Program Name	**: Diploma in Textile Manufacturers**
Program Code	**: TX**
Semester	**: Fourth**
Course Title	**: Basic Knitting Technology**
Course Code	**: 22463**

1.   RATIONALE

Knitting technology is the important area of textile industry. Knitted fabrics due to its unique feature of stretachability and other favorable properties are in good demand and are being used for under garments, sports uniforms, summer and winter dresses, etc. to a large extent. This sector is now also diversifying from apparels to technical textiles. Moreover, since last few years young generation has been attracted to readymade fashioned knitted garments due to quality, cost and availability. Therefore, it is important for the textile engineering students to know all the relevant technical knowledge for manufacturing of knitted fabrics and the machines used for manufacturing. Knowledge of this subject will also help the students to start their small scale industrial unit for self employment.

2.   COMPETENCY

The aim of this course is to help the student to attain the following industry identified competency through various teaching learning experiences:
- **Manufacture knitted fabrics for different applications.**

3.   COURSE OUTCOMES (COs)

The theory, practical experiences and relevant soft skills associated with this course are to be taught and implemented, so that the student demonstrates the following *industry oriented* COs associated with the above mentioned competency:
  a. Identify the knitted fabric for different applications.
  b. Use circular and flat knitting machines to knit the fabric.
  c. Analyse the knitted fabric to find the fabric parameters.
  d. Use the warp knitting machine to knit the fabric.
  e. Calculate the production of machines on given parameters.

4.   TEACHING AND EXAMINATION SCHEME

Teaching Scheme			Credit (L+T+P)	Examination Scheme													
				Paper Hrs.	Theory						Practical						
L	T	P			ESE		PA		Total		ESE		PA		Total	
					Max	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max	Min
3	-	2	5	3	70	28	30*	00	100	40	25#	10	25	10	50	20

(*): Under the theory PA, Out of 30 marks, 10 marks are for micro-project to facilitate integration of COs and the remaining 20 marks is the average of 2 tests to be taken during the semester for the assessment of the cognitive domain UOs required for the attainment of the COs.

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment.

