4TT3109T	Green Composites	R4TT3109P	Green Composites Lab
R4TT3110T	Textiles for Medical Applications	R4TT3110P	Textiles for Medical Applications Lab
R4TT3111T	Functional & Smart Textiles	R4TT3111P	Functional & Smart Textiles Lab
R4TT3112T	Nanotechnology application in Textiles	R4TT3112P	Nanotechnology application in Textiles Lab

Semester VIII List of Program Elective IV

Code	Title
R4TT3113T	Project Formulation and Appraisal in Textile Sector
R4TT3114T	Retail and Supply chain management
R4TT3115T	Entrepreneurship in Textiles
R4TT3116T	Industry 4.0 in Textiles

Programme Name	Bachelor of Technology in Textiles	Semester-VII
Course Title	Process Control in Textile Manufacturing	
Course Code	R4TT3010T	
Course Objective	To impart knowledge of process control for achieving desired quality and efficiency in spinning and weaving.	
Course outcomes	After completing the course, student will be able to: <ol style="list-style-type: none"> 1. Discuss the approach and methodology of process control in textile. 2. Identify various performance parameters for controlling spinning process. 3. Identify various performance parameters for controlling weaving process. 4. Asses the machine productivity index, efficiency, labour and machine allocation in spinning and weaving. 5. Explain the material handling systems in spinning and weaving. 	
Prerequisite	Knowledge of Textile manufacturing & processing.	

Course Content

Modules	Description
Module 1	Introduction & importance of process control in spinning: Key variables, establishing norms, Collection & interpretation of data for process control, Maximizing quality & Cost evaluation of fibre quality, Linear programming for cotton mixing. Yarn realization, estimation & control of yarn realization, Waste & their norms.
Module 2	Calculations pertaining to blow room and carding: Performance assessment of blow room line. Draft and production calculations at draw frame. Combing efficiency calculation, Machine and labour productivity. Process control in preparatory -Control of cotton contamination. Control of cleaning efficiency and waste in blow room and card, comber. Control of neps in sliver at card, drawframe and comber stage.
Module 3	Machine and labour productivity problems at speed frame and ringframe: Production per spindle calculation Yarn realisation, % waste calculation, TPI in yarn Doubling TPI, doubling count, shrinkage in doubled yarn, Yarn clearing efficiency, production in yards, operating efficiency of winder, Production per shift per winder Process control at yarn stage -Control of yarn imperfections and faults in yarns. Control of yarn count and count CV%. Control of strength, and strength CV%. Control of periodic mass variations, package faults. Productivity indices and evaluation of indices in spinning efficiency and machine allocation in preparatory and ring spinning.
Module 4	<p>Process control in winding: Knot quality, efficient removal of yarn faults and the control of productivity.</p> <p>Process control in warping: Control of end breaks, tension levels, quality and the productivity in warping.</p> <p>Process control in sizing: Choice and the control of size pick-up, yarn stretch and moisture in sized yarns. Improving weave ability of the sized yarn and the control of productivity and size losses.</p>
Module 5	Weaving:

	Raw material requirements, production and efficiency calculations, size add-on, sizing machine efficiency Approach, methodology and scope for process control in weaving. Fabric gramange, reed count. Loom production and efficiency, loom shed efficiency and value loss during weaving.
Module 6	Productivity: Definition, Idea of productivity calculations of weaving mill and factors affecting productivity, Productivity Indices used in weaving. Relation between machine allocation and machine efficiency. Calculations pertaining to production, efficiency and machine allocation in winding, warping, pirn winding, sizing and loom shed.
Module 7	Preparation of organization for spinning / weaving mill: Choice of machinery & its specification for different counts & blends. Principles of machinery lay-outs and different flow plans of material for spinning / weaving department.
Module 8	Material handling in spinning / weaving department. Humidification and air-conditioning provisions, ventilation & air changes.

Reference:

1. Process Control in Textile Manufacturing, Edited by A.Majumdar, A. Das, R. Alagirusamy, 2013, WPI, ISBN 978-0-85709-027-0.

Recommended reading:

1. Process control in Spinning by ATIRA.
2. Process control in Weaving by ATIRA.

Programme Name	Bachelor of Technology in Textiles	Semester-VII
Course Title	Process Control in Textile Manufacturing Lab	
Course Code	R4TT3010P	
Course Objective	To impart knowledge of process control for achieving desired quality and efficiency in spinning and weaving	
Course outcomes	After completing the course, student will be able to: <ol style="list-style-type: none"> 1. Depict the approach and methodology of process control. 2. Identify various performance parameters for controlling spinning process. 3. Identify various performance parameters for controlling weaving process. 4. Calculate the machine productivity index, efficiency, labour and machine allocation in spinning and weaving. 	
Prerequisite	Knowledge of Textile manufacturing & processing.	

Course Content

Modules	Description
Module 1	Spinning of carded yarn sample & testing of yarn properties
Module 2	Study of effect of break draft in Ring frame on yarn properties
Module 3	Study of effect of twist multiplier on yarn properties.
Module 4	Study of effect of traveller weight on yarn properties
Module 5	Sizing of the carded yarn sample
Module 6	Weaving of sized carded yarn sample

Programme Name	Bachelor of Technology in Textiles	Semester	VII
Course Code	R4TT3011T		
Course Title	Advanced Textile Materials		
Course Objective	To impart knowledge for making fabric structures using techniques other than basic weaving and knitting		
Course Outcomes	After completing this course, students will be able to: <ol style="list-style-type: none"> 1. Classify the different types of fabric forming techniques and understand the characteristics of each. 2. Understand the process requirements and raw materials for manufacture of knitted, nonwoven and braided structures 3. Relate the machinery required for manufacturing of nonwoven fabric structure and their applications 4. Comprehend various techniques for developing 3 Dimensional structures and their applications. 		
Prerequisite	Basics of fibres, yarns and woven and knitted fabrics		

Course Content

Modules	Description
Module 1	Introduction o various fabrics structures Introduction to various alternative fabric forming techniques. Raw material requirements for the different fabric forming techniques. Comparison of weaving technique vis-à-vis other fabric forming techniques.
Module 2	Introduction to Nonwoven fabrics Concept and Definition of nonwoven fabric, raw material used for the production of nonwoven fabrics. Study of properties of various fibers for the production of nonwoven fabrics Classification on the basis of use, on the basis of manufacturing process, on the basis of web formation, on the basis of bonding. Web forming technologies .
Module 3	Various methods of Web laying Raw material selection, preparation, web formation, layering, fiber orientation in parallel and cross laid webs, mechanisms of web laying and their processes
Module 4	Various methods of web bonding Needle punching, thermal bonding, chemical bonding, stitch bonding, hydro-entanglement, their manufacturing process, flow diagram, design aspects of various machine parts, structure and properties of nonwovens, process parameters and applications
Module 5	Concept of hybrid nonwoves Stitchbonding, Looping, SMS Technology, finishing techniques and formation of nonwoven products
Module 6	Applications of nonwovens: Nonwoven products used in filtration, geotextile, medical, hygiene, industrial, sound insulation and home textiles applications, their structure, finishing and evaluation
Module 7	3 Dimensional woven structures: Hollow 3D fabrics, Solid 3D fabrics and their types, interlock, orthogonal, interlaced, etc; shell and nodal 3 D fabrics, weaving of these 3 D fabrics ad their

	properties, applications of 3D woven fabrics
Module 8	3 Dimensional knitted structures: 3 dimensional knitted technologies, multiaxial knit fabrics, spacer fabrics, their structure and properties, applications of these structure
Module 9	Specialty nonwoven and braided structures Technology for developing of tubular and bifurcated braids, their properties and applications, making high bulk flat nonwovens and shaped 3 D nonwovens, their properties and applications

References:

1. Handbook of nonwovens-Edited by Russel,S.J.- Woodhead Publishing ISBN-13: 978-1-85573-603-0.
2. Albrecht, W., Fuchs, H., and Kittelmann, W., Nonwoven fabrics: Raw materials, manufacture, applications, characteristics, testing processes, Wiley-VCH, 2002 (Edited).

