

## FOR JOB ROLES

Polymers are all around us- from simple house hold articles and clothing materials to automobile, aircraft, to medical products, making it impossible to live without polymers. The polymer industry in India employs nearly 12 lakh peoples and is growing at a rate of 15 - 16% CAGR. As the per-capita consumption of polymers in India is far below the global average, the industry will continue to show robust growth in the next 10 - 15 years. This will create millions of job opportunities in polymer industries at all levels.

"Polymer Technology course explore different polymeric materials, their properties, important application and processing to make final products.

VHSE course in Polymer Technology provide candidates with hands-on and theoretical knowledge that prepares them for technician-level jobs in the rubber/plastics and composite industries. This is a great opportunity to learn in-demand job skills.

<b>GOVT/ SEMI GOVT SECTOR</b>	<b>PRIVATE SECTOR</b>	<b>SELF EMPLOYMENT</b>
<ul style="list-style-type: none"> <li>• Lab assistant - VHSE</li> <li>• Trades man - Polytechnic</li> <li>• Technical assistant - Rubber Board</li> <li>• Technical assistant CFSC</li> <li>• Lab technician Plantation corporation</li> <li>• Production Assistant - Hindustan Latex ltd.</li> <li>• Lab Technician - Rubber</li> <li>• Lab Technician - Plastics</li> <li>• Lab Technician - composites in VSSC, SCTIMST, Defence Laboratories, CSIR - research laboratories</li> </ul>	<ul style="list-style-type: none"> <li>• Rubber processing technician</li> <li>• Chemical weigher</li> <li>• Junior technician</li> <li>• Lab technician</li> <li>• QC inspector</li> <li>• Rubber moulding technician</li> <li>• Rubber Extruder operator</li> <li>• Plastic processing technician</li> <li>• Injection moulding machine operator</li> <li>• Extruder operator</li> <li>• Blow moulding machine operator</li> <li>• FRP (Fibre reinforced plastics) processing technician</li> </ul>	<ul style="list-style-type: none"> <li>• Latex product manufacturing (Gloves, finger cap, rubber band, toys, catheter)</li> <li>• Rubber moulded goods manufacturing</li> <li>• Tyre retreading</li> <li>• Plastic processing unit.</li> <li>• Injection moulding unit</li> <li>• Extrusion unit</li> <li>• Blow moulding unit</li> <li>• Fibre glass processing (FRP doors, biogas plant, helmet etc)</li> </ul>

## ABOUT THE COURSE

Vocational Higher Secondary Education in Kerala is a unique scheme of education which combines both vocational and academic stream of education. Learning vocational skills along with conventional academic education gives the students double advantage of vertical mobility as well as employability. It helps to develop vocational aptitude, work culture, values and attitudes of the learner and enhances his productivity. The vision of Vocational Higher Secondary Education in Kerala is to equip the youth with multiple skills matching the technological advancements and to produce skilled work force for meeting the demands of the emerging industries and service sectors with national and global orientation.

As India is emerging as a manufacturing hub to the world the demand for skilled manpower is on the rise. Kerala, traditionally known for its high quality man power all over the world can embark on this opportunity and equip our students with skills for the manufacturing sector and reduce the unemployability problems of the state.

The polymer technology course in VHSE is one such course from the manufacturing sector. Polymers have wide spread applications in our daily life like simple household articles, automobiles, spacecrafts, medical products etc and is rapidly replacing many conventional materials like metals in many applications. Hence acquiring skills in the manufacturing of polymer products will help the students to get early employment opportunities.

The course is designed for providing knowledge and skills to participants in Rubber, Plastics, and Composite products manufacturing. This course is now offered in modular format consisting of four modules with focus on multi skills development. One month On The Job Training and Production cum training centres are also an integral part of the course which gives exposure to real time work environment.

Upon successful completion of this course the candidate will be able to join Rubber/plastic/composite industries as junior level technicians and are also eligible for attending advanced courses on Polymer Technology or any other courses that can be pursued after plus two science stream

A few institutes offering higher learning courses in polymer technology are listed below.

1. Three polytechnics in Kerala offers Diploma in Polymer technology
2. IRI( Indian Rubber Institute) offers Diploma and B.Tech level courses similar to AMIE schemes

3. Cochin university of science and technology offers B.Tech in polymer science and rubber technology
4. UCAS (University College of Applied Science) Pullarikunnu, M.G University Kottayam offers B.Tech in polymer technology.
5. University college of engineering M.G University ,Muttam, Thodupuzha is offering B.Tech in Polymer Technology
6. CIPET (Central Institute of Plastic Engineering and Technology) is offering diploma, B.Sc, B.Tech and M.Tech courses in Plastic technology through 28 centres across the country.
7. FRP Institute-Chennai offers specialized certificate courses in composites.
8. Research programs in polymer science are available in almost all science/ technology universities, and research institutions

Thus finally you have a wonderful opportunity to learn in demand skills with higher learning opportunities. Come... let's explore the wonderful world of polymers.

### **SUBJECT APPROACH**

Polymer technology can be described in brief as the manufacture, processing and applications of long chain molecules (polymers). Materials that are classified as polymers typically include Rubbers, Plastics, and Fibres etc. We are living in an era in which human life is impossible without the use of polymer products. With its high strength to weight ratio, ease of fabrication, long life, and relatively low cost, polymers are replacing many conventional materials rapidly. Since the per-capita consumption of polymers India is far below the global average, this sector offers great scope for expansion. This will create millions of Job opportunities in this sector in the coming years.

The polymer industry in India including rubber, plastics and composites are facing acute shortage of skilled man power. This is because only very few institutes in India offers skill development programs in this sector. Hence the VHSE course in polymer Technology offers very good employment opportunities for students in India and abroad.

The VHSE Polymer Technology course curriculum is divided into four modules. In the first module the learner will learn about different types of polymers, their properties, and processing methods to make useful products from polymers. At the end of the first module the learner will acquire basic skills in polymer processing and can work as assistant to different polymer processing machine operators.

The second module specifically deals with rubber technology. The learner will learn in detail about different types of rubbers, their

compounding, and processing. At the end of the module the learner will acquire skills in the operation of different rubber processing machineries and in the manufacture of different kinds of rubber products. He may be able to work as rubber processing technician in various rubber industries.

The third module deals with plastics and its processing. The learner will learn about the different types of plastics and its processing. At the end of the module the learner will acquire skill in the operation of different plastic processing machines and in the manufacture of different kinds of plastic products. He may be able to work as plastic processing technician/ machine operator in plastic industries.

The fourth module deals with fibre reinforced plastics (composites). Composite materials have emerged as an important material system for industrial and societal applications. India has a good industrial base for making various products using these materials. However, there is no corresponding effort to impart education for beginners on how to use these materials and manufacture them. FRP module in VHSE polymer technology curriculum gives the basic understanding of the technology, skill in the manufacturing methods and applications. The aim is to provide the necessary knowledge to take up employment in composites (FRP) industry. This module is intended to cover the technology of fibre reinforced plastics (FRP) product manufacture utilizing various manufacturing processes. It consists of lectures, practical work, video demonstrations and a visit to an industry

The learning environment in VHSE schools is conducive for the transaction of the necessary skills. Knowledge inputs are provided through participative lectures and other training methodologies like group discussion, role play, multimedia presentations, field visits and other activities to ensure effective learning. The methodology followed to impart the skill is by means of practical work, On the Job Training and through production cum training centres.

### **ICT Enabled Education**

Information Communication Technology has a vital role in the transaction of polymer technology. Videos on the manufacture of rubber and rubber products prepared by Rubber Board are available in schools. All India rubber industries association has also developed videos for training purposes. Many of the rubber and plastic machinery manufactures have published operational videos of their latest machineries. Power point presentations on various subjects are already available in the schools. The students can easily grasp the content through videos, slides etc. IT@ School has laptops and LCD projectors in the schools. ICT enabled education will improve the quality of teaching learning process. The manufacture of different products like

tyres, tubes, plastic pipes, moulded goods and Fibre reinforced products and working of different machineries can be easily transacted through videos.