5.   COURSE MAP (with sample COs, PrOs, UOs, ADOs and topics)

This course map illustrates an overview of the flow and linkages of the topics at various levels of outcomes (details in subsequent sections) to be attained by the student by the end of the
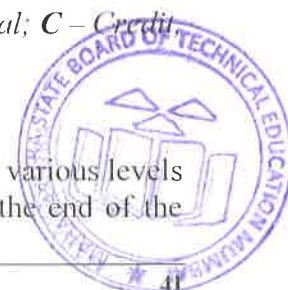
course, in all domains of learning in terms of the industry/employer identified competency depicted at the centre of this map.
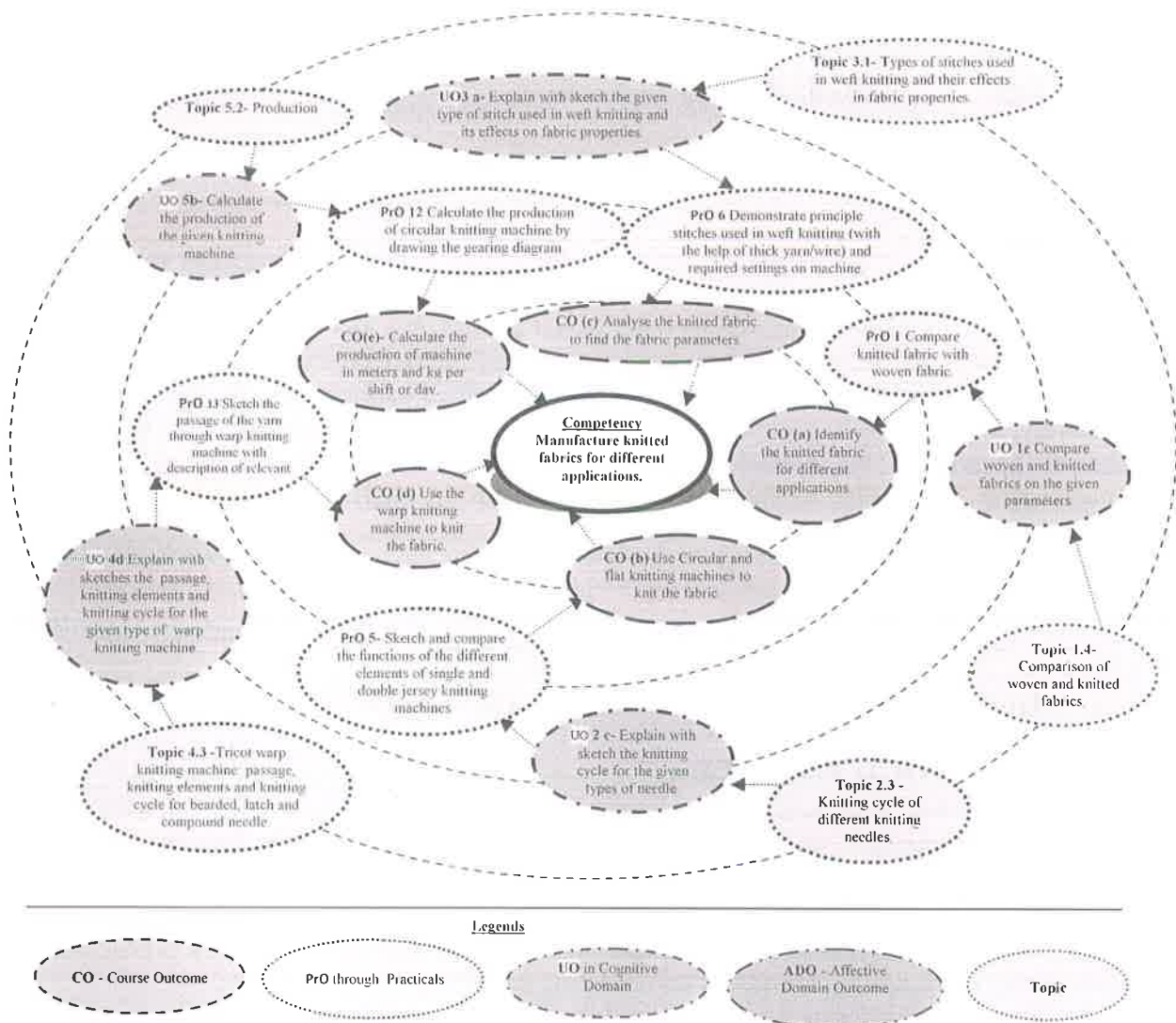

Figure 1 - Course Map

6.   SUGGESTED PRACTICALS/ EXERCISES

The practicals in this section are PrOs (i.e. sub-components of the COs) to be developed and assessed in the student for the attainment of the competency.

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
1.	Compare knitted fabric with woven fabric.	I	02*
2.	Compare weft knitting and warp knitting with respect to process and fabric.	I	02
3.	Sketch the passage of the yarn through single jersey circular knitting machine with description of relevant machine parts and processes after viewing the video clip.	II	02*
4.	Sketch the passage of the yarn through double jersey circular knitting machine with description of relevant machine parts and processes after viewing the video clip..	II	02*
5.	Sketch and compare the functions of the different elements of single and double jersey knitting machines after viewing the	II	02

S. No.	Practical Outcomes (PrOs)	Unit No.	Approx. Hrs. Required
	video clip.		
6.	Demonstrate principle stitches used in weft knitting (with the help of thick yarn/wire) and required settings on machine after viewing the video clip..	III	02*
7.	Analyze single jersey knitted fabric (part 1) – for courses and wales per inch, stitch length and count of yarn	V	02*
8.	Analyze single jersey knitted fabric (part 2) – for count of yarn, GSM, tightness factor and design	V	02
9.	Analyze double jersey(Rib) knitted fabric (part 1) – for courses and wales per inch, stitch length and count of yarn	V	02*
10.	Analyze double jersey (Rib)knitted fabric (part 2) – for count of yarn, GSM, tightness factor and design	V	02
11.	Analyze Interlock knitted fabric for courses and wales per inch, stitch length and count of yarn, GSM, tightness factor and design	V	02*
12.	Calculate the production of circular knitting machine by drawing the gearing diagram after viewing the video clip..	V	02*
13.	Sketch the passage of the yarn through warp knitting machine with description of relevant machine parts and processes after viewing the video clip.	IV	02*
14.	Sketch the passage of the yarn through flat knitting machine with description of relevant machine parts and processes after viewing the video clip.	II	02
15.	Knit the fabric using flat knitting machine with different yarns.	II	02
16.	Prepare the report after visit or watching the videos of modern knitting machine unit.	II	02
	Total		**32**