Recommended reading:

1. Nonwoven Fabrics- Edited by Wilhelm Albrecht Hilmar Fuchs Walter Kittelmann- WILEY-VCH- ISBN 3-527-30406-1.
2. Applications of nonwovens in technical textiles- Edited by R. A. Chapman, Woodhead Publishing, 978-1-84569-437-1.
3. Chapman R., Applications of Nonwovens in Technical Textiles , 1st Edition, 2010, Woodhead Publishing, Hardcover ISBN: 9781845694371, eBook ISBN: 978184569974

Programme Name	Bachelor of Technology in Textiles	Semester	VII
Course Code	R4TT3012T		
Course Title	Textile Composites		
Course Objective	To present knowledge of composite, its structure and use of various forms and textiles in the field of composites.		
Course Outcomes	<ol style="list-style-type: none"> 1. Describe the difference between monolithic and composite materials. 2. Describe the classification of composites based on reinforcing and matrix materials. 3. Express the importance of interfacial bond between reinforcing material and matrix. Its importance in deciding the end use of composites in applications. 4. Demonstrate skills in the product development of textile composites. 5. Outline the different mechanical properties of textile composites. 6. Formulate application of textile composites in various field of engineering. 		
Prerequisite	Knowledge of polymers, fibres and various forms of fabrics.		

Course Content

Modules	Description
Module 1	Importance of composites over other materials. Advantages and characteristics of composite materials, General requirements of composite materials.
Module 2	Classification of composites on the basis of reinforcement and matrix, Form and functions of reinforcement, Functions of matrices. Dispersion strengthened, particle strengthened and fiber-reinforced composites. Fibres and resin materials.
Module 3	Strengthening mechanisms, Aspect Ratio, Rule of Mixture, discontinuous and continuous fiber composites. Comparison of above composites. Characteristics and materials of reinforcements and matrices. Critical Fiber Length, Short and Continuous Fibers, Fiber Orientation. Matrix and Reinforcement Materials.
Module 4	Major composite classes: polymer matrix, métal matrix, ceramic matrix, carboncarbon, and intermetallic composites. Hybrid composites, Laminated composites. Examples of each class of composites. Particulates, Flakes, Whiskers, Fibers.
Module 5	Role of interfaces in composites, Toughening mechanisms in PMCs, MMCs, and CMCs.

Module 6	Fabrication of fiber reinforced plastic matrix composites: Fiber Forms, Prepregs, Molding Compounds-Processes, Lay-Ups, Filament Winding, Pultrusion, and Recycling. ; Matrix –Reinforcement Interface, Wettability
Module 7	Applications of advanced composite materials. Environmental effects in Composites, Green composites. ; Synthesis and Properties of Nanocomposites.

References:

1. Mathews F L and Rawlings R D, "Composite Materials Engineering Science", 1994.
2. Long A C, "Design and Manufacture of Textile Composites", Woodhead Publishing Ltd., UK, 2005.

Recommended reading:

1. Gupta L, "Advanced Composite Materials", Himalayam Books, 1998.
2. Bogdanocivh A and Pastore C, "Mechanics of Textile and Laminated Composites", Chapman & Hall Due, 1997.
3. Hearle J W S , "High Performance Fibres Composites and Engineering Textile Structures", Journal of the Textile Institute, Special issues, The Textile Institute, 1990

Programme Name	Bachelor of Technology in Textiles	Semester	VII
Course Code	R4TT3012P		
Course Title	Textile Composites Lab		
Course Objective	To present knowledge of making of textile composite and its analysis.		
Course Outcomes	<ol style="list-style-type: none"> 1. Demonstrate skills in the product development of textile fibre reinforced composites. 2. Express the effect of various physical and mechanical properties of textile fibres on mechanical properties of textile fibre reinforced composites. 		
Prerequisite	Knowledge of polymers, fibres and various forms of fabrics.		

Course Content

Modules	Description
Module 1	The General study of Hot Compression Moulding machine.
Module 2	The calculations related to volume fraction and weight fraction of reinforcement in composite.
Module 3	Thermoplastic composite manufacturing with glass fibre as reinforcement.
Module 4	Thermoplastic composite manufacturing with natural fibre as reinforcement.
Module 5	Thermoset composite Manufacturing with glass fibre as reinforcement.
Module 6	Thermoset composite Manufacturing with natural fibres as reinforcement.
Module 7	Mechanical Testing of Composites.
Module 8	Analysis of Composite structures.

Programme Name:	Bachelor of Technology in Textiles	Semester – VII
Course Code	R4TT3105T	
Course Title	CAD/CAM application for clothing	
Course Objective	To learn about the elements of solid modeling, creation of parts of increasing complexity and the assembly of parts to form a final design, along with mechanism simulation.	
Course Outcomes :	<ol style="list-style-type: none"> 1. To describe the fundamental theory and concepts of the CAD/CAM. 2. Describe computerized grading, Marker Planning and cutting. 3. Apply analytical decision making techniques in a fashion and textiles environment. 4. Aware the different 2D and 3D software for process of garment manufacturing. 5. Develop the concepts and underlying theory of modeling and the usage of models in different clothing manufacturing applications. 	
Prerequisites	Basic knowledge of spinning, weaving, chemical processing and garment designing.	

Course Content:

Modules	Description
Module 1	Introduction to computer – concepts of CAD CAD definition, fundamentals of CAD – Introduction, general process of design, abbreviations and Symbols used in CAD systems, application of computers for design, Benefits of CAD, Computers & the Fashion Industry, Quick response technology, CAD in Today's Fashion Industry
Module 2	Introduction to computer - concepts of CAM Usage of CAM in Garment Manufacturing. Principles of computer graphics, CAM - Computer controlled machinery for garment manufacturing - automated layout planning by various techniques - Algorithm for computer Production garment parts, Development of robotics for CAM, Creating marker plan and plotting markers.
Module 3	Computerized production pattern making

	Comparison of manual and CAD systems, Computerized production pattern Making – Hardware and software selection for CAD systems, How to produce a sample production pattern, Computer aided manipulation of pattern pieces to create individual styles, Operation of garment CAD software, Computer aided color matching- Computer used for purchase, inventory control and sales, computerization in quality control and production control.
Module 4	Computer aided production planning in Garment Manufacturing Introduction to finite scheduling concept and fast react software, Creating Product and order planning, updating. Eliminate late deliveries - General set up, allowances and matrices, Critical path and time tables. Reports generated by production planning software – production output reports by Customer/location/delivery date. Use of microcomputers for production control in garment industry
Module 5	Overview of 2D &3D CAD software Auto CAD for sketching, modeling, Overview of 3D CAD/CAM software like NX, CATIA, Pro-E for sketching, modeling, assembly, drafting, analysis and manufacturing, Overview of Textile-CAD software.
Module 6	Basic maintenance of operations Preference, setting up a document, what is resolution, saving files, files formats, zooming in & out, view options, CAD approach to design, vector graphics object Vs Raster design.
Module 7	Recent Developments in CAD/CAM 3D pattern making systems, WIP control using CAD software, 3D virtual clothing and simulation software
Module 8	CAD/CAM applications in fashion field – garment designing, weaving, knitting and embroidery, textile dyeing and printing

References:

1. Garment Manufacturing Technology, Edited by R K Nayak and Rajiv Padhye, 1st Edition, Woodhead Publishing 2015
2. Stephen Gray “CAD / CAM in clothing and Textiles ”, Gower Publishing Limited, 1998,

Recommended Readings:

1. CAD for Fashion Design by Renee Weiss Chase, Prentice hall Pub.

2. CAD/CAM/CIM by R.Radhakrishnan, S.subramanyan, V.Raju, New Age International Pub.
3. Fashion Design on Computers By M.kathleenColursy, Prentice Hall.2004.

Programme Name:	Bachelor of Technology in Textiles	Semester – VII
Course Code	R4TT3105P	
Course Title	CAD/CAM application in clothing Lab	
Course Objective	To help students to understand the fundamentals and principles of CAD/CAM	
Course Outcomes :	Student will be able to: <ol style="list-style-type: none"> 1. Use different tools for pattern making using Rich Peace software. 2. Develop the skills and ability to use grading tools using Rich Peace 3. Create a marker plan for the same and mixed sizes. 	
Prerequisites	Basic knowledge of spinning, weaving, chemical processing and garment designing.	