## Objectives

Upon successful completion, the Learners will be able to

- Explain basic Concepts involved in polymer technology
- List the industrial use of rubber, plastics and composites
- Elaborate on techniques involved in manufacturing of polymer products
- Describe the working principles, features and components of machines used for rubber mixing and to make articles out of rubber compounds
- Demonstrate skill in the mixing and moulding of rubbers
- Describe the working principles features and components of machines used in plastic processing
- Demonstrate skill in the working of plastic processing machineries.
- Describe the different FRP processing techniques
- Demonstrate the skill in the manufacture of FRP products
- Demonstrate new age practices and methods adopted in industries
- Practice testing of Rubber/plastic compounds & products
- Follow standards & specifications of systems and products
- Follow safety guidelines

## SYLLABUS

### **Basic Polymer Processing (340 periods)**

#### **Unit 1 - Introduction to Polymers (15 periods)**

##### **Basic concepts of monomers and polymers**

Define - Monomers, Polymers, Functionality of monomers, repeating units, Polymerisation, Addition and condensation Polymerisation

##### **Classification and applications of polymers**

Classification of polymers - Natural, Synthetic, organic, inorganic, homo polymer, copolymer, linear and branched polymers, thermosets and thermoplastics, Rubbers, Plastics, Fibres etc,

##### **Molecular weight of polymers**

Molecular weight of polymers - Concept of Average Molecular weight, Degree of Polymerisation, Molecular Weight Distribution, Practical

significance of polymer molecular weight and molecular weight distribution

## **Unit 2 - Properties of Polymers (40 periods)**

### **Characteristics of polymers**

Characteristics of polymers such as Low Density, Low coefficient of friction, Good corrosion resistance, electrical insulation, surface finish, processibility, Economical, Poor tensile strength, Low mechanical properties, Poor temperature resistance, Attractive colours, Comparison with metals, wood etc

### **Structure and properties of polymers**

Structure and properties of polymers Effect of Chain length, Side groups, Branching and crosslinking on the physical properties of polymers

### **Thermal and mechanical behaviour of polymers**

Thermal behaviour of polymers Glass Transition Temperature T<sub>g</sub>, Factors affecting T<sub>g</sub>, Melting Point. Mechanical properties of polymers - stress, strain, modulus, toughness Creep and Stress relaxation

## **Unit 3 - Polymer Materials (120 periods)**

### **Thermoplastic Materials**

Production, Properties, grades, and applications of Thermoplastics such as PE, PP, PS, PVC, PMMA and PET

### **Thermoset plastics**

Production, Properties, grades, and applications of thermoset resins like Phenol Formaldehyde, Melamine formaldehyde, Urea formaldehyde resins

### **General purpose rubbers**

Production, Properties, grades, and applications of General purpose rubbers such as NR, SBR, Butadiene Rubber, EPDM and Reclaim rubber

### **Special purpose synthetic rubbers**

Production, properties, Compounding and application of, NBR, CR, IIR, CSM, CM, ACM, Fluoro carbon rubbers, Silicone Rubbers, and Poly urethane

### **Fibres**

Production, Properties, grades, processing and applications of different fibres such as cotton, glass fibre, nylon, rayon, carbon, aramid and carbon fibres

**Identification of polymers**

Identification of CR, NBR, Silicone Rubber, Nylon, PVC, PP and PVC through visual inspection, response to heat and flame, elemental analysis and chemical analysis

**Unit 4 - Polymer Additives (50 periods)****Additives for Plastics**

Additives for Plastics - Antioxidants, blowing agents, colourants, coupling agents, flame retardants, heat stabilisers, impact modifiers, lubricants, plasticizers, preservatives, UV stabilisers, etc.

**Additives for Rubbers**

Activators, Co activator, Antioxidants, Antiozonants-staining - non staining, fillers- reinforcing - non reinforcing, process aids, vulcanizing agents, accelerators- different types

**Unit 5 - Polymer Processing (85 periods)****Rubber Processing**

Mixing - Mixing Mills, Internal Mixers, Moulding - Compression moulding, Transfer moulding, Injection moulding, Extrusion, Calendaring, Autoclave curing

**Plastic Processing**

Mixing - Plastic compound mixing, preparation of pellets, Moulding - Injection moulding, Blow Moulding Compression Moulding, Rotational Moulding, Extrusion, and thermoforming.

**Unit 6 - Basic Engineering Drawing (30 periods)**

Drawing standards, Lettering and Numbering, Dimensioning, Projection of Points, Projection of Lines, Projection of Planes, Orthographic Projection of Objects, Sectional views, Isometric views

**Module 2****Rubber Processing (340 Periods)****Unit 1 - Natural Rubber (60 periods)****History and development of Natural Rubber**

History and development of Natural Rubber. Role of Columbus, Henry Wickhalm, Joseph Priestly, H.N. Ridley, Charles Goodyear, Thomas Hancock and JJ Murphy. World Production / Consumption statistics, Large Plantations in India, Geographical distribution, Climatic requirements and activities of Rubber board

**Harvesting and preservation of Natural rubber latex**

Tapping, Tappability, tapping systems, tapping utensils, knives, tapping task, tapping rest, yield stimulants and rain guarding. Puncture

tapping, slaughter tapping, Field crops. Composition of latex, spontaneous coagulation. Preservation of latex- ammonia as a preservative, merits and demerits of ammonia. LATZ system

### **Concentration of NR Latex**

Need for concentration of latex, DRC, Different concentration methods, Creaming process - creaming agents, theory, factors affecting the efficiency of creaming Centrifuging, - Process - Machines - skim latex and cenex, comparison of centrifuging and creaming

### **Preparation of Ribbed Smoked Sheets**

Various steps, dosage of chemicals and acids, Same day and next day sheeting, drying in smoke houses, Grading

### **Manufacture of crepe rubber and technically specified rubber**

Manufacture of pale latex crepe and estate brown crepe - processing and machineries Manufacture of TSR - Need for TSR, Comparison of TSR and sheet rubber. Different grades and technical specifications. Manufacturing process - equipment and testing.

## **Unit 2 - Rubber Compounding (40 periods)**

### **Rubber compounding**

Definition, Objectives of rubber compounding. Sulphur vulcanisation - Different systems. Non sulphur vulcanisation systems

### **Compounding Ingredients**

Vulcanising agents, accelerators - different classes - Amines, Guanidines, Thiazoles, Sulphenamides, Thiurams, Dithiocarbamates, and xanthates, Primary and secondary accelerators.

Activators, Co activators, Anti oxidants/ ozonants - SP, Hindered phenols, TMQ, PBN, 6PPD, IPPD

Fillers - Reinforcing fillers - Carbon blacks and silica Non reinforcing fillers - China clay, Calcium carbonate, Whiting, Aluminium silicate, barytes etc. Effect of particle size on reinforcement. Process aids - Process oils- aromatic, naphthenic, and paraffinic, Plasticizers -DOP, DBP, CPW, Factice Special purpose additives - Blowing agents, fire retardants, retarders etc.

### **Design of rubber compounds**

Design of rubber compounds with various hardness using NR and different dosages of different fillers Design of NR compound for - good mechanical properties, good heat resistance

Design of good abrasion resistant rubber, Oil resistant compound for oil seals, Weather resistant compound using EPDM, Chemical Resistant Compound using IIR, IIR Compound for Automobile tubes. Design of

fire resistant compound, Extrusion compounds using NR and EPDM, Design of FKM and Silicone compounds

### **Unit 3 - Manufacture of Latex Products (80 periods)**

#### **Latex compounding principles**

Preparation of solution, dispersion and emulsions, Ball mills and attritor mills, Factors affecting the efficiency of ball mill. Latex compounding, Wet weight and dry weight.

#### **Manufacture of latex dipped products**

Manufacture of dipped goods like Gloves - surgeons, examination, house hold and electricians gloves, Rubber band, Balloons and Finger caps

#### **Manufacture of other latex products**

Manufacture Latex thread, latex casting, Latex foam - Dunlop Process, Thalalay process, Latex cements and adhesives.