Note
i.   A suggestive list of PrOs is given in the above table. More such PrOs can be added to attain the COs and competency. A judicial mix of minimum 12 or more practical need to be performed, out of which, the practicals marked as '*' are compulsory, so that the student reaches the 'Precision Level' of Dave's 'Psychomotor Domain Taxonomy' as generally required by the industry.
ii. The 'Process' and 'Product' related skills associated with each PrO is to be assessed according to a suggested sample given below:

S. No.	Performance Indicators	Weightage in %
1	Selection of relevant knitted fabrics.	10
2	Use of relevant knitting technique/ Machines.	30
3	Analysis of knitted fabrics.	30
4	Calculations of machine production and fabric.	20
5	Identification of knitted fabric defects	10
	Total	**100**

The above PrOs also comprise of the following social skills/attitudes which are Affective Domain Outcomes (ADOs) that are best developed through the laboratory/field based experiences:
a.   Follow safety practices.

b. Practice good housekeeping.
c. Demonstrate working as a leader/a team member.
d. Maintain tools and equipment.
e. Follow ethical practices.

The ADOs are not specific to any one PrO, but are embedded in many PrOs. Hence, the acquisition of the ADOs takes place gradually in the student when s/he undertakes a series of practical experiences over a period of time. Moreover, the level of achievement of the ADOs according to Krathwohl's 'Affective Domain Taxonomy' should gradually increase as planned below:

- 'Valuing Level' in 1st year
- 'Organising Level' in 2nd year
- 'Characterising Level' in 3rd year.

7.   MAJOR EQUIPMENT/ INSTRUMENTS REQUIRED

The major equipment with broad specification mentioned here will usher in uniformity in conduct of experiments, as well as aid to procure equipment by authorities concerned.

S. No.	Equipment Name with Broad Specifications	PrO. No.
1	Magnification glass or Pick glass, needle, scissor	1,2,6 to 9
2	Single Jersey Circular knitting machine of 34 inch diameter	3,5,10,12
3	Double Jersey Knitting machine of 30 inch diameter	4,5,10,12
4	Manual Flat knitting machine	13
5	Warp knitting machine with single guide bar	10 to 12
6	Single jersey, rib and interlock fabric with 30 CPI and 24 WPI	6 to 9
7	Yarn count balance or weighing balance with range of 10 mg to 300 gms.	7 to 9
8	Fabric GSM cutter with 100 square cm area.	7 to 9
9	Related video clips of all	All