Course Content:

Modules	Description
Module 1	To understand the usage of the basic tools available for pattern making in any of the CAD software.
Module 2	Draft the basic block using the tools available in the CAD software
Module 3	Grade the basic block using grading tools available in CAD software
Module 4	To add darts/pleats/notches/folds in the patterns
Module 5	Create marker plan for a set of patterns drafted in CAD
Module 6	Create a mixed marker plan for all the sizes drafted/graded and plot the pattern with the plotter

Program Name	Bachelor of Technology in Textiles	Semester-VII
Course Code	R4TT3106T	
Course Title	Coated and Laminated Textiles	
Course Objective	To provide knowledge to the students about the basic concept of coated and laminated textiles.	
Course Outcomes	After completing this course, students will able to: <ol style="list-style-type: none"> 1. Describe the basic concept of coated and laminated textiles 2. Explain the various polymeric materials used for coated and laminated textiles 3. Outline the methods for the production of coated and laminated textile products 4. Discuss the applications and properties required for coated and laminated materials 5. Learn and develop the eco-friendly processes for the production of coated and laminated textiles to maintain sustainability 	
Prerequisites:	Knowledge of textile manufacturing & polymer	

Course Content:

Module	Description
Module 1	Introduction to Coating and Lamination : Concept, Definition, Need and market potential of coating and lamination textiles. The technical scope of coated and laminated textiles. Properties that can be obtained by fabric resin coating or by film lamination.
Module 2	Materials for coating and lamination: Substrate for coating: Various natural and synthetic textile substrate used in the production of coated and laminated textiles. Selection of fabric as substrate for coating. Polymeric Materials for Coating: Rubbers (natural & synthetic), PVC, Polyurethane, Acrylics, Adhesives and foams. Processing of the polymers for coating of textiles. Basic chemistry involved in coating and lamination, formulation recipe.
Module 3	Methods of Coating and Lamination: Methods of coating and lamination: Post and pre-metering methods, fluid coating technology, transfer coating, hot melt coating, dry and wet lamination, direct and flame lamination etc. Paste preparation and evaluation techniques.
Module 4	Machines for Coating and Laminations: Brief Study of Roller coating, Knife coating and knife over roller coating, type of knives. Process parameters: temperature, pressure, thickness of coating and curing, etc. Roller coating methods. Direct coating methods, other methods of coating. Calendering technology for fabric coating, applications and Problems Encountered During Calendering.
Module 5	Product from Coated and Laminated fabric Protective clothing-sports and industrial, functional clothing, automotive application, Marine application, Building , construction and Architecture application, Household product, Medical use, Defense textiles, Conductive coating for textiles, Breathable textiles from coated and laminated process.
Module 6	Characterization of Coated and Laminated Textiles: Basic test standards and methods for evaluation of products, GSM, permeability criteria, , degree of adhesion etc, Performance test: Water repellency and water proofing, Flammability and launderability etc.
Module 7	Best Available Techniques for Coating and Lamination:

	Foam coating technique with its merits and demerits, coating of specialty textiles: conductive and breathable textiles, Nano and plasma coating technology for industrial applications
Module 8	Environmental consideration in Coating and Lamination : Environmental protection, VOC, Green house emission, Machine and Human safety norms: Temperature, Material storage and handling consideration, pollution control norms in coating and lamination technology

References:

1. Sen A.K., Coated Textiles: Principle and Application, 2nd Edition, CRC Press, 2007
2. Walter Fung; Coated and Laminated Textiles, Woodhead Publication Ltd, 2002,
3. Smith W.C., Smart Textiles Coating and laminating, Woodhead Publication Ltd, 2010

Recommended reading:

1. Carr C.M., ‘ Chemistry of Textile Industry’, Chapter 07, Chapman and Hall India, 1995.
2. Giesmann Andreas, Coating Substrate and Textiles: A Practical guide to coating and laminating Technologists, By Springer, 2012.

Program Name	Bachelor of Technology in Textiles	Semester-VII
Course Code	R4TT3106P	
Course Title	Coated and Laminated Textiles Lab	
Course Objective	To expose the students to practical aspects in the field of coating and lamination	
Course Outcomes	After completing this course, students will able to, 1. Learn the mechanism involved in the coating and lamination operation 2. Grasp the paste formulation technique for production of coated and laminated textiles 3. Explain various process parameters in coating and lamination process 4. Appraise the advance characterization techniques for evaluation of products	
Prerequisites:	Knowledge of coated and laminated structures for various applications	

Course Content:

Module	Description
Module 1	Study of properties and preparation of textile substrate for coating
Module 2	Study of knife coating machine
Module 3	Coating of cotton and cotton/polyester blend fabric for flame retardant applications
Module 4	Development of water repellent textiles using coating technology
Module 5	Development of water proofing textiles using coating technology
Module 6	Development of flame retardant textiles using coating technology
Module 7	Development of combined fragrance and antimicrobial textiles using coating technology
Module 8	Study of various characterization techniques in coating and lamination technology

Programme Name	Bachelor of Technology in Textiles	Semester	VII
Course Code	R4TT3107T		
Course Title	Processing of Fibers and Blends		
Course Objectives	To introduce the students about mechanical and chemical processing aspects of various fibers and blends		
Course outcome	After completing this course, students will be able to: <ol style="list-style-type: none"> 1. Discuss the concept of mechanical processing of fibers and blends at various stages of spinning 2. Compute the process parameters for mechanical processing of blended materials. 3. Outline the requirements of wet processing of blending materials. 4. Analyse the impact of various process parameters on properties of blending material at wet processing. 5. Evaluate the blended products using various physical and chemical methods. 		
Prerequisite	Knowledge about basic mechanical and chemical processing of textiles		

Course Content

Modules	Description
Module 1	Introduction Concept of fiber blending, Objectives, Classification and Methods of blending etc.
Module 2	Processing at Blow room and Carding Blending at blow room, Process segregation for blending, Selection criteria for blending, Important setting and machine parameters for processing of blends and Measurement of effectiveness of blend etc.
Module 3	Processing at Draw frame Roving and Ring frame Concept of draw frame blending, Important setting and machine parameters for processing of blends, Merits and demerits of draw frame blending, Break draft and its significance, Significance of twist, Doubling and cabling of blended yarns, TFO and Fancy doublers for production of blended yarn etc.
Module 4	Processing at Unconventional Spinning Systems Processing of blends at rotor, friction and air jet spinning, Raw material preparation , Important setting and machine parameters for processing of blends and effect of process parameters on the parameters, Spinning of blends on other spinning systems such as solo, siro and self-twist spinning systems etc.
Module 5	Pre and Post Wet Processing of Blends Process flow for pre and post wet processing for blends, Methodology for wet processing of blends, Sequence of machine, Estimation of process parameters and its effect on the fabric quality, Selection criteria for auxiliary and effect chemicals etc.
Module 6	Printing and Finishing of Blends Various methods for printing and finishing of blended goods, Mechanical and chemical finishing of blended goods, preparation and formulation of paste for printing of blends, Estimation of process parameters and its effect on the fabric quality etc, emerging methods for printing and finishing of blended goods etc.
Module 7	Evaluation Techniques of Blended Goods Need and requirement for evaluation, Various physical and chemical techniques for the evaluation of blended goods etc.

References:

1. K.R. Salhotra, Spinning of Manmade & Blends on Cotton System, Textile Association (India), 2004.
2. Process control in textile manufacturing, Edited by A.Majumdar, A. Das, R. Alagirusamy, 2013, WPI, ISBN 978-0-85709-027-0.
3. Tomar, R.S. – Hand Book of Wool and Blended Suiting Process, 2010, WPI, ISBN: 978-1-84569-954-3.

Recommended reading:

1. P.R. Lord, Hand Book of Yarn Production : Science, Technology and Economics, Taylor and Francis, 2003
2. Chemical Finishing of textiles, W.D.Schindler & P.J.Hauser, 2004, WPI, ISBN 1 85573 905 4.
3. Functional finishes for textiles, Edited by Roshan Paul, 2015, WPI, ISBN 978-0-85709-839-9.

Programme Name	Bachelor of Technology in Textiles	Semester	VII
Course Code	R4TT3107P		
Course Title	Processing of Fibers and Blends Lab		
Course Objectives	To teach students about the actual methods used in the production of blended textile products from basic spinning up to the wet processing technique.		
Course outcome	<ol style="list-style-type: none"> 1. Estimate the basic fiber properties for purpose of blending 2. Discuss the various process parameters at different stages of spinning for blended yarn production 3. Estimate the blend composition in the given textile material 4. Design the experimental set up for pretreatment and dyeing of blended fabrics 5. Explain the various techniques for the value addition in blended fabrics. 		
Prerequisite	Knowledge about basic principles of spinning, mechanical and chemical processing of textiles		

Course Content:

Modules	Description
Module 1	Calculation of mixing and blending parameters for the production of blended yarn
Module 2	Important setting at carding and comber for blended yarn production. Analysis of waste at different stages in the carding and comber.
Module 3	Concept of draw frame blending and important setting for the blended yarn production.
Module 4	Production of blended yarn on direct twisting machine.
Module 5	Analysis of blends of blend composition in the given fabric sample
Module 6	Pretreatment of P/C blended fabrics
Module 7	Dyeing of blended fabrics
Module 8	Mechanical finishing for blended fabrics
Module 9	Chemical finishing of blended fabrics

