Session 2

Yarn
Yarn

- A yarn is a product of substantial length and relatively small cross-section of fibres and/or filaments with or without twists.

- According to the types of fibres present in the yarn, it is sub-divided into
  - Staple spun yarn
  &
  - Continuous filament yarn
Staple Spun Yarn

- A staple spun yarn is a yarn that consists of fibres of regular or irregular lengths, usually bound together by twists
Principle of Spinning

- Short lengths of fibres, such as cotton (average 1 inch in length), are assembled together to form a piece of yarn of indefinite length.
- Fibres are first appropriately lined up.
- The group of fibre is then held together by inserting twists.
Schematic Diagram of Spinning

1. opened loose fibre
2. parallelization
3. twist insertion
4. reduction to appropriate weight
How Twist Holds Fibres Together

- fibre assembly with twists (yarn)
- one of the fibres in the assembly
- when the fibre is pulled along the length
Twist Direction

S-twist  Z-twist
Continuous Filament Yarn

- A filament is a fibre of indefinite length and a continuous filament yarn is a yarn composed of one or more filaments that run the whole length of the yarn
Multi-filament Yarns

- without twists
- textured (crimped, bulked)
- twisted
Yarn Structures

- Single yarn
- Ply yarn
- Cable yarn
- Fancy yarn
- Cover yarn
- Core spun yarn
- Wrap yarn
**Single Yarn**

- Formed by twisting staple fibres together
- Twists is measured by turns per metre or turns per inch
- Less twist gives a softer yarn but less cohesion of fibre and hence fibre strength
- High twist yarn tends to untwist and causes distortion of fabric
- Generally, yarn properties of low twist yarn are preferred
Twist in Yarn

- The effect of twists on holding a fibre assembly is related to the angle of the fibre in the yarn with the yarn axis, the helix angle.
- Therefore heavier (thicker) yarn requires lower tpi (turns per inch) to have the same twist effect as a lighter yarn with higher tpi.
- Both yarn is then of the same twist factor.
Twist Factor and tpi

\[ \text{twist} = 0.75 \text{ tpi} \]
\[ \text{twist factor} = 3.2 \]
\[ \text{helix angle} = \theta \]

\[ \text{twist} = 3.5 \text{ tpi} \]
\[ \text{twist factor} = 3.2 \]
\[ \text{helix angle} = \theta \]
\[ \text{twist factor} = \frac{tpi}{\sqrt{\text{count}}} \]
Ply Yarn

- 2 ends of single yarn twisted together to form 1 end of **two fold yarn**
- Folding twist is usually in opposite direction to the single yarn (e.g. single yarn twists in Z and folding twist in S)
- 3-ply yarn is the twisting of 3 ends of single yarns to form 1 end of yarn
- Some sewing threads are 6-ply yarns
Cable Yarn

- Cable yarn is formed by twisting folded yarns together.
Fancy (novelty) Yarn

- Boucle yarn
- Flake, flock or seed yarn
- Nub, spot or knop yarn
- Slub yarn
- Spiral or corkscrew yarn
- Chenille yarns
Cover Yarn and Core Spun Yarn
Wrap Yarn

A. Yarn to be wrapped

B. Tube of wrapping yarn

C. Twist former
Linear Density of Yarn

- A measurement of the weight of yarn with respect to its weight
- It is important as an indicator of yarn thickness
- Yarn thickness is difficult to be measured accurately
Measurement of Linear Density

- **Direct system:**
  - the weight of the piece yarn of a standard length is measured
  - the heavier the yarn, the thicker it will be

- **Indirect system:**
  - for a standard weight the number of standard lengths of yarn is counted
  - the more standard lengths, the thinner will be the yarn
Direct System - Tex

- The standard length is 1,000 m
- The weight unit is gram
- Take a length of 1,000 m for measurement of weight
- If the weight is found to be 20 g then the yarn is said to be 20 tex
- A 30 tex yarn is heavier than a 20 tex yarn and the 30 tex yarn is expected to be thicker
Indirect System - Count

- The standard weight is 1 lb
- The standard length to be counted is 840 yards and is call a **HANK**
- Take some yarn so that it weighs exactly 1 lb
- Measure the length of this 1 lb of yarn to see how many (counting) **hanks** are there
- If there are 20 hanks (each 840 yards) then the yarn is a 20’s yarn
- Then another yarn found to have only 16 hank in 1 lb will be a 16’s yarn and is expected to be thicker than a 20’s yarn
- This is also known as the numbering system
Numbering Systems

- **Direct system**
  - Tex – number of gm for 1,000 m
  - Denier – number of gm for 9,000 m

- **Indirect system**
  - Cotton count – number of hanks of 840 yd per lb
  - Worsted count – number of hanks of 560 yd per lb
  - Metric count – number of hanks of 1,000 m per kg
Useful Conversions

- $1 \text{ kg} = 2.2 \text{ lb}$
- $1 \text{ inch} = 2.54 \text{ cm}$
Schematic Diagram of Spinning

