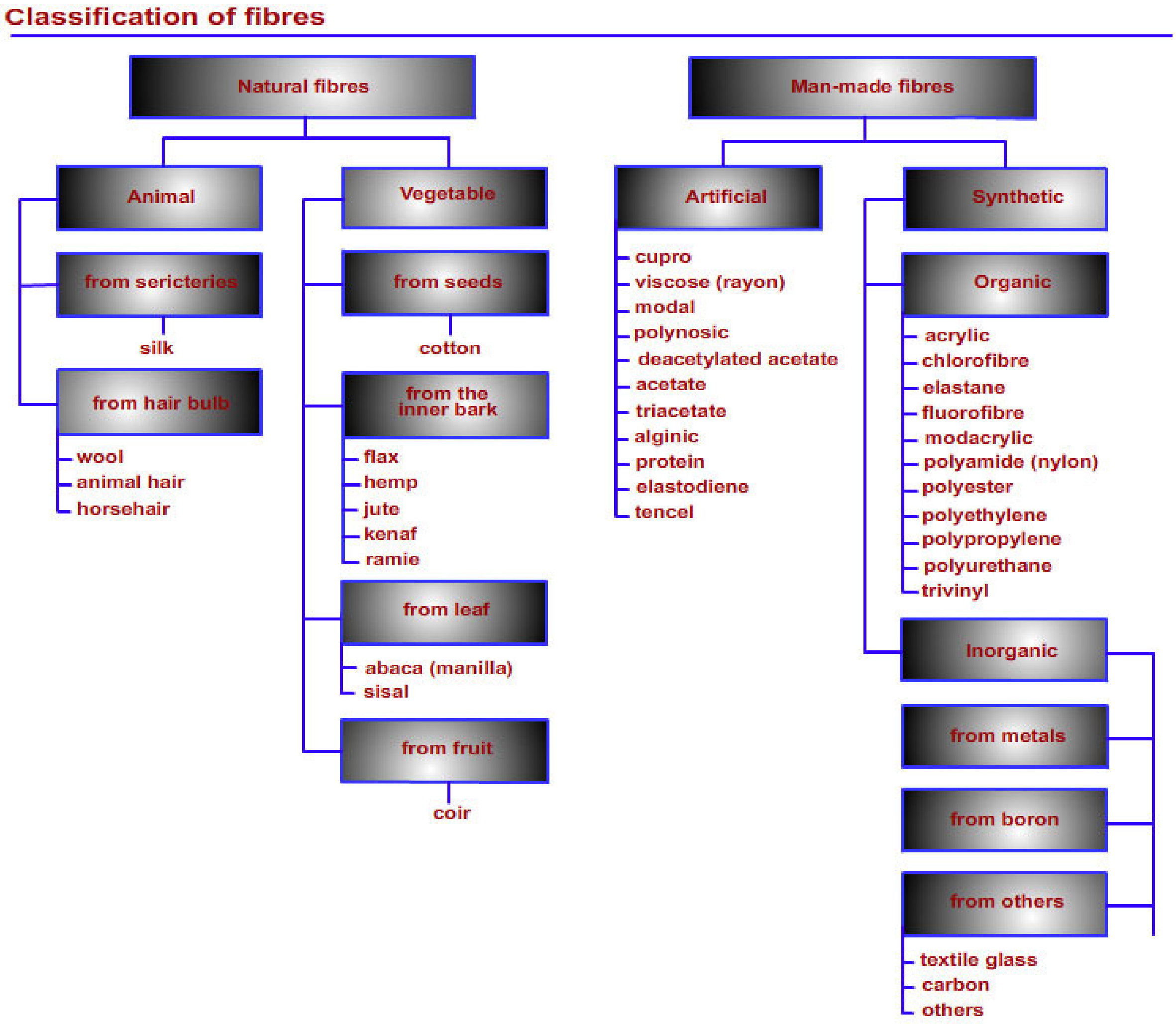
MID TERM MODEL QUESTION PAPER WITH ANSWER KEY

TEXTILE TECHNOLOGY (III SEM.)

SUBJECT- TEXTILE FIBRE

MID TERM –I

Q.1 Classify different type of textile fibre?