Program Name	Bachelor of Technology in Textiles	Semester	VII
Course Code	R4TT3108T		
Course Title	Post Spinning Processing of Manmade Fibres		
Course objective	To give exposure on post spinning processing of man-made fibres.		
Course outcome	<p>After completing this course, student will be able to:</p> <ol style="list-style-type: none"> 1. Explain the concept of manmade fibre drawing and process parameters that influence it. 2. Outline post spinning processes like spin finish application and heat setting. 3. Explain the process of texturizing made-made filaments 4. Describe tow to top conversion. 5. Test textured yarns. 		
Prerequisite	Basic knowledge of man-made fibre spinning		

Course Content

Module	Description
Module 1	Synthetic Yarn And Their Production: Outline of various manufacturing processes, Concept of drawing and draw warping, necking phenomenon, variables and machines, effect of drawing parameters on structure and properties of fibres, structure development during drawing. High speed spinning and spin-draw process, Drawing of preoriented yarn and draw warping.
Module 2	Spin Finish and its application: Properties, Role of Spin Finish, Components, spin finish for staple fibre and filament, application techniques, problem encountered.
Module 3	Heat Setting: Types of heat setting, Different parameters affecting heat settings, Polymer interaction, nature of set, implication. Heat setting behavior of thermoplastic and thermoset fibres-Changes in structure and properties on heat setting, Effect of tension on properties, Thermal Healing, Setting under dry and wet heat. Evaluation of settability and degree of set.
Module 4	<p>Textured yarns & Texturing techniques: Types, special features, Properties of yarn and fabric made, applications.</p> <p>Process-Feed Material-Variables-Machines for:</p> <ul style="list-style-type: none"> • False twist texturing • Draw texturing • Stuffer box Knife texturing • Edge texturing • Inert mingling • Gear Mesh texturing • Knit-de-knit texturing • Air jet texturing
Module 5	Evaluation of Textured Yarn.

	Measurement of Yarn Instability, Physical Bulk, Crimp, Shrinkage Determination of Size, form and frequency of Loops, etc Standard & Methods of Evaluation.
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References:

Yarn Texturing Technology; JWS Hearle, L.Hollick & D.K.Wilson, 2001, CRC Press, ISBN 0-8493-1310-4.

Recommended Readings:

- 1) Manufactured Fibre Technology – Edited by V.B.Gupta & V.K.Kothari (Chapman & Hall Publication), 1997, ISBN 978-94-010-6473-6.
- 2) Textile Yarns Technology , Structure and Applications –B.C Goswami, J.G.Martindale & F.L.Scardino (Wiley Interscience Publication.).
- 3) Modern Yarn Production from Manmade Fibres - Edited by G. R. Wray (Columbine Press)

Programme Name	Bachelor of Technology in Textiles	Semester	VII
Course Code	R4TT3108P		
Course Title	Post Spinning Processing of Manmade Fibres Lab		
Course objective	To impart practical knowledge on post spinning processing of manmade fibres		
Course outcome	After completing this course, student will be able to: <ol style="list-style-type: none"> 1. Criticize the process parameters that influence man-made fibre drawing 2. Demonstrate post spinning processes like spin finish application and heat setting 3. Recognize process of texturing of made made yarns and tow to top conversion 4. Assess the quality of textured yarns 		
Prerequisite	Basic knowledge of manmade fibre spinning		

Course Content

Module	Description
Module 1	Evaluation of effect of drawing on properties of synthetic yarn
Module 2	Study of effect of additives on properties of manmade yarn
Module 3	Study of textured and intermingled yarn
Module 4	Study of crimp rigidity of textured yarn
Module 5	Study of shrinkage of textured yarn
Module 6	Study of bulk of textured yarn
Module 7	Determining spin finish content in yarn

Programme Name	B. Tech. (All Branches)	Semester	VII
Course Code	R4TT3602T		
Course Title	Structural Composites		
Course Objective	To impart knowledge of making, their performance under different conditions and critical analysis of composite materials.		
Course Outcome	After attending this course students will be able to: <ol style="list-style-type: none"> 1. Understand the composite materials and impact of aggregation of constituent materials. 2. Depict the approach and methodology of fabrication of such aggregate. 3. Schooled various models analysing the design and performance of composite materials. 4. Understand the composite modulus, strength and fracture behaviour for structural applications. 		
Prerequisite	Basic knowledge of Engineering Physics and Engineering Chemistry.		

Course Content

Module	Description
1.	Introduction: Definition of composite material, Classification based on matrix and topology, Constituents of composites, Interfaces and Interphases, Distribution of constituents, Nano-composites.
2.	Performance of Structural Composites: Combination effects (Summation, Complementation and Interaction), Basic analytical concepts. Performance analysis by various models (Law of Mixtures, Shear lag model, Laminated plate model - thermoelasticity, plasticity and creep), Strengthening mechanisms, Stress distribution in fibre and the matrix (shear stress and axial tensile stress in the fibre along its length), critical length of fibre for full strengthening, Analysis of uniaxial tensile stress-strain curve of unidirectional continuous and short fibre composites, Estimation of the required minimum amount of fibre and critical amount of fibre to gain a composite strength, Analysis of strength of a composite during loading at an angle to the fibres, Nano-structured composites.
3.	Performance of Composite in Nonstructural Applications : Composites in Electrical, Superconducting and Magnetic Applications, Nano-composite devices.
4.	Fabrication Composites : Fabrication of Metal Matrix Composites: Commonly used Matrices, Basic Requirements in Selection of constituents, solidification processing of composites - XD process, Spray processes - Osprey Process, Rapid solidification processing, Dispersion Processes. Fabrication of Polymer Matrix Composites - Commonly used Matrices Basic Requirements in selection of Constituents, Moulding method, Low pressure closed moulding, pultrusion, Filament winding, Fabrication of ceramic matrix composites - Various techniques of vapour deposition, Liquid phase method and Hot pressing etc., Fabrication of nano-composites.
5.	Characterisation of Composites : Control of particle/fibre and porosity content, particle/fibre distribution, Interfacial Reaction of matrix-reinforcing component, Coating

	of reinforcing component, Strength analysis.
6.	Secondary Processing and Joining of Composite : Forging and extrusion of composites – critical issues, dynamic recovery and dynamic recrystallization, mechanical properties; Induction Heating, Fusion Bonding, Ultrasonic welding, Gas tungsten arc welding, Gas metal arc welding, Resistance spot & seam welding, Resistance brazing, Resistance spot joining, Resistant spot brazing, Resistance welding of thermoplastic graphite composite, Weld bonding, Brazing of MMC.
7.	Industrial Application of Composite Materials : Civil constructions of structures/pannels, Aerospace industries, Automobile and other surface transport industries, Packaging industries, House hold and sports components etc.
8.	Fracture & Safety of Composite : Fracture behaviour of composites, Mechanics and Weakest link statistics, Griffith theory of brittle fracture and modification for structural materials, Basic fracture mechanics of composite (Fracture toughness, COD and J-integral approaches, Fatigue crack growth rate), Fracture Mechanics of brittle matrix fibre composite, Fracture mechanics of metal matrix fibre composite, Experimental evaluation (composite), Elementary reliability analysis.

References:

- Sanjay Mazumdar, Composites Manufacturing-Materials, Product and Process Engineering, 2002, CRC Press, ISBN 0-8493-0583-3.
- Fibrous and composite materials for civil engineering applications, edited by R. Figueiro, 2011, WPI, ISBN 978-1-84569-558-3.
- Textile advances in automotive industry, edited by R. Shishoo, Woodhead Publishing in Textiles: No. 79, ISBN 978-1-84569-331-2.

Recommended Readings:

- Nanocomposite Science and Technology, P. M. Ajayan, L. S. Schadler, P. V. Braun, (2003), Wiley-VCH Verlag GmbH Co. KGaA, Weinheim.
- Mechanics and Analysis of Composite Materials, V.V. Vasiliev and E.V. Morozov, (2001), Elsevier Science Ltd, The Boulevard, Langford Lane, Kidlington, Oxford OX5 1GB, UK.
- Ceramic matrix composites, K.K. Chawala, 1st ed., (1993) Chapman & Hall, London.