8.   UNDERPINNING THEORY COMPONENTS

The following topics are to be taught and assessed in order to develop the sample UOs given below for achieving the COs to attain the identified competency. More UOs could be added.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
Unit – I Basics in knitting technology	1a. Describe with sketches the given method of fabric forming systems. 1b. Explain the reasons for suitability of knitted fabrics for the given applications. 1c. Describe with sketches the process to compare woven and knitted fabrics on the given parameters. 1d. Describe with sketches the given basic terms of knitted fabric.	1.1 Methods of fabric forming systems. 1.2 Comparison of weaving and knitting with respect to process, structure and properties of fabric. 1.3 Applications of knitted fabrics with respect to properties of knitted fabric. 1.4 Reasons for growth of knitting industry 1.5 Definitions of basic terms used in knitting: Knitting, weft and warp knitting, courses, wales, face loop, back loop, needle loop, sinker loop, technical face, technical back, stitch density, stitch length, course length, open loop, close loop.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
		1.6 Classifications of knitting machines.
Unit– II Weft Knitting	2a. Explain with sketches the functioning of the given element of weft knitting machine with sketch. 2b. Describe with sketches the process to compare the given types of knitting needles with their merits and limits. 2c. Describe with sketches the knitting cycle for the given type of needle. 2d. Describe with sketches the passage of yarn for the given type of knitting machine. 2e. Explain the knitting process for the given type of knitting machine with sketches. 2f. Distinguish the knitting process for the given knitting machines based on principle of knitting.	2.1 Elements of knitting machine-creel, feeder, positive feeder, cylinder, dial, spreader and take down. 2.2 Types of knitting needles and its comparisons 2.3 Knitting cycle of different knitting needles. 2.4 Single jersey circular knitting machine: passage, knitting elements and knitting cycle. 2.5 Double jersey (Rib and Interlock) circular knitting machine: trick, cam, needle arrangement of cylinder and dial, knitting cycle. 2.6 Flat knitting machine: passage, knitting elements and knitting cycle.
Unit – III Weft knit structures	3a. Explain with sketch the given type of stitch used in weft knitting and its effects on fabric properties. 3b. Describe with sketch the principle stitches with given method of representation. 3c. Describe with sketch the relevant notation for the given knitted fabric. 3d. Explain the characteristics of given type of the weft knitted fabric.	3.1 Types of principle stitches used in weft knitting and their effects in fabric properties. 3.2 Methods of representation-verbal, line diagram, symbolic and diagrammatic. 3.3 Symbolic and diagrammatic notations of knitted fabrics: single jersey, Rib, Interlock and Purl. 3.4 Characteristics of Single Jersey, Rib, Interlock and Purl. 3.5 Ornamentations of Single knit fabric-using variation in yarn colour, count, twist and material.
Unit– IV Warp knitting	4a. Describe with sketches the process to compare the weft and warp knitting on given parameters. 4b. Describe with sketches the functions of given elements of warp knitting machine with sketches. 4c. Explain with sketches the passage, knitting elements and knitting cycle for the given type of warp knitting machine 4d. Describe with sketches the	4.1 Comparison of weft and warp knitting-structure, properties and process. 4.2 Basic Warp knitting terms- overlap, underlap, open & closed lap 4.3 Tricot warp knitting machine: Functions of knitting elements-Needle bar, Guide bar, shinker bar, pattern wheel, chain link, and knitting cycle for latch and compound needle. 4.4 Methods of representation-Lapping movement and chain notation.

Unit	Unit Outcomes (UOs) (in cognitive domain)	Topics and Sub-topics
	representations of the given warp knit structures.	4.5 Notations of warp knit structures: pillar, Atlas, Tricot, Locknit, sateen, reverse locknit. 4.6 Applications of warp knitted fabric
Unit– V Knitting Calculations	5a. Determine the stitch length of the given fabric. 5b. Calculate the production of the given knitting machine 5c. Calculate the fabric weight in grams per square meter and grams per linear meter of the given fabric 5d. Determine the tightness factor of the given fabric. 5e. Describe the given knitted fabric defect, its causes and its remedies	5.1 Stitch length. 5.2 Production. 5.3 Fabric weight calculations 5.4 Tightness factor. 5.5 Important knitted fabric defects and their remedies.

Note: *To attain the COs and competency, above listed UOs need to be undertaken to achieve the 'Application Level' and above of Bloom's 'Cognitive Domain Taxonomy'*

9.   SUGGESTED SPECIFICATION TABLE FOR QUESTION PAPER DESIGN

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics in knitting technology	06	3	5	2	10
II	Weft Knitting	14	3	8	4	15
III	Weft knit structures	10	4	8	4	16
IV	Warp knitting	12	4	8	3	15
V	Knitting Calculations	06	5	4	5	14
	Total	**48**	**19**	**33**	**18**	**70**

Legends: *R=Remember, U=Understand, A=Apply and above (Bloom's Revised taxonomy)*
Note: *This specification table provides general guidelines to assist student for their learning and to teachers to teach and assess with respect to attainment of UOs. The actual distribution of marks at different taxonomy levels (of R, U and A) in the question paper may vary from above table.*

10.   SUGGESTED STUDENT ACTIVITIES
Other than the classroom and laboratory learning, following are the suggested student-related *co-curricular* activities which can be undertaken to accelerate the attainment of the various outcomes in this course: Students should conduct following activities in group and prepare reports of about 5 pages for each activity, also collect/record physical evidences for their (student's) portfolio which will be useful for their placement interviews:
   a. Student should maintain a scrapbook containing knitted fabric swatches.
   b. Student should observe and try the hand knitting process.
   c. Students should watch videos related to knitting operation.
   d. Student should collect the machine parameters of different make from journals

11.   SUGGESTED SPECIAL INSTRUCTIONAL STRATEGIES

These are sample strategies, which the teacher can use to accelerate the attainment of the various outcomes in this course:

a. Massive open online courses (*MOOCs*) may be used to teach various topics/sub topics.

b. *'L' in item No. 4* does not mean only the traditional lecture method, but different types of teaching methods and media that are to be employed to develop the outcomes.

c. About *15-20% of the topics/sub-topics* which is relatively simpler or descriptive in nature is to be given to the students for *self-directed learning* and assess the development of the COs through classroom presentations (see implementation guideline for details).

d. With respect to item No.10, teachers need to ensure to create opportunities and provisions for *co-curricular activities*.

e. Guide student(s) in undertaking micro-projects.

f. Use of video animation films to explain concept, Facts and applications.