### **Unit 4 - Manufacture of Dry Rubber Products (80 periods)**

#### **Rubber moulded goods**

Manufacture of different kinds of rubber moulded goods such as Diaphragms, Grommets, O-rings, Oil seals, expanded rubber sheets, footwear soles and other automobile parts

#### **Manufacture of Conveyer belt and power transmission belts**

Manufacture of Conveyer belt - applications- Different structures and reinforcements. Manufacture methods, Vulcanisation - step cure and Rotocure. V belts - Applications- Advantages Different types - Components of V belt, Manufacturing method, Vulcanisation

#### **Manufacture of rubber hoses and cables**

Manufacture of Garden hoses, Automobile hoses - Radiator hoses - components - tube, reinforcements and cover, Manufacturing methods - curing - lead cutting, autoclave curing, braided hose. Cables - Manufacturing process - Cross head dual extrusion - Classification of cables, steam vulcanisation

#### **Manufacture of rubber to metal bonded products**

Rubber to metal bonding - Ebonite bonding, brass bonding, Adhesive bonding, Surface preparation

#### **Manufacture of Rubber covered Rolls, Rubber lining of chemical tanks**

Rubber to metal bonded automobile components - Shock absorber bushes, engine mountings etc

### **Common defects and remedies in the manufacture of Rubber Products**

Shrinkage, Undercure, Sponging and porosity, Over cure, Air trapping, poor knitting or flow cracks, back grinding, tearing on removal from cavity, bloom, Excess flash, Distortion, sticking in cavity, poor registration of mould marks

### **Unit 5 - Manufacture of Tyres And Tubes (50 periods)**

#### **Introduction to tyres**

Development of pneumatic tyres and its functions, Tyre components and its functions - Tread, Sidewall, Bead, bead apex, bead flipper, carcass plies, breaker plies, belt plies, chafer strips, inner liner etc Tyre constructions, Tread patterns, and Tyre Markings - Bias tyre, Radial tyre, bias belted tyres Lug Design, Semi lug design, and Rib designs Markings on a tyre and its interpretations

#### **Tyre Building, curing and post cure operations**

Preparation of different tyre components and their assembling in tyre building machine to complete the green tyre. Tyre curing and post cure operations

#### **Manufacture of cycle tyres and solid tyres**

Manufacture of cycle tyres - monoband building, Manufacture of solid tyres

#### **Manufacture of Automobile Tubes & flaps**

Manufacture of Automobile Tubes & flaps Suitable formulations for automobile tubes and flaps, Compound preparation, extrusion, cutting to lengths, valve holing, valve fixing, splicing, and molding

#### **Tyre Retreading**

Definition, need for retreading, advantages of retreading, Different methods of retreading - Conventional or hot process, - cold or pre cured process, Retreading process - inspection, buffing, cleaning, solvent application, cushion gum application tread application, vulcanisation and inspection

### **Unit 6 - Testing and Quality Control in Rubber Industry (30 periods)**

#### **Testing and latex and technically specified rubber**

Latex testing - DRC, TSC, NH<sub>3</sub> Content, Coagulum content, Sludge content, VFA, MST, Dry Rubber Testing - Dirt content, P<sub>0</sub> -PRI, Ash content, Volatile matter, Mooney viscosity

#### **Rubber compound testing**

Density - Zinc chloride method, Mooney viscosity, Cure characteristics using rheometer.

**Tests on vulcanised Rubber**

Test on rubber vulcanisates Hardness, Tensile strength, Modulus, elongation at break, tear resistance, abrasion resistance, Compression set, Flex resistance - crack initiation and crack growth resistance, Rebound resilience,

**Quality Management systems**

Basic concepts of Quality management systems like Standard operating Procedures, Good manufacturing practices, 5S, Kaizen, ISO9000, QS9000, TS16949, TPM, TQM and ISO 14000

**LEARNING OUTCOMES**

At the end of class XI the learner will be able to

**MODULE 1. BASIC POLYMER PROCESSING**

Learners will be able to

**1.1. Basic Polymer Science**

- 1.1.1 Explain monomers, polymers, Polymerisation, functionality of monomers, addition and condensation polymers
- 1.1.2 Identify polymers based on their origin, monomers, molecular structure, type of Polymerisation, response to heat and application.
- 1.1.3 Realise the concept of average molecular weight, degree of polymerisation and molecular weight distribution of polymers

**1.2. Properties of Polymers**

- 1.2.1 Explain the characteristics of polymers such as density, strength, processibility, service life etc.
- 1.2.2 Compare polymers with other materials such as wood, metal etc
- 1.2.3 Explain the effect of Chain length, Side groups, Branching and cross linking on the physical properties of polymers
- 1.2.4 Realise the thermal behaviour of polymers such as T<sub>g</sub>, T<sub>m</sub>, and factors affecting them
- 1.2.5 Realise the mechanical properties and long term behaviour of polymers

**1.3. Polymer Materials**

- 1.3.1 Explain the production properties and applications of Thermoplastics such as PE, PP, PS, PVC, PMMA and PET
- 1.3.2 Choose suitable thermoplastics for specified applications

- 1.3.3 Explain the production properties and applications of thermoset resins like PF, MF,UF resins
- 1.3.4 Select suitable thermoset plastics for specified applications
- 1.3.5 Explain the production, properties and applications of General purpose rubbers such as NR, SBR, Butadiene Rubber, EPDM and reclaim rubber
- 1.3.6 Explain the Production, properties, Compounding and application of, special purpose synthetic rubbers like NBR, CR, IIR, CSM, CM, ACM. Flouro carbon rubbers, Silicone Rubbers, and Poly urethane
- 1.3.7 Select suitable rubbers for specified applications

#### **1.4 Polymer Additives**

- 1.4.1 Choose suitable additives for plastics for different applications
- 1.4.2 Realise the basic concepts in rubber processing such as mastication, vulcanisation, scorching, master batching, and blending.
- 1.4.3 Realise the function of different ingredients used in rubber compounding.
- 1.4.4 Prepare sample rubber formulations.
- 1.4.5 Do mastication and blending of rubbers

#### **1.5 Polymer Processing**

- 1.5.1 Describe the working of rubber mixing mills, intermix, banbury and kneaders
- 1.5.2 Demonstrate the mixing of rubber compounds in a mixing mill
- 1.5.3 Explain different rubber molding techniques like compression molding, transfer molding, and injection moulding
- 1.5.4 Demonstrate the compression molding of a rubber product
- 1.5.5 Describe the rubber processing methods such as Extrusion, calendaring, and autoclave vulcanisation
- 1.5.6 Describe the working principle, features and components of machines used in plastic injection molding, blow molding, compression molding, rotational molding, extrusion and thermoforming
- 1.5.7 Demonstrate plastic injection molding, and compression molding in hand/semi automatic injection molding and compression molding machineries

## **1.6 Basic Engineering Drawing**

- 1.6.1 Use various Drawing Standards in appropriate situations
- 1.6.2 Use proper lettering and Numbering while preparing drawing sheets
- 1.6.3 Use proper Dimensioning method
- 1.6.4 Use proper angle of Projection to project points
- 1.6.5 Use proper angle of Projection to project lines
- 1.6.6 Use proper angle of Projection to project planes
- 1.6.7 Drawing of objects using Orthographic Projection methods
- 1.6.8 Drawing Sectional View of an object
- 1.6.9 Drawing Isometric views of an object

## **MODULE 2. Rubber Compounding**

### **2.1. Natural Rubber**

- 2.1.1 Describe the history and development of Natural Rubber
- 2.1.2 Identify the important sources of natural rubber
- 2.1.3 Relate the climatic requirements and geographical distribution of rubber in India.
- 2.1.4 Evaluate the impact of Natural rubber on Kerala's Economy
- 2.1.5 Describe different tapping methods, Tappability, tapping rest, tapping knives, tapping systems, directions etc
- 2.1.6 Discuss the profile of a rubber tapper in Kerala's society
- 2.1.7 Identify the different forms of rubber crop from the field
- 2.1.8 Explain the composition and spontaneous coagulation of latex.
- 2.1.9 Realise the need for preservation of latex
- 2.1.10 Perform the preservation of natural rubber latex using ammonia and LATZ systems.
- 2.1.11 Describe the different latex concentration techniques and the need for concentration of latex
- 2.1.12 Prepare concentrated latex by creaming
- 2.1.13 Compare creaming and centrifuging methods
- 2.1.14 Describe the preparation of Ribbed Smoked Sheets and its grading
- 2.1.15 Prepare Ribbed Smoked Sheets
- 2.1.16 Describe the manufacture of different grades of Crepe Rubber