SEM – VIII

Programme Name	Bachelor of Technology in Textiles	Semester VIII
Course Code	R4TT3015T	
Course Title	Textile Management	
Course Objective	To impart knowledge of various management concepts.	
Course outcome	After completing this course, student will be able to: 1. Understand the role and importance of management principle 2. Describe the process of planning and optimization in textile industry 3. Describe the marketing and financial management importance in textile industry 4. Apply the knowledge of productivity improvement techniques, quality engineering concepts. 5. Comprehend the external environment framework of textile industry.	
Prerequisite	Textile Manufacturing process knowledge	

Course Contents:

Module	Description
Module 1	Management Principles Planning, Organizing, Staffing, Leading, Directing and Control.
Module 2	Financial Management-Sources of funds for textile industry, Introduction to working capital, Balance sheet, Profit & Loss Account, Budget, Budgeting, Auditing. Analysis & interpretation of Balance sheet, Ratio analysis, fund-flow statement. pay-back period. Reconciliation of financial & cost accounts.
Module 3	Marketing management Concept, marketing function, pricing practice, advertising& sales promotion, market research.
Module-4	Objective, Factors governing of site selection for textile mill, kinds of layout their advantages & disadvantages, effect of automation on plant layout, advantages of a good layout, symptoms of bad layout. Safety provisions in textile industry.
Module -5	Advanced techniques of Industrial Engineering: - Just in Time, Concurrent Engineering, SMED, Kaizen, Business Process Reengineering, Supply Chain Management, Value Engineering, Lean Thinking, Visual Workplace, Poka-Yoke, Strategic Human Resource Management, Applications of the techniques in textile industry.
Module-6	Textile industry scenario, Textile Industry growth, problems & government policy. Make in India concept, start up policy of government its utilization for textile industry.
Module-7	Export-Import policies & Documentations for Textile industry
Module-8	Industry laws like labor laws, factory acts and its study.

References:

1. Textile Project Management – A. Ormerod, Textile Institute Publication, ISBN 978-1870-8123-82.

Recommended Readings:

1. Industrial Organization and Engg. Economics by T.R. Banga and S.C.Sharma,O. P. Khanna, Publishers, Delhi.
2. ‘Textile Manufacturing’, M.G. Kulkarni, Current literature Co. Pvt. Ltd., Malhotra House, Mumbai.

Programme Name	Bachelor of Technology in Textiles	Semester	VIII
Course Code	R4TT3016T		
Course Title	Sustainable Textile Manufacturing		
Course Objective	To impart comprehensive knowledge about the environmental and ecological aspects of textile materials and processing.		
Course outcome:	After attending this course, students will be able to: <ol style="list-style-type: none"> 1. Discuss the need and requirement of sustainable textiles. 2. Outline the ecological aspects in spinning, weaving and processing of textiles. 3. Explain the energy saving aspects in textile process 4. Utilize the emerging techniques for production of sustainable textile products. 5. Assess the impact of textile process on environment. 		
Prerequisite	Knowledge of basic fiber production, spinning, weaving and processing of textile materials.		

Course Content

Module	Description
Module 1	Introduction to Sustainable Textile Materials and Production : Concept, Definition, Need and requirements of sustainable textile materials
Module 2	Ecological Aspects in Fiber production: Eco-Fiber and their production with reference to organic cotton and its comparison with conventional cotton, Ecological aspects in the production of bamboo, hemp and other allied fibers, The genetic modification of cotton and its impact on environment and naturally coloured cotton production and its benefits
Module 3	Ecological Consideration in Spinning and Weaving Area: Fluff and noise generation and its impact, Plant design considerations to minimize the noise, Role of humidification for minimizing fluff generation and maintain the heat balance. Design aspects for controlling the noise, Comparison of old and modern plants with respect to noise and fluff generation
Module 4	Ecological Aspects in Wet Processing: Comparison between old and modern pre and post wet processing techniques, Banned dyes, Banned Auxiliaries, Substitute chemicals and their norms.
Module 5	Ecological Consideration in Coated and Laminated Textiles: Water and Polymeric base compounds in coating and laminating operations, Assessment of VOC and toxic fume gases, Process parameters and safety requirement
Module 6	Energy Saving aspects in Utility Engineering: Selection of proper size of motors in spinning and weaving operations, Humidification parameters to maintain the heat load, Boiler house operations, Counter flow technique for wet processing operations and its merits, salt, size and dye recovery technique. Need of Common influent treatment plant, Terms in COTP, BOD, COD and TDS etc.
Module 7	Best Available Techniques for Textiles Wet Processing: Waterless dyeing technology, Ultrasonic assisted dyeing for various fibers with its merits and demerits, Plasma processing of textiles etc.

Module 8	Environmental Legislations in Textile Production : Environmental protection, International and National policy regarding environmental protection, Protective applications, Legislation, Pollution measurement problems, Environmental auditing, eco-labeling-Oeko Tex Standards, Concept of COTP etc.
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References:

1. M. Miraftab, Horrocks A.R, Eco textiles the way forward for sustainable development of textiles, 2007, Woodhead Publications, ISBN 978-1-84569-214-8.
2. Saltar Keith, Environmental Impact of Textile Production- Process and Protection, Textile Institute, UK.

Recommended Readings:

1. Indian Journal of fibre and textile research, Special issue on environmental issues:- Technology options for textile industry' 2001, June, edited by Prof. R.B.Chavan , IIT, Delhi.
2. Shastree N.K., 'Environmental resource management, noise pollution: standards and control', Anmol Publication Pvt. Ltd., New Delhi.(1997).
Environmental impact of textiles, Keith Slater, Woodhead Publishers, June 2003.

Program Name:	Bachelor of Technology in Textiles	Semester-VIII
Course Code:	R4TT3109T	
Course Title:	Green Composite	
Course Objective	To make students aware about the basics and advances in the field of green composites	
Course Outcomes:	After completing this course, students will able to: <ol style="list-style-type: none"> 1. Learn the basics and advances in the field of green composites for various industrial applications 2. Compare the structure of green composites with synthetic composite 3. Describe the method for preparation of green composite 4. Learn various modern characterization techniques and life cycle analysis for evaluation of green composites 	
Prerequisites:	Knowledge about the basic concept of green composite	

Course Content:

Module	Description
Module 1	Introduction to green composites Concept of green composites, Need and requirement. Role of green composite in reduction of overall environmental footprint.
Module 2	Materials for green composites Natural reinforced and matrix materials such as cellulose and protein base fibers and matrix material, properties of different green fibrous and matrix materials.
Module 3	Biopolymers Different types of natural thermoset biopolymers and natural thermoplastic biopolymers used in making of green composites.
Module 4	Treatment to natural fibres Various Physical and chemical treatment to natural fibres to improve mechanical and to reduce hydrophobicity of natural fibres
Module 5	Methods for making of Green Composites Overview of basic manufacturing technology of green composites, Initial preparation for making green composites: Fiber opening and cutting, Concept of hand laying technique. Process parameters and its effect on the properties of green composites. Use of nanoparticles in composites.
Module 6	Characterization and Evaluation of green reinforcement and matrix materials Length and Diameter measurement for determination of aspect ratio of various fibers, Evolution of fiber-matrix compatibility, measurement of viscosity of matrix material etc. Evolution of fiber cross section and its effect on the properties of composites.

Module 7	Applications of green composites Applications in medical, packing, automotive industries supported with case studies
Module 8	Instrumentation techniques for evaluation of green composite products Techniques for evaluation of surface characteristics: SEM and TEM etc XRD, SAX techniques for evaluation of crystallinity, Study of Tensile, Impact, Flexural strength for evolution of mechanical characteristics

References:

1. Green composites from natural resources by Vijay Thakur
2. Green composites, polymer composite and environment by Baillie

Recommended Readings

Recent articles from journal of bioprocessing and bio-techniques based on green composites

Program Name:	Bachelor of Technology in Textiles	Semester-VIII
Course Code:	R4TT3109P	
Course Title:	Green Composite Lab	
Course Objective	To expose the students about the concept and application of green composites	
Course Outcomes:	After completing this course, students will able to, 1. Outline the basic manufacturing techniques for making green composites 2. Grasp the knowledge of various green reinforced and matrix materials used for making green composites 3. Learn the properties of raw materials for used for development of green composites 4. Appraise the advance characterization techniques for evaluation of products	
Prerequisites:	knowledge about the basic manufacturing techniques development of green composites	

Course Content:

Module	Description
Module 1	Study of basic manufacturing techniques for development of Polymer Matrix Composites.
Module 2	Development and evolution of green composite using sunhemp fiber
Module 3	Development and evolution of green composite using jute/coir as reinforcement material
Module 4	Development and evolution of green composite using soya fiber as a matrix and lignin as a binder
Module 5	Development and evolution of green composite using enzyme treated natural fiber
Module 6	Effect of process parameters on the mechanical properties of green composites
Module 7	Comparative study of jute-soya and glass-epoxy composites

Programme Name	Bachelor of Technology in Textiles	Semester	VIII
Course Code	R4TT3110T		
Course Title	Textiles for Medical Applications		
Course objective	To impart knowledge about textile materials for development of medical product.		
Course outcome	<ol style="list-style-type: none"> 1. Compute the requirement of textile materials for medical applications. 2. Outline of various fields of medical textiles 3. Discuss the raw material requirement for the medical textiles 4. Explain the conventional and new technology for development of medicated textile products 5. Evaluate the textile products with respect to medical applications. 		
Prerequisite	Knowledge of spinning, weaving and finishing of textile materials.		