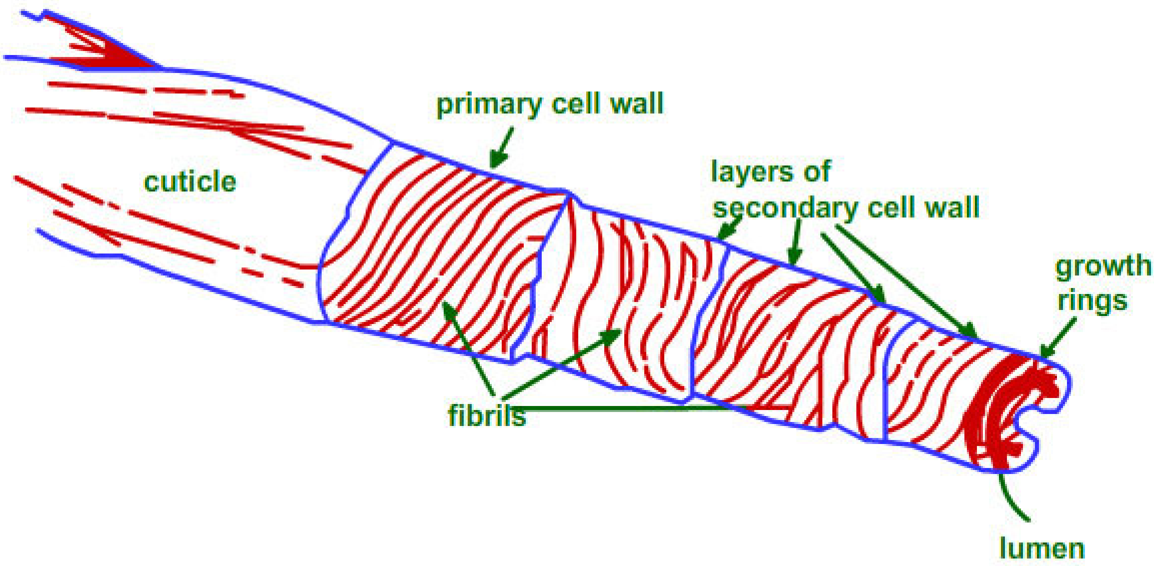
Q.2. Explain microstructure of cotton fibre.

The cotton fiber is a single plant cell. It has a distinct cuticle, well developed primary and secondary walls, and a lumen.

- The **"cuticle"** is the outer waxy layer, exists very outside of the cotton fiber. Cuticle consists of pectins and proteinaceous materials. It serves as a smooth, water-resistant coating, which protects the fiber from chemical and other degrading agents. The waxy nature of the cuticle enables it to adhere tenaciously to the primary wall of the fiber. This layer is removed from the fiber by scouring.
- The **"primary wall"** is the original thin cell wall, which is immediately present underneath the cuticle . It is 200nm thick. It mainly consists of cellulose or network

of small strands of cellulose, called fibrils. The fibrils spiral at about 70° to the fiber axis. This spiraling imparts strength to the primary cell, and hence, to the fiber. This makes for a well-organized system of continuous, very fine capillaries. The fine surface capillaries of each cotton fiber contribute greatly to cotton's wipe-dry performance.

- The **"secondary wall"** layers of cellulose consist of concentric layers present beneath the primary cell wall , which constitutes the main portion of the cotton fiber. After the fiber has attained its maximum diameter, new layers of cellulose fibrils are added to form the secondary wall. Its fibrils are about 10 nm thick, but of undefined length. Near the primary cell wall, the fibrils of the secondary wall spiral at about 20° to 30° to the fiber axis. The fibrils are packed close together, again, forming small capillaries. As the fibrils change the direction of their spirals, a weak area exists in the secondary wall structure which results in weak areas are responsible for alternation of the direction of the twists of the covolutions.
- The **"lumen"** is the hollow canal that runs the length of the fiber. It is filled with cell sap during the growth period. The lumen was once the central vacuole of the growing cotton fiber . After the fiber matures and the boll opens, the protoplast dries up, and the lumen naturally collapses, leaving a central void in each fiber. When the sap evaporates , its constituents remain behind to contribute to the color of the cotton fiber . As the sap evaporates, the pressure inside the fiber become less than the atmospheric pressure on the outside. This caused the fiber to collapse inward resulting in the bean or kidney-shaped cross-section of the cotton fiber.



MID TERM –II

Q.1. Write physical and chemical properties of nylon.

Physical properties

Now question arises why does nylon make such good fibers? The answer is due to their intermolecular forces. The most important intermolecular force in nylon is hydrogen bonding. The nitrogen-bonded hydrogen atoms of one nylon chain will form hydrogen bond very strongly with the carbonyl oxygen atoms of another nylon chain. These hydrogen bonds results in very strong nylon crystals because they hold the nylon chains together very tightly. These strong crystals make strong fibers. Before drawing nylon fibers consist of 20-30% crystalline regions when in solid form. Even though it is non-crystalline, the chains are still bound strongly to each other by hydrogen bonds. This combination of crystalline and strongly bound amorphous phases makes nylon thermoplastics so tough. When drawn into fibers, nylons become almost crystalline.

Tenacity

The good to very good tenacity of nylon is due to its very crystalline polymer system and the excellent potential to form hydrogen bonds between polymer chains. The loss of tenacity by nylon when wet is due to water molecules hydrolysing a significant number of hydrogen bonds present in the amorphous regions of the polymer system.