2.1.17 Describe the manufacture and testing of different grades of Technically Specified rubber

2.1.18 Compare Sheet rubber and Technically specified rubber

## **2.2. Rubber Compounding**

2.2.1 Explain the principles of rubber compounding and its importance in rubber manufacturing.

2.2.2 Describe different vulcanisation systems and its specific applications

2.2.3 Differentiate between various Vulcanising agents and explain their specific function and importance

2.2.4 Identify different compounding ingredients and list their functions.

2.2.5 Design the compound for specific applications.

2.2.6 Demonstrate rubber compounding.

## **2.3. Manufacture Of Latex Products**

2.3.1 Explain the basic concepts of latex compounding.

2.3.2 Prepare dispersions, emulsions and solutions for latex compounding

2.3.3 Demonstrate the working of a ball mill

2.3.4 Design and Prepare simple latex compounds.

2.3.5 Produce latex products such as gloves, balloons, finger caps, and rubber bands using dipping process

2.3.6 Produce latex toys by casting

2.3.7 Explain the production of latex threads by extrusion

2.3.8 Describe the production of latex foam

2.3.9 Explain the production of latex cements and adhesives

## **2.4. Manufactures of Dry Rubber Products**

2.4.1 Describe the manufacture of rubber moulded goods such as O-rings, Oil seals, expanded rubber sheets, etc

2.4.2 Produce rubber moulded goods

2.4.3 Describe the manufacture of rubber conveyor belts and V belts

2.4.4 Describe the manufacture of rubber hoses and cables

2.4.5 Describe the rubber to metal bonding processes

2.4.6 Explain the manufacture of rubber covered rolls and rubber lining of chemical tanks

2.4.7 Describe the common defects and remedies in the manufacture of rubber products

## **2.5. Manufacture of Tyres And Tubes**

- 2.5.1 Describe the pneumatic tyre and its functions
- 2.5.2 Describe the components of a tyre and its functions
- 2.5.3 Compare different tyre constructions
- 2.5.4 Distinguish different tread designs
- 2.5.5 Identify the markings on a tyre
- 2.5.6 Describe the preparation of different tyre components
- 2.5.7 Describe the tyre building operation
- 2.5.8 Describe the tyre curing and post cure operations
- 2.5.9 Describe the manufacture solid tyres and cycle tyres
- 2.5.10 Describe the different steps in the manufacture of automobile tubes and flaps
- 2.5.11 Describe different steps involved in the tyre retreading process
- 2.5.12 Perform the retreading of tyres

## **2.6. Testing and Quality Control in Rubber Industry**

- 2.6.1 Perform various tests rubber latex such as - DRC, TSC, NH<sub>3</sub> Content, Coagulum content, Sludge content, VFA, and MST
- 2.6.2 Perform various tests related to raw rubber such as Dirt content, P<sub>0</sub> -PRI, Ash content, Volatile matter, Mooney viscosity
- 2.6.3 Perform various tests on rubber compounds - Density - Zinc chloride method, Mooney viscosity, Cure characteristics using rheometer.
- 2.6.4 Perform Hardness, Tensile properties, tear resistance, abrasion resistance, Compression set, Flex resistance, Rebound resilience, tests on rubber vulcanisates and products
- 2.6.5 Acquaint with the features of good quality management systems like 5S, Kaizen, ISO9000, QS9000, TS16949, TPM, TQM and ISO 14000

**SCHEME OF WORK**

<b>Unit</b>	<b>Month</b>	<b>Unit Name</b>	<b>Period</b>
1.1	June	Basic Polymer Science	15
1.2	June	Properties of Polymers	40
1.3	June	Polymer Materials	13
1.3	July	Polymer Materials	68
1.3	August	Polymer Materials	39
1.4	August	Polymer Additives	29
1.4	September	Polymer Additives	21
1.5	September	Polymer Processing	47
1.5	October	Polymer Processing	38
1.6	October	Basic Engineering Drawing	30
2.1	November	Natural Rubber	60
2.2	November	Rubber Compounding	8
2.2	December	Rubber Compounding	32
2.3	December	Manufacture Of Latex Products	36
2.3	January	Manufacture Of Latex Products	44
2.4	January	Manufacture Of Dry Rubber Products	24
2.4	February	Manufacture Of Dry Rubber Products	56
2.5	February	Manufacture Of Tyres And Tubes	12
2.5	March	Manufacture Of Tyres And Tubes	38
2.6	March	Testing and quality control in Rubber Industry	30

**COURSE STRUCTURE**

This course consists of Four Modules

Module I	Basic Polymer Processing	340
Module II	Rubber Processing	340
Module III	Plastic Processing	340
Module IV	Fiber Reinforced Plastic Processing	340

**CLASSROOM ACTIVITIES**

- Product presentation through PowerPoint
- Exhibitions
- Charts

- Video Presentations
- Diagrams
- Animated CDs
- Group Discussions
- Debate
- Seminar
- Prepare questionnaire
- Assignment
- Interview
- Project
- Demonstration
- Quiz
- Survey

## PRACTICAL ACTIVITIES

### Module - 1

#### **Unit-1.1 Basic polymer science**

1. Identify polymer samples,
2. Collection of polymer samples

#### **Unit -1. 2 Properties of polymers**

1. Estimation of density of polymers
2. Estimation of melting point of polymers
3. Aging studies on Polymer samples with and without antidegradants

#### **Unit - 1.3 Polymer Materials**

1. Preparation of PMMA
2. Preparation of Poly styrene
3. Comparative study of NR&SBR
4. Preparation of polymeric resins PFresin,UF,MFresins
5. Identification of polymer samples such as Natural Rubber, SBR, Polybutadiene Rubber, NBR, and CR and plastics such as PE, PP, PVC, PS, and NYON through Visual inspection, response to heat, flame and elemental and chemical analysis

#### **Unit -1. 4 Polymer additives**

1. Plastic compounding -preparation of pellets
2. Mastication of NR-work practice
3. Blending of NR&SBR

**Unit -1. 5 Polymer Processing**

1. Preparation of rubber compound
2. Compression molding of rubber products such as paper weight, bush etc
3. Work practice on
  1. Hand injection molding machine
  2. Semi automatic blow molding machine
  3. Plastic extrusion
  4. Thermoforming
4. Field Visit

**Unit -1. 6 Basic Engineering drawing**

1. Drawing standards
2. Lettering numbering and dimensioning
3. Projection of points
4. Projection of lines
5. Orthographic projection of objects
6. Sectional views
7. Isometric view

**Module - 2****Unit - 2.1 Natural rubber**

1. Identification of tapping utensils
2. Field trip to plantation & crop processing units
3. Effect of surroundings & various chemicals on the stability of latex.
4. Preservation of latex
5. Estimation of ammonia content of latex
6. Latex creaming
7. Estimation of DRC
8. Estimation of TSC
9. Preparation of RSS

**Unit -2. 2 Rubber Compounding**

1. Preparation of rubber compounds for
  1. Abrasion resistance
  2. Oil resistance
  3. Weather resistance
  4. Fire resistance
2. Preparation of NR, SBR, NBR, and EPDM compounds

**Unit -2. 3 Manufacture of latex products**

1. Preparation of dispersions
2. Preparation of emulsion
3. Preparation of solutions
4. Preparation of latex compound
5. Manufacture of latex dipped products - gloves, finger cap, balloon and rubber band
6. Preparation of latex toys
7. Preparation of latex foam

**Unit -2. 4 - Manufacture of dry rubber products**

1. Production of compression moulded rubber products like oil seals, paper weight, rubber bush, mat etc
2. Production of rubber to metal bonded products
3. Simulated experiment- defects in rubber molding& trouble shooting

**Unit - 2.5 - Manufacture of Tyres and Tubes**

1. Identification of tyres in various vehicles
2. Retreading of tyres
3. Field visit

**Unit -2.6 Testing and quality control in rubber industry**

1. Estimation of coagulum content
2. Estimation of sludge content
3. Estimation of VFA
4. Estimation of MST
5. Estimation of Dirt content
6. Estimation of P0 &PRI
7. Estimation of ash content
8. Estimation of volatile matter
9. Estimation of money viscosity
10. Estimation of cure characteristics
11. Estimation of hardness
12. Estimation of tensile properties
13. Estimation of teat resistance
14. Estimation of abrasion resistance
15. Estimation of compression set
16. Determination of flex resistance

17. Determination of rebound resilience

18. OJT

### ON THE JOB TRAINING

On the job training which is an integral part of vocational education that takes place in real job situations under the supervision of an expert in plant supervisor aiming at the development of proficiency and self confidence

The OJT program is of 4 weeks duration. It can be done in two spells of 2 week each during the second module, and fourth module.