Course Content

Module	Description
Module 1	Introduction to Medical Textiles : Concept, Role of Textiles in Medical Applications, Outline of Medical Textiles, Current status of medical textiles, Future growth of medical textiles.
Module 2	Textiles for Implantable Medical Applications Introduction, Substrates for implantable applications, Technology involved in the manufacturing, emerging trends in implantable materials.
Module 3	Textiles for Non-implantable Medical Applications: Introduction, Substrates for implantable applications, Technology involved in the manufacturing, emerging trends in implantable materials
Module 4	Textiles for Extracorporeal Devices: Introduction, Substrates for implantable applications, Technology involved in the manufacturing, emerging trends in implantable materials
Module 5	Evaluation of Medical Textile Products Surface characterization, Antimicrobial activity, Bioactivity and Biodegradability, Physical and Mechanical Characterization, Performance Test: Toxicity test etc.

References:

1. Handbook of Medical Textiles, Edited by V.T Bartels, 2011, Woodhead Publishing in Textiles: No. 100, ISBN 978-1-84569-691-7.

Recommended Readings:

1. Medical Textiles and Biomaterials for healthcare applications, Edited by S.C Anand, J.F Kennedy, Dr. Miraftab and Dr. Rajendran, 2010, Woodhead Publishing Ltd., ISBN 978-1-84569-224-7.
2. S. Ghosh, Medical Textiles, Proceedings of International Conference 24 & 25 Aug,1999, Boltan, UK.

Programme Name	Bachelor of Technology in Textiles	Semester	VIII
Course Code	R4TT3110P		
Course Title	Textiles for Medical Applications Lab Lab		
Course Objectives	To provide the practical exposure to the students for evaluation of medical textile products.		
Course outcome	<ol style="list-style-type: none"> 1. Explain the various methods for characterization on medical textile products. 2. Measure the antimicrobial properties of medical textile products. 3. Estimate the physical and chemical properties medical textiles. 4. Measure the saline water absorption and wicking properties of medical textile products. 5. Mechanical testing of medical textiles. 6. Determine the biocompatibility and biodegradability of medical textile products. 		
Prerequisite	Knowledge about basic methods for characterization of textile materials.		

Course Content:

Modules	Description
Module 1	Identification of various types of medical textile products.
Module 2	Measurement of antimicrobial activity of medical textile product using qualitative method.
Module 3	Measurement of antimicrobial activity of medical textile product using quantitative method.
Module 4	Measurement of saline water absorption and wicking properties of medical textile products.
Module 5	Estimation of physical and chemical properties of simple gauze fabric.
Module 6	Determination of biocompatibility of given sample.
Module 7	Determination of biodegradability of given sample.
Module 8	Measurement of tensile properties of medical textile products.

Programme Name:	Bachelor of Technology in Textiles	Semester – VIII
Course Code	R4TT3111T	
Course Title	Functional and Smart Textiles	
Course Objective	To impart knowledge about Functional and smart textile materials	
Course Outcomes	After completing this course, students will be able to: <ol style="list-style-type: none"> 1. Explain the role of functional and smart textiles 2. Describe the design and development of thermo-regulatory textiles. 3. Explain the utility of hollow fibre membranes. 4. Apply the knowledge of intelligent polymer for specific applications. 5. Explain the usefulness of Smart medical textiles. 6. Get exposure to the design-development and application of conductive textiles. 	
Prerequisites	Knowledge of technical textiles	

Course Content

Module 1	Development of functional and smart textiles and clothing: Understanding existing materials and technologies, Research and development in new products-niche application
Module 2	Heat storage and thermo-regulated textiles: Basic concepts of heat storage materials, manufacturing of thermo-regulated textiles, Application and future trends.
Module 3	Stimuli responsive textiles: Fundamental concepts, Current status, Textiles working on mechanical stimulus- permeation stimulus-optical stimulus, Application, Future trends.
Module 4	Hollow fibre membranes for fluid separation: Importance, Historical overview, Theories of permeation process, Development of phase inversion and hollow fibre membranes, Future trends.
Module 5	Tailor made intelligent polymers for specific applications: Concept of Shape memory materials, Textile scaffolds in tissue engineering.
Module 6	Smart medical textiles: Smart wound care materials, Textile based drug release systems, Textile based sensors for health care.
Module 7	Adaptive Responsive Textile Structures (ARTS): Textiles in computing, energy harvesting, Concept of wearable electronics, application, Future trends.
Module 8	Conductive textiles as flexible substrates: Method of manufacturing

	conductive textiles, Techno-economic aspects of various technologies, Application of conductive textiles as EM shielding screen- Clean room curtain and flooring- Wearable antenna- Embedded electrodes in soft ground improvement.
Module 9	Testing of smart textiles: Role of smart textile testing, Testing of shape memory effect Fabrics- phase change materials- Self cleaning materials- Electronic responsiveness-EM shielding, Future trends.

References:

1. Smart fibres, fabrics and clothing: Edt.Xiaoming Tao, The Textile Institute and Woodhead Publishing, 2001, ISBN 1 85573 546 6.
2. Smart textiles for medicine and health care: Materials, Systems and Applications, Edtd.by L.Van Langenhove, The Textile Institute and Woodhead Publishing, 2007, ISBN 13: 978-1-84569-027-4.
3. Fabric Testing: Edt. By Jinlian Hu, The Textile Institute and Woodhead Publishing, 2008, ISBN: 978-1-84569-297-1

Program Name:	Bachelor of Technology in Textiles	Semester-VIII
Course Code:	R4TT3112T	
Course Title:	Nanotechnology in Textile Applications	
Course Objective:	To highlight the scope of nanotechnology and its various application in textiles.	
Course Outcomes:	After completing this course, students will able to: <ol style="list-style-type: none"> 1. Discuss the fundamentals of nanoscience and nanotechnology. 2. Outline the various techniques for manufacturing nano materials 3. Explain the applications of various nanomaterials in area of textiles. 4. Analyze and evaluate the nanomaterials using various analytical techniques. 5. Assess the impact of nanotechnology on the environment. 	
Prerequisites:	Knowledge about physics, chemistry and mathematics.	

Course Content

Module	Description
Module 1	Introduction to Nanotechnology: Fundamental of Nanoscience Nanotechnology, Introduction and classification of nanomaterials: Definition, Concept, Requirement
Module 2	Production of Nanomaterials: Principle and production of nanomaterials, nanoparticles, nanospheres etc, Top down and bottom down approaches for production of nanomaterials.
Module 3	Nanoparticles and potential applications in Textiles: Carbon Black nanoparticle, carbon nanotubes, classification and, application, Formulations of Titanium Nano particles, Metal Nano Particle, Clay Nano Particle and study of their properties.
Module 4	Nanofibers for Textile Applications: Production of nanofibers, Applications of Nanofibers in Air and water filtration, Controlled drug delivery Tissue reconstruction, Barrier materials, Anti-bacterial fabric and other advanced technique in field of various engineering.
Module 5	Nano-Enhanced Finishing Treatments: Nano formulations for dyes ,Nano coatings and nano finishing, Nano Emulsion to get value addition on Textiles.

Module 6	Nano-Textile Products and their utility: Sports fabrics: improved mechanical properties, and odour-reducing antibacterial properties, Therapeutic textiles: antimicrobial wound dressings, clothing and bedding, PPE (personal protective equipment) : improved chemical or heat resistance , Military textiles: flexible body armor, radio shielding and camouflage, Wearable electronics: computers made from nanofibers and flexible circuit board, Nano composites and their applications
Module 7	Societal implications of nanoscience: Ethical, legal and environmental implications, Concept of bio-nanotechnology and its merits.
Module 8	Analysis of Nano Scale Textile Material: Principles and Instrumental Technique (SEM, XRD, AFM, TEM, Particle size and Particle size distribution, Stability etc).