12.   SUGGESTED MICRO-PROJECTS

Only one micro-project is planned to be undertaken by a student that needs to be assigned to him/her in the beginning of the semester. In the first four semesters, the micro-project are group-based. However, in the fifth and sixth semesters, it should be preferably be *individually* undertaken to build up the skill and confidence in every student to become problem solver so that s/he contributes to the projects of the industry. In special situations where groups have to be formed for micro-projects, the number of students in the group should *not exceed three.*

The micro-project could be industry application based, internet-based, workshop-based, laboratory-based or field-based. Each micro-project should encompass two or more COs which are in fact, an integration of PrOs, UOs and ADOs. Each student will have to maintain dated work diary consisting of individual contribution in the project work and give a seminar presentation of it before submission. The total duration of the micro-project should not be less than *16 (sixteen) student engagement hours* during the course. The student ought to submit micro-project by the end of the semester to develop the industry oriented COs.

A suggestive list of micro-projects are given here. Similar micro-projects could be added by the concerned faculty:

a. Each batch will prepare the small model of basic knitting elements using colored wire and collect the knitted fabric swatches according to end use. Prepare a booklet and report by sticking the elements on card sheet and specification respectively.

b. Every batch will collect various types of needles, shinkers, and photographs of basic elements and prepare booklet by writing their technical specification.

c. Each batch will create the wire model of basic knitted structure, principle stitches and prepare album of created models.

d. Each batch will collect different videos of warp knitting machine and draw the knitting cycles of Tricot machine on card sheet.

e. Each batch will prepare the booklet showing picture and relevant information of modern developments in warp and weft knitting.

f. Each batch will prepare the fabrics on different knitting machines using different types of yarns of different material, count and twists.

13.   SUGGESTED LEARNING RESOURCES

S. No.	Title of Book	Author	Publication
1.	Knitting Technology	David J. Spencer	Woodhead Publication Ltd. ISBN : 9781855733336

2.	Knitting Fundamentals, Machines, Structures and developments	Anbumani, N	New Age International Pvt Ltd ISBN : 9788122419542
3.	Warp Knit Engineering	A. Reisfeld	National Knitted Outerwear Association, New York.
4	Warp Knitting Technology	D.F. Paling	Columbine Press Limited ISBN : 9780900298028
5	Circular Knitting Technology	Iyer Chandrshekhar	Meisenbach, 1992 ISBN : 9783875250558
6	Warp Knitting Production	Dr. S. Raz	Melliand Textilberichte, 1987 ISBN : 9783875290226
7	Knitting Technology	Prof.D.B. Ajgaonkar	Universal Publication Corp., Bombay ISBN : 9788185027340

14.   SUGGESTED SOFTWARE/ LEARNING WEBSITES
   a.   http://nptel.ac.in/courses/116102008/1
   b.   http://nptel.ac.in/courses/116102008/3
   c.   http://nptel.ac.in/courses/116102008/8
   d.   http://nptel.ac.in/courses/116102008/19
   e.   http://nptel.ac.in/courses/116102008/27
   f.   Introduction to knitting https://www.slideshare.net/mobile/karthikamdev/introduction-knitting
   g.   https://googleweblight.com/i?u=https://en.m.wikipedia.org/wiki/knitting&grqid=ciFF6PHP&hl=en-IN
   h.   https://www.scribd.com/mobile/document/115586174/Knitting-Technology-Introduction
   i.   https://googleweblight.com/i?u=http://engrshipon.blogspot.com/2012/04/introduction-to-knitting-technology.html?m%3D1&grqid=GCOdZL3C&hl=en=IN
   j.   http://engrshipon.blogspot.in/2012/04/introduction-to-knitting-technology.html?m=1