For the OJT of Polymer technology course Rubber, Plastics, and Fibre reinforced plastic industries can be chosen.

A list of industries is given below

#### **Rubber**

1. Rubber Research Institute of India Puthuppally
2. MIDAS Retreads
3. Paragon
4. MRF
5. Rubco
6. CFSC Changanacherry
7. Vajra Rubber
8. Rubber park, Irapuram

#### **Plastics**

9. Centre for Bio polymer science and Technology, Kochi
10. Family plastics
11. Kavery plastics
12. Plastoplast
13. Nedyara extrusions
14. Shakthiman super
15. Hycount
16. Megha water tanks etc.
17. Fibre reinforced plastics
18. Matha marines
19. Wonderla
20. Festel tanks

## CERTIFICATION

Skill certificates will be issued to students after the completion of each module

1. Certificate in Basic Polymer Processing.
2. Certificate in Rubber Processing
3. Certificate in Plastics Processing
4. Certificate in FRP (Fibre reinforced plastics) Processing

## OVERVIEW OF MODULE - 1

### Basic Polymer Processing

This module is designed to equip the learner with knowledge and skills required start working in a polymer processing industry. The module consists of basic polymer science, properties of polymers, different types of polymeric materials, additives for plastics and rubbers and processing techniques for rubber and plastics.

After completing the module he /she will be able identify various plastics/rubbers and other additives used in the polymer industry, will have the knowledge of various processing techniques used in the polymer industry and will be able to work on hand operated rubber and plastic processing machineries. He/she will be able to work as chemical weigher, trainee operator, assistant to rubber mixing mill operator, assistant to injection molding operator etc

### Module: 01 Basic Polymer Processing

Unit No	Name of unit	Total Periods
1.1	Introductions to Polymers	15
1.2	Properties of polymers	40
1.3	Polymer Materials	120
1.4	Polymer Additives	50
1.5	Polymer Processing	85
1.6	Basic Engineering Drawing	30
	<b>TOTAL PERIODS</b>	<b>340</b>

## Unit : BASIC POLYMER SCIENCE (15 periods)

## Module 1 : BASIC POLYMER PROCESSING

Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<ul style="list-style-type: none"> <li>Introduction to polymers - Define - Monomers, Polymers, Functionality of monomers, repeating units, Polymerisation, Addition and condensation Polymerisation Skills</li> <li>Observing, Communicating, Classification of polymers - Natural, Synthetic, organic, inorganic, homo polymer, copolymer, linear and branched polymers, thermosets and thermoplastics, Rubbers, Plastics, Fibres and Resins etc, Skills</li> <li>Observing, Communicating, Classifying</li> </ul>	<p>The learner will be able to</p> <ul style="list-style-type: none"> <li>Explain monomers, polymers, polymerisation, functionality of monomers, addition and condensation polymers</li> </ul> <p>The learner will be able to</p> <ul style="list-style-type: none"> <li>Identify polymers based on their origin, monomers, molecular structure, type of Polymerisation, response to heat and application.</li> </ul>	<ul style="list-style-type: none"> <li>General discussion with molecular models and Polymer Product samples Chart</li> <li>General discussion with polymer samples Charting</li> </ul>	<ul style="list-style-type: none"> <li>Participation in discussion Chart</li> <li>Participation in discussion Chart</li> </ul>
<ul style="list-style-type: none"> <li>Molecular weight of polymers - Concept of Average Molecular weight, Degree of Polymerisation, Molecular Weight Distribution, Practical significance of polymer molecular weight and molecular weight distribution Skills</li> <li>Observing, Communicating, Inferring</li> </ul>	<p>The learner will be able to</p> <ul style="list-style-type: none"> <li>Realise the concept of average molecular weight, degree of polymerisation and molecular weight distribution of polymers</li> </ul>	<ul style="list-style-type: none"> <li>Interactive lecture with PPT, Numerical problems</li> </ul>	<ul style="list-style-type: none"> <li>Participation in discussion Solving numerical problems</li> </ul>

**Module 1 : BASIC POLYMER PROCESSING** **Unit : PROPERTIES OF POLYMERS (40 periods)**

<b>Ideas/Concepts/Skill</b>	<b>Learning Outcomes</b>	<b>Suggested Activities</b>	<b>Assessment</b>
<ul style="list-style-type: none"> <li>• Characteristics of polymers such as Low Density, Low coefficient of friction, Good corrosion resistance, electrical insulation, surface finish, processibility, Economical, Poor tensile strength, Poor temperature resistance, Attractive colours and service life. Comparison with metals, wood etc</li> <li>Skills</li> <li>Observing</li> <li>Understanding</li> <li>Comparing</li> </ul>	<p>The learner will be able to</p> <ul style="list-style-type: none"> <li>• Explain the characteristics of polymers such as density, strength, processibility, service life etc.</li> <li>• Compare polymers with other materials such as wood, metal etc.</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion on the properties of polymers</li> <li>Group discussion</li> </ul>	<ul style="list-style-type: none"> <li>• Participation in discussion, Presentation/ write up</li> </ul>
<ul style="list-style-type: none"> <li>• Structure and properties of polymers</li> <li>Effect of Chain length, Side groups, Branching and crosslinking on the physical properties of polymers</li> <li>Skills</li> <li>Observing</li> <li>Understanding</li> <li>Inferring</li> <li>Comparing</li> </ul>	<p>The learner will be able to</p> <ul style="list-style-type: none"> <li>• Explain the effect of Chain length, Side groups, Branching and crosslinking on the physical properties of polymers</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion with PPT</li> <li>Brainstorming - Comparative study of polymers with different structures</li> </ul>	<ul style="list-style-type: none"> <li>• Participation in discussion, Oral test</li> <li>Write up</li> </ul>
<ul style="list-style-type: none"> <li>• Thermal behaviour of polymers</li> <li>Glass Transition Temperature Tg, Factors affecting Tg, Melting Point, Mechanical properties of polymers - stress, strain, modulus, toughness</li> <li>Creep and Stress relaxation</li> <li>Skills</li> <li>Observing</li> <li>Understanding</li> <li>Comparing</li> </ul>	<p>The learner will be able to</p> <ul style="list-style-type: none"> <li>• Realise the thermal behaviour of polymers such as Tg, Tm, and factors affecting them</li> <li>• Realise the mechanical properties and long term behaviour of polymers.</li> </ul>	<ul style="list-style-type: none"> <li>• General discussion on the thermal behaviour of polymers.</li> <li>Lab work</li> <li>Group Discussion using the stress strain graphs of different polymers</li> </ul>	<ul style="list-style-type: none"> <li>• Participation in discussion</li> <li>Oral test</li> <li>Write ups</li> </ul>