References:

1. Nanofibers and nanotechnology in textiles, Edited by P Brown and K Stevens, 2007, Woodhead Publishing Series in Textiles No. 673, ISBN 978-1-84569-105-9.
2. Nanoparticles: From Theory to Application, Edited by: G. Schmid, Chichester, John Wiley, 2004

Recommended Readings:

1. "Polymer-Clay Nanocomposites", Pinnavaia, T. J., and Beall, G. W., Wiley and Sons, NY, 2000
2. Adanur, S., and Ascioğlu, B., "Processing Characterization of PVA Nanofibers in Electrospinning", Proc. of ICCE/11, Hilton Head, SC, August 8-14, 2004

Programme Name	Bachelor of Technology in Textiles	Semester VIII
Course Code	R4TT3112P	
Course Title	Nanotechnology Application in Textile lab	
Course Objective	To Impart Practical Knowledge of Different Methodologies, Machineries and Process Variables Involved In Nanotechnology.	
Course Outcomes	After completing this course, students will be able to: 1. Understand the need and demand of nanotechnology in textile 2. Identify the engineering principles involved in various Nano product manufacturing processes. 3. Experience the practical know-how of production of nano materials. 4. Characterize and test various nanomaterials	
Prerequisite	Basic knowledge of polymers, fibres and various forms of textile materials	

Course Content

Modules	Description
Module 1	Identification of Types of Nanomaterials and Their Manufacturing Processes
Module 2	Production of Nanomaterial by Sol Gel Method
Module 3	Production of Nanomaterial by Precipitation Method
Module 4	Optimization of Process Parameters for Electrospinning
Module 5	Production of PVDF nanofibers via electrospinning
Module 6	Production of PAN nanofibers via electrospinning
Module 7	Identification of Size of Nanomaterials by Particle Size Analysis
Module 8	Characterization of nanomaterial by SEM and FTIR
Module 9	Introduction to advanced Characterization techniques for Nanomaterials

Programme Name	Bachelor of Technology in Textiles	Semester VIII
Course Code	R4TT3113T	
Course Title	Project Formulation and Appraisal in Textile Sector	
Course Objective	To provide the sound knowledge to the students about the concept and principles of project formulation in textile sector	
Course outcome:	After completing this course, students will able to: 1. Learn the fundamental concepts of project formulation in textile 2. Determine the basic constraints for project formulation 3. Outline the various government laws and legislations prior to project formulations 4. Summarize the concept of cash flow statements and profitability in the project formulation of textiles	
Prerequisite	Knowledge of Textile Manufacturing, processing & process control aspects	

Course Content

Module	Description
Module 1	Introduction to Project Planning : Concept of project planning, Phases involved in budget planning,
Module 2	Formulation of project for various textile process: Assumptions, Requirement of Miscellaneous Fixed Assets & Machinery Stores & Spares, Requirement & Calculations related to Electrical Power, Lighting, Water, Steam, Compressed Air and Captive power generation etc. Calculations of cost of project, Estimates of sales & production – cost of production – working Capital requirement – Profitability Projection – Break Even point – Projected cash flow statements.
Module 3	Financial Aspects in Project Formulation: Concept of taxation, types of tax, depreciation provision for building and machineries, types of depreciations, concept of DSCR ratio in project formulation.
Module 4	Site Selection Aspects: Selection of site for textile mill, Criteria for site selection: Transportation facilities, Laws and regulations in industrial estate, climatic requirements etc. selection of actual site locations: Electricity requirements, soil criteria for building construction etc.
Module 5	Plant Construction Management : Structural Design aspects of textile mill building: height, ventilation aspects etc. General principles of building construction & building functions, Types of factory buildings: Saw tooth and arched structure, Types of building construction. Supportive construction materials for designing of floors, false ceilings, ducts, fire resistance, sound proof, etc. concept of contracts and tenders etc.
Module 6	Machinery Selection and Calculation of Capacity Constraints: Selection of machines & machinery specifications required for the product in spinning, weaving, knitting etc. Calculation of spin and weave plan. Waste, crimp, ideal spindle/machine consideration in the calculation of spin and weave plan, selection criteria for humidification, boiler, compressor, transformer etc.

Module 7	<p>Plant Layout: Concept, objectives and principles of layouts, study of layouts and their comparisons, flow pattern, work station design, concept of line balancing, storage space requirements, plant layout procedure, factors influencing layouts, selection of layout, symptoms of bad layout. Utility and administrative consideration in plat layout</p>
Module 8	<p>Material Handling and Labor complements : Requirement of material handling systems, ergonomics aspects in designing of material handling systems, understanding the functions of various material handling systems, inventory management, calculation of no. of labor required for spinning, weaving and knitting mills, cost of labor, concept of fringe benefits to the staff and workers</p>

References:

1. Textile Project Management by A. Ormerod, The Textile Institute Publication.
2. Charles T Horngren, George Foster and Srikant M Datar, “Cost Accounting, A Managerial Approach”, 2003 Varma H K, “Costing in Textile Industry”, Prentice Hall Inc, 1992

Recommended Readings:

3. Goal Directed Project Management by E.S. Andersen, K.V. Grude & Tor Hang, Coopers & Cybranal Publication.
4. Project, Planning Analysis, Selection Implementation & Review by Prasanna Chandra, Tata McGraw Hill Publishing Co. Ltd.
5. Management of Textile Production, A. Ormorod. Newnes – Butter Wortrs Publication.

Programme Name	Bachelor of Technology in Textiles	Semester VIII
Course Code	R4TT3114T	
Course Title	Retail & Supply chain Management	
Course Objective	To provide insights into all functional areas of retailing, its perspective in the national and international scenario along with concept of supply chain management.	
Course outcome	<p>After attending this course, students will be able to:</p> <ol style="list-style-type: none"> 1. Demonstrate an understanding of key concept and issue pertaining to retail environment of firm and their retail marketing strategies including store consumption, location, image, target customer, pricing, human resources and distribution channel. 2. Develop alternative strategies for integrated retail marketing plans and explain suggestions for implementing such ideas. 3. Illustrate the concept of supply chain management. 4. Adopt different marketing channels for developing business. 5. Analyse the effect of environment and legislations on retailing 	
Prerequisite	Student should have Marketing Knowledge and Product Knowledge.	

Course content

	Description
Module 1	Introduction to Retailing: Concept, Functions of retailing, Terms & Definition, Retail formats and types, Retailing Channels, Growing Importance of Retailing, Factors Influencing Retailing, Retail Industry in India, Changing trends in retailing, Retail Models and Theory of Retail Development, Business Models in Retail,
Module 2	Understanding the Retail Consumer: Retail consumer behavior, Factors influencing the retail consumer, Customer decision making process and its Marketing Implications, Types of decision making, Market research for understanding retail consumer. Market Segmentation and its benefits, kinds of markets, Definition of Retail strategy, Strategy for effective market segmentation, Strategies for penetration of new markets, Growth strategies, Retail value chain.
Module 3	<p>Retail Operation and Retail Pricing: Store administration, Premises management, Inventory management, Store Management, Receipt Management, Customer Service, Retail Pricing, Factor influencing retail prices, Pricing strategies, Controlling costs.</p> <p>Retail Space Management and Marketing: Definition of Space Management, Store layout and Design, Visual Merchandising, Promotions Strategy, Relationship</p> <p>Marketing Strategies: CRM, Retail marketing Mix, Retail Communication Mix, Environment and Legislation for Retailing</p>
Module 4	Electronic Retailing- Role of IT in Business, Influencing Parameters for use of IT in Retailing, Efficiency in Operations Effective Management of Online catalogue, Direct Retailing Methods Database Management, Data warehousing, Critical Analysis of E-Retailing Strategies, Customer Relationship Management.

	Emerging trends in retailing: Changing nature of retailing, Organized retailing, Modern retail formats, Challenges faced by the retail sector.
Module 5	Supply Chain Management (SCM): Introduction, Concept, Objectives, Meaning of supply chain process, Push and Pull View of Supply Chain Process. Current scenario of SCM in Textile industry. Drivers and issues in value chain, Value Chain Management in Textile. Supply Chain networks, Apparel Sourcing: - Domestic, Foreign Sourcing. Resident Buying Office (RBO). Supply Chain Decisions, Location, Production, Inventory and Transportation. Strategies and planning in SCM, Difficulties in implementation of SCM.
Module 6	Marketing Channels: Definition and Importance, Different forms of channels, Unconventional channels ,Channels for Consumer goods, Industrial Goods & Services, Integrated Marketing Channels ,Horizontal, Vertical, Multichannel. Functions of Marketing Channels: Channel Management, Channel, Selection Process & criteria, Performance appraisal of Channel Members ,Channel Conflicts & Techniques to resolve channel conflicts. Retail planning: Human Resource Management in Retailing Recruitment, Selection and Training needs for Employees, Relationship Marketing in Retailing, Social Marketing in Retailing, Brand Management, Financial Performances and Financial Strategy, Accounting Methods, Calculation of Profitability of Retail Stores, Consumer's Rights.
Module 7	Current Trends in Supply chain Management: Green Supply Chain Management, Customer Relationship Management, Supplier Relationship Management, E-Business and the Supply Chain; E-Business in Practice Strategic Cost Management in Supply Chain: The financial impacts, Volume leveraging and cross docking, global logistics and material positioning, global supplier development, target pricing, cost management enablers, Measuring service levels in supply chains, Customer Satisfaction/Value/Profitability/Differential Advantage.
Module 8	International retailing- International Retail Environment, Study and Analysis of Retailing in Global Setting, Methods of International Retailing Multi-country competition and Global Competition, Retail Structure, Global Structure.