Elastic-plastic nature

The very good elastic property of nylon filaments or staple fibers is due to the very regular grid of strong hydrogen bonds in the nylon polymer system. These hydrogen bonds prevent polymer slippage and causing the polymers to return to their original position in the polymer system, after removal of strain. Nylon textile materials return readily to original configuration, shedding any wrinkles or creases up to certain limit. Excessive strain will cause hydrogen bond breakage, resulting polymer slippage. This causes distortion, wrinkling or creasing of the nylon textile material.

The zig-zag configuration is due to the strong hydrogen bonds. The straightening of the zig-zag configuration of the nylon when a load is applied results in about 22 per cent of the elasticity of nylon filaments or staple fibers. This elasticity of nylon polymer or grid of strong hydrogen bonds makes nylon toughest and durable textile fiber in common use.

Hygroscopic nature

Nylon filaments or staple fibers are not absorbent due to its crystalline nature even though there is a relatively strong attraction for water molecules by the polar amide groups. Crysralline system of nylon allows few water molecules to be absorbed. The nylon fiber registered under the trade mark Qiana is claimed to be more absorbent than all other nylon types. This is because nylon polymers contain polar hydroxyl groups, which attract more water molecules. But Qiana polymer is somewhat more amorphous and allows a few more water molecules to enter the polymer system.

Nylon textile materials develop static electricity, as they are unable to absorb sufficient water molecules to dissipate any build-up of it. Compounds containing hydroxyl groups are added to its spinning solutions. The addition of hydroxyl containing compounds will attract an increased number of water molecules. The polarity of the hydroxyl groups will minimize the build-up of static electricity and thus nylon is sold as ‘anti-static’ nylon.

Thermal properties

Nylon shows poor heat conductivity and low heat resistance. Heat causes the nylon polymers to become excited and this result in a breakdown of inter-polymer bonding. The handle is restored as soon as the nylon is cooled because most of the broken hydrogen bonds are reformed. The application of excessive heat causes the nylon polymers to become so excited that most of the nylon textile material melts. The application of more heat will result in burning. If heat is applied under controlled conditions, the nylon material can be heat set by breaking the inter polymer hydrogen bonds. During heat setting of nylon, the objective is to break those hydrogen bonds which are under strain to enable the material to assume the desired configuration.

Chemical properties

Effect of acids

Nylon is less resistant to acids compared to alkalis. This is due to the reason that amide groups in the nylon polymers are readily hydrolyzed under acidic conditions. Acid hydrolysis of nylon polymers result in loss of inter-polymer hydrogen bonding, and weakening of the nylon filament or staple fiber. This is the reason that exposure to perspiration or a polluted atmosphere, will cause some polymer hydrolysis on the surface of the filaments or staple fibers. This changes white nylon textile materials to yellow hue, whilst colored nylon may appear duller.

Effect of alkalis

Prolonged and frequent exposure to alkalis will cause significant alkali hydrolysis of nylon polymers. The effect of alkalis on the nylon polymer is the same as for acid hydrolysis that is weakening of the nylon textile material and yellowing of the white fiber or dulling of colored nylon textiles.

Nylon textiles materials do not require bleaching as it is inherently white. When bleaching is necessary, only bleaches used are oxidizing bleaches which are used under slightly alkaline conditions as these bleaches have the least detrimental effect upon the nylon polymer system. The oxygen from these bleaches reacts with the degraded surface polymers which cause the discoloration of the nylon to form water soluble products which are washed off the textile material by the bleach liquor.

Effect of sunlight and weather

Nylon has only a fair resistance to sunlight and weather. Ultraviolet rays of sunlight causes the imino groups of the amide groups to react with the oxygen in the air, and produces groups that are more reactive and more water soluble. The groups that are produced reacts further causes breaking of inter-polymer hydrogen bonds and polymer fragmentation resulting in the severe weakening of the nylon textile material. In acidic environment like polluted atmosphere these processes are accelerated.

Q.2. Write about microstructure of wool fibre.

The micro structure of wool fiber consists of three main components, the cuticle, cortex and medulla.

- **Cuticle :** The cuticle is the layer of overlapping epithelial cell's surrounding the wool fiber. There are three cuticle.
    - Epi Cuticle: The epicuticle is the outermost layer covers of the wool fiber.
    - Exocuticle : The overlapping epithelial cell forms the exocuticle.
    - Endocuticle: The endocuticle is the intermediate connecting layer bonding the epithelial cell of the cortex of the wool fiber.

- **The Cortex:** The cortex or core, of the fiber forms about 90% of the fiber volume. It consists of countless, long, spindle shaped cells or cortical cells. It is composed of two regions known as ortho and para cortex. The ortho cortex absorbing more dye than para cortex. The ortho and para cortex spiral around one another. Fine wool fibers have about 20 such cells, whereas coarse wool fibers have about 50 cortical cells across diameter of their cross-section.

- **Medulla:** Coarser fibers have a hollow space running lengthwise through the center. T medulla.