**Unit : POLYMER MATERIALS (120 periods)**

**Module 1 : BASIC POLYMER PROCESSING**

<b>Ideas/Concepts/Skill</b>	<b>Learning Outcomes</b>	<b>Suggested Activities</b>	<b>Assessment</b>
<ul style="list-style-type: none"> <li>Plastics</li> <li>Production, Properties, grades, and applications of Thermoplastics such as PE, PP, PS, PVC, PMMA and PET</li> <li>Skills</li> <li>Observing</li> <li>Classifying</li> <li>Inferring</li> <li>Experimenting</li> </ul>	<p>The learner will be able to</p> <ul style="list-style-type: none"> <li>Explain the production properties and applications of Thermoplastics such as PE, PP, PS, PVC, PMMA and PET</li> <li>Choose suitable thermoplastics for specified applications</li> </ul>	<ul style="list-style-type: none"> <li>General discussion with PPT and plastic samples.</li> <li>Laboratory work</li> <li>Preparation of chart of plastics and their applications</li> </ul>	<ul style="list-style-type: none"> <li>Participation in discussion</li> <li>Lab work</li> <li>Chart</li> </ul>
<ul style="list-style-type: none"> <li>Production, Properties, grades, and applications of thermoset resins like Phenol Formaldehyde, Melamine formaldehyde, Urea formaldehyde resins</li> <li>Skills</li> <li>Observing</li> <li>Classifying</li> <li>Inferring</li> <li>Experimenting</li> </ul>	<p>The learner will be able to</p> <ul style="list-style-type: none"> <li>Explain the production properties and applications of thermoset resins like PF, MF, UF resins</li> <li>Select suitable thermoset plastics for specified applications</li> </ul>	<ul style="list-style-type: none"> <li>Interactive lecture with product samples</li> <li>Lab work</li> <li>Group discussion</li> <li>Chart preparation</li> </ul>	<ul style="list-style-type: none"> <li>Participation in discussion</li> <li>Lab work</li> <li>Group discussion</li> <li>Chart</li> </ul>
<ul style="list-style-type: none"> <li>Rubbers -</li> <li>Production, Properties, grades, and applications of General purpose rubbers such as NR, SBR, Butadiene Rubber, EPDM and Reclaim rubber</li> <li>Skills</li> <li>Observing</li> <li>Classifying</li> <li>Inferring</li> <li>comparing</li> </ul>	<p>The learner will be able to</p> <ul style="list-style-type: none"> <li>Explain the production, properties and applications of General purpose rubbers such as NR, SBR, Butadiene Rubber, EPDM and reclaim rubber</li> </ul>	<ul style="list-style-type: none"> <li>General discussions with PPT and rubber samples.</li> <li>Preparation of comparison chart of NR &amp; SBR.</li> </ul>	<ul style="list-style-type: none"> <li>Participation in discussion</li> <li>Oral Test,</li> <li>Chart</li> </ul>

**Module 1 : BASIC POLYMER PROCESSING** **Unit : POLYMER MATERIALS (120 periods)**

<b>Ideas/Concepts/Skill</b>	<b>Learning Outcomes</b>	<b>Suggested Activities</b>	<b>Assessment</b>
<ul style="list-style-type: none"> <li>Special purpose synthetic rubbers Production, properties, Compounding and application of , NBR, CR, IIR, CSM, CM,ACM, Flouro carbon rubbers, Silicone Rubbers, and Poly urethane</li> <li>Skills</li> <li>Observing</li> <li>Classifying</li> <li>Inferring</li> <li>comparing</li> </ul>	<p>The learner will be able to</p> <ul style="list-style-type: none"> <li>Explain the Production, properties, Compounding and application of, special purpose synthetic rubbers like NBR, CR, IIR, CSM, CM, ACM. Flouro carbon rubbers, Silicone Rubbers, and Poly urethane</li> <li>Select suitable rubbers for specified applications</li> </ul>	<ul style="list-style-type: none"> <li>Group discussion with material data sheets</li> <li>Compare different synthetic rubbers using material data sheets</li> </ul>	<ul style="list-style-type: none"> <li>Group discussion</li> <li>Quiz</li> </ul>

Module 1 : BASIC POLYMER PROCESSING		Unit : POLYMER ADDITIVES (50 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<ul style="list-style-type: none"> <li>Additives for Plastics - Antioxidants, blowing agents, colourants, coupling agents, flame retardants, heat stabilisers, impact modifiers, lubricants, plasticizers, preservatives, uv stabilisers, etc.</li> <li>Skills Observing Inferring Comparing Selecting</li> <li>Additives for Rubbers Basic concepts in rubber processing such as mastication, vulcanisation, and scorching master batching, and blending. Additives such as activators, Co activator, Antioxidants, Antiozonants-staining - non staining, fillers-reinforcing - non reinforcing, process aids, vulcanizing agents - sulphur, non sulphur, accelerators-different types</li> <li>Skills Observing Inferring Comparing Selecting experimenting</li> </ul>	<p>The learner will be able to</p> <ul style="list-style-type: none"> <li>Choose suitable additives for plastics for different applications</li> </ul> <p>The learner will be able to</p> <ul style="list-style-type: none"> <li>Realise the basic concepts in rubber processing such as mastication, vulcanisation, scorching, master batching, and blending.</li> <li>Realise the function of different ingredients used in rubber compounding,</li> <li>Prepare sample rubber formulations</li> <li>Do mastication and blending of rubbers</li> </ul>	<ul style="list-style-type: none"> <li>Group discussion on plastic additives using product data sheets of additives and charts</li> <li>Preparation of plastic compounds</li> </ul> <ul style="list-style-type: none"> <li>Laboratory work on Mastication and blending</li> <li>Demonstration of rubber compound preparation.</li> <li>Group Discussion on rubber additives using data sheets</li> </ul>	<ul style="list-style-type: none"> <li>Participation in the discussion Write ups</li> </ul> <ul style="list-style-type: none"> <li>Lab work Quiz Report</li> </ul>

**Module 1 : BASIC POLYMER PROCESSING** **Unit : POLYMER PROCESSING (85 periods)**

<b>Ideas/Concepts/Skill</b>	<b>Learning Outcomes</b>	<b>Suggested Activities</b>	<b>Assessment</b>
<ul style="list-style-type: none"> <li>Rubber Processing</li> <li>Mixing - Mixing Mills, Internal Mixers</li> <li>Compression molding, Transfer Molding, Injection molding, Extrusion, Calendaring, Autoclave curing Skills</li> <li>Observing</li> <li>Inferring</li> <li>Comparing</li> <li>Demonstrating</li> </ul>	<p>The learner will be able to</p> <ul style="list-style-type: none"> <li>Describe the working of rubber mixing mills, intermix, banbury and kneaders</li> <li>Demonstrate the mixing of rubber compounds in a mixing mill.</li> <li>Explain different rubber molding techniques like compression molding, transfer molding, and injection molding</li> <li>Demonstrate the compression molding of a rubber product</li> <li>Describe the rubber processing methods such as Extrusion, calendaring, and autoclave vulcanisation</li> </ul>	<ul style="list-style-type: none"> <li>Interactive lecture</li> <li>Field visit</li> <li>Group discussion</li> <li>Assignment</li> <li>Lab work</li> <li>Video show</li> </ul>	<ul style="list-style-type: none"> <li>Lab record,</li> <li>Oral test,</li> <li>Group discussion report</li> <li>Participation in discussion</li> </ul>
<ul style="list-style-type: none"> <li>Plastic Processing-</li> <li>Plastic compound mixing, preparation of pellets</li> <li>Injection molding</li> <li>Blow Molding</li> <li>Compression Molding</li> <li>Rotational Molding</li> <li>Extrusion</li> <li>Thermo forming</li> <li>Skills</li> <li>Observing</li> <li>Inferring</li> <li>Comparing</li> <li>Demonstrating</li> </ul>	<p>The learner will be able to</p> <ul style="list-style-type: none"> <li>Describe the working principle, features and components of machines used in plastic injection molding, blow molding, compression molding, rotational molding, extrusion and thermoforming</li> <li>Demonstrate plastic injection molding, and compression molding in hand/semi automatic machines</li> </ul>	<ul style="list-style-type: none"> <li>Interactive lecture with PPT, Video show</li> <li>Field visit</li> <li>Lab work</li> <li>Group discussion</li> </ul>	<ul style="list-style-type: none"> <li>Lab record,</li> <li>Oral test,</li> <li>Group discussion report</li> <li>Participation in discussion</li> <li>Field visit report</li> </ul>



## OVERVIEW OF MODULE - 2

This module is designed to equip the learner with knowledge and skills required start working in a Rubber processing industry. The module consists of the production of natural rubber, rubber compounding, manufacture of latex products, manufacture of dry rubber products, manufacture of tyres and tubes, and testing and quality control in rubber industry..

After completing the module he /she will be able identify various rubbers, rubber additives and their functions. He/she will have the knowledge in the manufacture of various rubber products such as tyres tubes, conveyor belts, cables, hoses, rubber to metal bonded products etc. He/she will be able to work on hand operated rubber and plastic processing machineries. He/she will be able to work rubber mixing mill, compression moulding and other rubber processing machines. He/ she will be able to manufacture latex products such as gloves, rubber band, balloon etc.