References:

1. Supply Chain Management by Sunil Chopra, Peter Meindl & D.V.Kalra
2. Inventory Management by L.C.Jhamb
3. Principles and Practices of Costing by Sunita Pokharna, Success Publications, Pune

4. Retailing Management by Michael Levy and Weitz Barton A, Publisher: John Wiley and Sons

Recommended Readings:

1. Sales and Distribution Management by Krishna K. Havaladar & Vasant MCavale
2. Purchasing and Supply Management by Dobler and Burt
3. Supply Chain Management Best Practices by David Blanchard
4. Channel Management & Retail Management by Meenal Dhotre
5. Essentials of Supply Chain Management by NJ Hugos, Publisher: John Wiley and Son

Programme Name	Bachelor of Technology in Textiles.	Semester	VIII
Course Code	R4TT3115T		
Course Title	Entrepreneurship in Textiles		
Course Objective	To facilitate an interactive learning experience that addresses the challenges and issues faced by entrepreneurs in starting and growing a venture.		
Course outcome	After attending this course, students will be able to: <ol style="list-style-type: none"> 1. Comprehend the requirements for startup company in both pre and post revenue stages. 2. Understand the concept of focusing on the team, funding, product development, business models, and internal processes. 3. Discuss the importance of values and ethics when engaged in entrepreneurial activities. 4. Assess the possibility of integrating the actual based on simulation. 5. Develop a strong knowledge base which will help implementation of creative and innovative ideas 		
Prerequisite	Insightful knowledge of Textile Industry and Engineering is essential and mandatory		

Course content

Modules	Description
Module 1	Creativity, innovation and its commercialization: Basic concept of creativity and innovation w.r.t entrepreneurship. Trends in Technology development. Entrepreneur: Characteristics and role of an entrepreneur in industrial development, the critical success factors for entrepreneurial companies, major disruptions driving innovation and entrepreneurship today Entrepreneurship: Entrepreneurship Management And Ownership, Contrast entrepreneurship with management, theories of entrepreneurship. Starting A New Business: Business Planning/ Strategic Planning And Strategic Management, Site Selection And Layout
Module 2	Establishing New Venture: Opportunities for Entrepreneurship, Meaning and Definition of SSI, Importance of SSI, Government policies for SSI. Basic criteria for final selection of a business opportunity, Amount of investment, Input requirement for setting up SSI, Institutional support to SSI at State & National level. Products Identification in various fields, Causes of industrial disputes , Machinery for settlement of disputes, Idea of risk management.
Module 3	The Business Plan Development: What is a Business Plan? The Need for a Business Plan, Define the structure of

	a business plan, Discuss the critical elements of an effective business plan, Preparing a Business Plan: a) Forecasting Developments and Charting an Action Plan b) Identifying the Product/Service c) Evaluating the Business Venture d) Market Research and Feasibility Study.
Module 4	Enterprise Management: Identify mechanisms and requirements for growth of a venture, Describe effective organizational structures, Discuss the operational challenges for entrepreneurships, Review alternative operations strategies for adapting an organization to changes in the marketplace, Procedures involved in the management of man, machine, material and methods of production and operation.
Module 5	Financing Business: Type of capital, importance of financial management in context to small scale industry, Sources of Debt Financing, Sources of Equity Financing, Financial Controls. Marketing Products: Creating the Marketing Plan, Pricing for Profit, Creative Advertising and Promotion. Forecasting Market Conditions, Assessing Alternative strategic plans.
Module 6	Promoting Entrepreneurship in Textiles: Scope in Textile Entrepreneurship, Problems in textile entrepreneurship, Govt. schemes in promoting textile entrepreneurs (SIDO, SENET, SISI) . Overview of Incentives and Subsidies given by governments. Financial Assistance for Small Enterprise: a)Bank Loan(RBI, IDBI, SIDBI) b) Venture Funding c) Self Employment Schemes of Government of Maharashtra d) Schemes available for Textile sector by GOI
Module 7	Indian Entrepreneurship and Case Studies: Overview and analysis of successful entrepreneurs in India. (Such as Aditya Birla, DirubaiAmbani, etc.).

References:

1. Vasant Desai, "Dynamics of Entrepreneurship Development".
2. Dr.P.C.Shejwalkar, "Entrepreneurship Development".

Recommended Readings:

1. David H. Holt, "Entrepreneurship"– New Venture Creations.
2. Hisrich Peters, "Entrepreneurship".
3. ShrinivasPandit, "Thought Leaders".
4. Brigitte Berger, "The culture of Entrepreneurship

Programme Name	Bachelor of Technology in Textiles	Semester VIII
Course Code	R4TT3116T	
Course Title	Industry 4.0 in Textiles	
Course Objectives	To apprise the students about the concept of industry 4.0 in the textile.	
Course outcome	After attending this course, students will be able to: <ol style="list-style-type: none"> 1. Discuss the industrial revolutions and its scope in textiles. 2. Explain the various tools of industry 4.0 in textile process. 3. Outline the various textile process in the context of industry 4.0 4. Analyze and solve the various textile problems using the tools of industry 4.0. 5. Assess the use of artificial intelligence in textile supply chain management 	
Prerequisite	Knowledge about basic mechanical, electronics and computer engineering.	

Course Content

Modules	Description
Module 1	Introduction to Industry 4.0 Overview of industrial revolution and its role in textile industry, Role of industry 4.0 in textile sectors, Comparison of conventional and today's textile organizations, concept of smart factory, Challenges and need of smart factories in textiles, Trends of Industrial Big Data and Predictive Analytics in textiles.
Module 2	Tools of Industry 4.0 for Textiles Internet of things and its application in textiles, Cyber security and its role in textiles: Data sharing and security. Smart manufacturing, Use of smart devices and products in textiles for monitoring the quality of materials and maintaining the standards. Smart logistics: Material transfer systems from spinning to the garment. Benefits of smart material handling systems. Human interaction with computers and its use in textile apparel, Principles for human computer interactions.
Module 3	System, Technologies for enabling Industry 4.0 Role of automation in textiles. Merits and demerits of automation in various stages of textiles. Working of various automations in textiles: Automatic fiber transportation system, auto doffing and transportation system, water and chemical recycling systems in wet processing area. Digital based fabric for fabric structure analysis, Digital system for weave pattern recognition, Computer based fabric defect analysis, Colour measurement etc.

Module 4	Data and Information sharing using Industry 4.0 Role of wireless data transfer systems in textiles for controlling the process. Data sharing systems: Transferring the CAD design to the machines, RFID based real time production tracing system, Data sharing for production planning and control and process optimization. Concept of MIS and its applications in textiles. Other applications and case studies in the field of textiles: Sketch based garment design, Surface flattening for virtual garments, Online garment shopping systems and 3D body scanning etc.
Module 5	Issues for Implementing Industry 4.0 in textiles Lack of Standardization of process in textiles, Variable inventory requirements. Skill staff and skill operators in textile organization, Maintaining the standard condition, Costing constraints for implementing the industry 4.0
Module 6	Role of Artificial Intelligence in Apparel supply Chain Management Discuss the use of neural networks, genetic algorithms, fuzzy set theory and extreme learning machines for intelligent sales forecasting and intelligent product cross-selling systems. Optimizing decision making in the apparel supply chain using artificial intelligence (AI): From production to retail provides detailed coverage of these techniques, outlining how they are used to assist decision makers in tackling key supply chain problems.

References:

1. Jinlian Hu, Computer technology for textiles and apparels, 2011, Woodhead publications, ISBN 978-1-84569-729-7.
2. Optimizing Decision Making in the Apparel Supply Chain Using Artificial Intelligence (AI), Calvin Wong Z. X. Guo S Y S Leung, 2013, Woodhead Publishing, ISBN: 9780857097798.

Recommended Readings:

1. Turquin, E., Cani, M. and Hughes, J.F., 2004. Sketching garments for virtual characters. Proc. Eurographics Workshop on Sketch-Based Interfaces and Modeling, Edited by T. Igarashi and J.A. Jorge (eds), Eurographics, pp. 175–182.
2. Watanabe A, Kurosaki S N, Konda F and Nishimura Y (1992a), ‘Analysis of blend irregularity in yarns using image-processing. I. Fundamental investigation of model yarns’, Text Res J, 62, 690–696.
3. Y. Zhang, Z. Lu and J. Li, ‘Fabric defect detection and classification using Gabor filters and Gaussian mixture model’, Proc. 9th Asian Conference on Computer Vision, Xian, China, 2009.