1. opened loose fibre
2. parallelization
3. twist insertion
4. reduction to appropriate weight
Principles of Staple Yarn Spinning

- There are two main systems for yarn manufacture because the fibres lengths are significantly different
- Cotton system (short staples)
- Wool system (long staples)
Cotton System

- Bale breaking: to shake loose the fibres
- Carding: to clean and parallelize before condensing into a sliver
- Combing: to clean and removal of short fibres
- Drawing: to reduce weight and improve regularity
- Roving: to further reduce weight
- Spinning: to reduce to the exact weight and insert twists
- Winding and doubling: to put into suitable package, cones. Doubling forms two fold yarn.
Bale Breaking Forming Lap
Lap Forming for Carding

Metal fingers

Lap rolled up at the end of the machine

Institute of Textiles and Clothing
Carding Engine
Sliver, Condensed Fibre Web
Combing (for Better Quality Yarn)
Drawing
Drafting (Drawing)

- **Heavy (Thick)**: Back Roller
- **Light (Thin)**: Front Roller

- **Slow**
- **Fast**
Roving
Spinning

Each spindle is making one end of yarn

The drafting rollers

Institute of Textiles and Clothing
Ring Spinning

Ring spinner.
Open-end Rotor Spinning
Winding and Doubling

- The yarn made by the ring spinners is in small package of about 35 gm.
- Winding machine will joint the small packages into larger cones of yarn of about 2 kg.
- The large packages can be further fed to a ring twister to twist 2 ends of yarns together to form 2 fold yarn.
Quality of Cotton Yarn

- Cleanliness
- Evenness
- Carded yarn
- Fully combed yarn
- Semi combed yarn
Wool Spinning

- Worsted spinning for longer wool fibres from 2 inches to 12 inches
- Woollen spinning shorter wool fibre of no more than about 2 inches
- Due to the length of the fibre machines are required to be designed differently according to the fibre length and therefore two sets of machines are needed.
- They are two different industries
Wool Fibre Preparation

- After wool shearing the fibres have to be sorted according to quality and baled.
- Scouring is the process to remove the natural impurities and dirt from wool.
- The fibre will then be ready for either woollen spinning or worsted spinning according to the fibre length.
Worsted Spinning

- The loose wool fibres are first opened and converted into slivers for further parallelization.
- For long wool the process is mainly a combing action using pin and called gilling.
- For shorter wool of up to some 4 inches, worsted card will be used.
Principle of Gilling
Principle of Wool Card

Schematic diagram of a roller card for wool
Wool Sliver
Combing

- Combing removes all traces of impurities and short fibres
- 2 types of combing machine for wool
  - Noble comb – circular comb
  - French comb – linear comb
Nobel Comb

Wool Combing
French Comb
Roving

- After combing the sliver will be further drafted and blended by gilling
- The gilled sliver is further drafted to form rovings by a roving machine
- Rovings are a lot thinner than slivers and is slightly twisted for fibre control during future drafting into even finer material which is the yarn
Spinning

- Worsted yarn is mostly ring spun
- Rotor spinning is not suitable for long fibres
Woollen Spinning

- This system is for short fibres such as lambs wool, cashmere and fibre recovered from waste
- Hard waste refers to those from yarn or fabric
- Soft waste refers to those loose fibre from a spinning mill
Woollen System

- Carding – gives slubbings
- Spinning – gives yarn
Textured Yarn

- Continuous filament synthetic yarns are modified by texturing process
- for bulkiness
- for stretch properties
- The effect is usually achieved by inserting crimps in the yarn
Before texturing the filament yarn is smooth, straight, closely packed and parallel

After texturing the filament yarn is imparted with crimp, loop or coiled, curled, displaced
Common Texturing Methods

- Twisting
- Stuffer box crimping
- Air jet texturing
- knit-de-knit
Texturing by Twisting

TEXTURIZING BY TWISTING

Uptwisting to insert high twist

Heat setting

Detwisting to remove twist
Stuffer Box Crimping

STUFFER BOX CRIMPING

feed-rollers

stuffer box (heated)

resultant yarn
Air Jet Texturing

(a)

HIGH-PRESSURE AIR

AIR-VORTEX MOTION

NEEDLE

(b)

TEXTURED YARN 70 - 200 m/min.

FILAMENTS SEPARATE

TWISTED UNTEXTURED YARN

Air turbulence separates, loops and reassembles filaments into a textured form.

Note: (a) Shows air only; (b) Shows filaments only.
knit-de-knit

Constant Tension Yarn Feed.

Knitting m/c.

Upper Draw Rolls.

Heater.

Take-up Package.

Feed Rolls.

Bulking Attachment (Optional)

Yarn Unraveled From Fabric.

Fabric store Transferred From Previous m/c.
Assignment

- Write an account on any one of the following areas
- Worsted spinning process
- Cotton spinning process
- Woollen spinning process
Contents of Assignment

- Flow chart of the whole process
- Outline operation principle of each step
- Objective of each process step
Doing the Assignment

- Group effort of no more than 4 students
- Expected length: approx. 2,000 words
- Use pictures and diagrams