### MODULE 2

#### RUBBER PROCESSING

Periods: 340

Unit No.	Name of units	Periods
2.1	Natural Rubber	60
2.2	Rubber Compounding	40
2.3	Manufacture of Latex Products	80
2.4	Manufacture of Dry Rubber Products	80
2.5	Manufacture of Tyres and Tubes	50
2.6	Testing and Quality Control in Rubber Industries	30
	<b>TOTAL PERIODS</b>	<b>340</b>

Unit : NATURAL RUBBER (60 periods)				
Module 2 : RUBBER PROCESSING	Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<ul style="list-style-type: none"> <li>History and development of Natural Rubber. Role of Columbus, Henry Wickham, Joseph Priestly, H.N. Ridley, Charles Goodyear, Thomas Hancock and JJ Murphy. World Production / Consumption statistics, Large Plantations in India, Geographical distribution, Climatic requirements and activities of Rubber board</li> <li>Skills</li> <li>Observing, communication</li> <li>Relating</li> <li>Evaluating</li> <li>Harvesting and preservation of Natural rubber latex - Tapping, Tappability, tapping systems, Tapping utensils, knives, tapping task, tapping rest, yield stimulants and rain guarding, Puncture tapping, slaughter tapping, Field crops.</li> <li>Composition of latex, spontaneous coagulation. Preservation of latex-ammonia as a preservative, merits and demerits of ammonia. LATZ system</li> <li>Skills</li> <li>Observing, communication, Experimenting, Inferring</li> </ul>	<ul style="list-style-type: none"> <li>The learner will be able to Describe the history and development of Natural Rubber</li> <li>Identify the important sources of natural rubber</li> <li>Relate the climatic requirements and geographical distribution of rubber India.</li> <li>Discuss the impact of Natural rubber on Kerala's Economy</li> </ul>	<ul style="list-style-type: none"> <li>General discussion on the History and development of Natural Rubber.</li> <li>Data collection</li> <li>Assignment</li> </ul>	<ul style="list-style-type: none"> <li>Oral Test/ Assignment</li> </ul>	
<ul style="list-style-type: none"> <li>Harvesting and preservation of Natural rubber latex - Tapping, Tappability, tapping systems, Tapping utensils, knives, tapping task, tapping rest, yield stimulants and rain guarding, Puncture tapping, slaughter tapping, Field crops.</li> <li>Composition of latex, spontaneous coagulation. Preservation of latex-ammonia as a preservative, merits and demerits of ammonia. LATZ system</li> <li>Skills</li> <li>Observing, communication, Experimenting, Inferring</li> </ul>	<ul style="list-style-type: none"> <li>The learner will be able to Describe different tapping methods, Tappability, tapping rest, tapping knives, tapping systems, directions etc</li> <li>Discuss the profile of a rubber tapper in Kerala's society</li> <li>Identify the different forms of rubber crop from the field</li> <li>Explain the composition and spontaneous coagulation of latex.</li> <li>Realise the need for preservation of latex</li> <li>Perform the preservation of natural rubber latex using ammonia and LATZ systems.</li> </ul>	<ul style="list-style-type: none"> <li>Interactive lecture with PPT, Video Show</li> <li>Field Visit to a rubber plantation</li> <li>Lab practical</li> <li>Lab lectures</li> </ul>	<ul style="list-style-type: none"> <li>Participation in the discussion</li> <li>Oral test</li> <li>Field visit report</li> <li>Lab record</li> </ul>	

Unit : NATURAL RUBBER (60 periods)				
Module 2 : RUBBER PROCESSING	Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<ul style="list-style-type: none"> <li>Concentration of NR Latex Need for concentration of latex, DRC, Different concentration methods, Creaming process - creaming agents, theory, factors affecting the efficiency of creaming</li> <li>Centrifuging, - Process - Machines - skim latex and cenex, comparison of centrifuging and creaming Skills</li> <li>Observing, communication, Experimenting, Inferring</li> <li>Preparation of Ribbed Smoked Sheets - Various steps, dosage of chemicals and acids, Same day and next day sheeting, drying in smoke houses, Grading Skills</li> <li>Observing, communication, Experimenting, Inferring</li> <li>Manufacture of pale latex crepe and estate brown crepe - processing and machineries</li> <li>Manufacture of TSR - Need for TSR, Comparison of TSR and sheet rubber. Different grades and technical specifications.</li> <li>Manufacturing process - equipment and testing. Skills</li> <li>Observing, communication, Experimenting, Inferring</li> </ul>	<ul style="list-style-type: none"> <li>The learner will be able to Describe the different latex concentration techniques and the need for concentration of latex by Prepare concentrated latex by creaming</li> <li>Compare creaming and centrifuging methods</li> <li>The learner will be able to Describe the preparation of Ribbed Smoked Sheets and its grading</li> <li>Prepare Ribbed Smoked Sheets</li> <li>The learner will be able to Describe the manufacture of different grades of Crepe Rubber. Describe the manufacture and testing of different grades of Technically Specified rubber</li> <li>Compare Sheet rubber and Technically specified rubber</li> </ul>	<ul style="list-style-type: none"> <li>Interactive Discussion with PPT, Video Show</li> <li>Field Visit</li> <li>Lab practical</li> <li>Interactive Discussion, Video Show</li> <li>Field Visit</li> <li>Lab Practical</li> <li>Interactive Discussion, Video Show</li> <li>Field Visit</li> </ul>	<ul style="list-style-type: none"> <li>Participation in the discussion</li> <li>Oral test</li> <li>Field visit report</li> <li>Lab record</li> <li>Participation in the discussion</li> <li>Oral test</li> <li>Field visit report</li> <li>Participation in the discussion</li> <li>Oral test</li> <li>Field visit report</li> </ul>	

Module 2 : RUBBER PROCESSING		Unit : RUBBER COMPOUNDING (40 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<ul style="list-style-type: none"> <li>Rubber compounding - Definition-Objectives, Sulphur vulcanisation - Different systems. Non sulphur vulcanisation systems Skills</li> <li>Observing, communication, Inferring Vulcanising agents, accelerators - different classes - Amines, Guanidines, Thiazoles, Sulphenamides, Thiurams, Dithiocarbamates, and xanthates, Primary and secondary accelerators. Activators, Co activators, Anti oxidants/ ozonants - SP, Hindered phenols, TMQ, PBN, 6PPD, IPPD, Fillers - Reinforcing fillers - Carbon blacks and silica Non reinforcing fillers - China clay, Calcium carbonate, Whiting, Aluminium silicate, barytes etc. Effect of particle size on reinforcement. Process oils- aromatic, naphthenic, paraffinic, Plasticizers -DOP, DBP, CPW, Factice Special purpose additives - Blowing agents, fire retardants, retarders etc. Skills Observing, Classifying, communication, Inferring</li> </ul>	<ul style="list-style-type: none"> <li>The learner will be able to Explain the principles of rubber compounding and its importance in rubber manufacturing. Describe different vulcanisation systems and its specific applications The learner will be able to Differentiate between various Vulcanising agents and explain their specific function and importance Identify different compounding ingredients and list their functions</li> </ul>	<ul style="list-style-type: none"> <li>Interactive lecture with PPT, Seminar on compounding ingredients Group discussion Chart</li> <li>Interactive lecture with PPT, Demonstration in lab Group discussion</li> </ul>	<ul style="list-style-type: none"> <li>Chart Seminar Participation in discussion Chart Write ups Participation in lecture Write up of demonstration in lab Report of group discussion</li> </ul>

Module 2 : RUBBER PROCESSING		Unit : RUBBER COMPOUNDING (40 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<ul style="list-style-type: none"> <li>Design of rubber compounds with various hardness using NR and different dosages of different fillers, Design of NR compound for - good mechanical properties, good heat resistance, good abrasion resistance, Oil resistant compound for oil seals, Weather resistant compound using EPDM, Chemical Resistant Compound using IIR, IIR Compound for Automobile tubes, fire resistant compound, extrusion compounds using NR and EPDM, Design of FKM and Silicone compounds</li> <li>Observing, communication, Experimenting, Designing</li> </ul>	<ul style="list-style-type: none"> <li>The learner will be able to Design rubber compound for specific applications. Demonstrate rubber compounding.</li> </ul>	<ul style="list-style-type: none"> <li>Interactive lecture with PPT, Student learning Resource Book, Video Show</li> <li>Field Visit</li> </ul>	

Module 2 : RUBBER PROCESSING		Unit : MANUFACTURE OF LATEX PRODUCTS (80 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<ul style="list-style-type: none"> <li>Latex compounding principles. Preparation of solution, dispersion and emulsions, Ball mills and attritor mills, Factors affecting the efficiency of ball mill. Latex compounding, Wet weight and dry weight. Skill Observing Communicating Interpreting</li> <li>Manufacture of dipped goods like Gloves - surgeons, examination, house hold and electricians gloves, Rubber band, Balloons and Finger caps Skill Observing Communicating Manufacturing</li> <li>Manufacture Latex thread, latex casting, Latex foam - Dunlop Process, Thalalay process, Latex cements and adhesives. Skill Observing Communicating Manufacturing</li> </ul>	<ul style="list-style-type: none"> <li>The learner will be able to Explain the basic concepts of latex compounding. Prepare dispersions, emulsions, and solutions for latex compounding Demonstrate the working of ball mill Design and Prepare simple latex compounds</li> <li>The learner will be able to Produce latex products such as gloves, balloons, finger caps, and rubber bands using dipping process</li> <li>The learner will be able to Produce latex toys by casting Explain the production of latex threads by extrusion Describe the production of latex foam Explain the production of latex cements and adhesives</li> </ul>	<ul style="list-style-type: none"> <li>Interactive lecture with PPT, Group discussion Preparation of charts Demonstration Practical work Demonstration Practice</li> <li>Interactive lecture Demonstration Lab work</li> <li>Video show Field visit</li> </ul>	<ul style="list-style-type: none"> <li>Participation in discussion Chart Preparation Lab work Participation</li> <li>Oral assessment records/lab work</li> <li>Field visit report Oral assessment</li> </ul>

Module 2 : RUBBER PROCESSING		Unit : MANUFACTURE OF DRY RUBBER PRODUCTS (80 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<ul style="list-style-type: none"> <li>Manufacture of different kinds of rubber moulded goods such as O-rings, Oil seals, Erasers, Expanded rubber sheets etc</li> <li>Skills Manufacturing Observing</li> <li>Conveyer belt - applications- structures and reinforcements. Manufacture Vulcanisation - step cure and Rotocure.</li> <li>V belts - Applications- Advantages</li> <li>Different types - Components of V belt, Manufacturing method, Vulcanisation</li> <li>Skills Manufacturing , Observing communicating</li> <li>Manufacture of Garden hoses, Automobile hoses - Radiator hoses - components - tube, reinforcements and cover, Manufacturing methods - curing - lead cutting, autoclave curing, Braided hose</li> <li>Cables - Manufacturing process - Cross head dual extrusion - Classification of cables, steam vulcanisation</li> <li>Skills Manufacturing Observing communicating</li> </ul>	<ul style="list-style-type: none"> <li>The learner will be able to Describe the manufacture of rubber moulded goods such as O-rings, Oil seals, expanded rubber sheets, etc Produce rubber moulded goods</li> <li>The learner will be able to Describe the manufacture of rubber conveyer belts and V belts</li> <li>The learner will be able to Describe the manufacture of rubber hoses and cables</li> </ul>	<ul style="list-style-type: none"> <li>Demonstration Field visit Lab work Video Show</li> <li>Demonstration Field visit Lab work Video Show</li> <li>Demonstration Field visit Lab work Video Show</li> </ul>	<ul style="list-style-type: none"> <li>Field visit report Collection of specimen Lab work</li> <li>Lab work Report on video show Lecture note</li> <li>Report on video show Lecture note</li> </ul>

Module 2 : RUBBER PROCESSING		Unit : MANUFACTURE OF DRY RUBBER PRODUCTS (80 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<ul style="list-style-type: none"> <li>Rubber to metal bonding - Ebonite bonding, brass bonding, Adhesive bonding, Surface preparation, Manufacture of Rubber covered Rolls, Rubber lining of chemical tanks, Rubber to metal bonded automobile components - Shock absorber bushes, engine mountings etc Skills</li> <li>Manufacturing Observing communicating</li> <li>Common defects and remedies in the manufacture of Rubber Products Shrinkage, Undercure, Sponging and porosity, Over cure, Air trapping, poor knitting or flow cracks, back grinding, tearing on removal from cavity, bloom, Excess flash, Distortion, sticking in cavity, poor registration of mould marks Skills</li> <li>Troubleshooting Observing communicating</li> </ul>	<ul style="list-style-type: none"> <li>The learner will be able to Describe the rubber to metal bonding processes Explain the manufacture of rubber covered rolls and rubber lining of chemical tanks</li> <li>The learner will be able to Describe the common defects and remedies in the manufacture of rubber products</li> </ul>	<ul style="list-style-type: none"> <li>Interactive lecture. Group discussion</li> <li>Interactive lecture detailing the common defects and remedies for rubber products Field visit Chart preparation</li> </ul>	<ul style="list-style-type: none"> <li>Group discussion Chart Group discussion report Lecture note Chart</li> <li>Report on lecture Field visit report Chart</li> </ul>

Unit : MANUFACTURE OF TYRES AND TUBES (50 periods)			
Module 2 : RUBBER PROCESSING	Learning Outcomes	Suggested Activities	Assessment
<p><b>Ideas/Concepts/Skill</b></p> <ul style="list-style-type: none"> <li>Development of pneumatic tyres and its functions Skills Observing Interpreting</li> <li>Components of Tyres and its functions - Tread, Sidewall, Bead, bead apex, bead flipper, carcass plies, breaker plies, belt plies, chafer strips, inner liner etc Skills Observing Interpreting classifying</li> <li>Tyre constructions, Tread patterns, and Tyre Markings - Bias tyre, Radial tyre, bias belted tyres Lug Design, Semi lug design, and Rib designs Markings on a tyre and its interpretations Skills Observing Comparing Interpreting</li> <li>Preparation of different tyre components and their assembling in tyre building machine to complete the green tyre Skills Observing Comparing manufacturing</li> </ul>	<ul style="list-style-type: none"> <li>The learner will be able to Describe the pneumatic tyre and its functions</li> <li>The learner will be able to Describe the components of a tyre and its functions</li> <li>Compare different tyre constructions distinguish different tread designs Identify the markings on a tyre</li> <li>The learner will be able to Explain the preparation of different tyre components Describe the tyre building operation</li> </ul>	<ul style="list-style-type: none"> <li>Interactive lecture Field visit Chart</li> <li>Interactive lecture Field visit Cut tyre analysis Chart Group discussion</li> <li>Interactive lecture Chart demonstration</li> <li>Interactive lecture Field visit Video show</li> </ul>	<ul style="list-style-type: none"> <li>Field visit report Participation in lecture chart</li> <li>Field visit report Participation in lecture chart</li> <li>Group discussion Interactive lecture Chart</li> <li>Field visit report Interactive lecture Chart</li> </ul>

Unit : MANUFACTURE OF TYRES AND TUBES (50 periods)			
Module 2 : RUBBER PROCESSING	Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities
			<b>Assessment</b>
<ul style="list-style-type: none"> <li>• Tyre curing and post cure operations Skills</li> <li>• Observing</li> <li>• Comparing manufacturing of cycle tyres - monoband building</li> <li>• Manufacture of solid tyres Skills</li> <li>• Observing</li> <li>• Comparing manufacturing</li> <li>• Automobile Tubes &amp; flaps Suitable formulations for automobile tubes and flaps</li> <li>• Compound preparation, extrusion, cutting to lengths, valve holing, valve fixing, splicing, molding</li> <li>• Skills</li> <li>• Observing</li> <li>• Comparing manufacturing</li> <li>• Tyre Retreading -Definition, need for retreading, advantages of retreading</li> <li>• Different methods of retreading - Conventional or hot process, - cold or pre cured process</li> <li>• Retreading process - inspection, buffing, cleaning, solvent application, cushion gum application tread application, vulcanisation and inspection</li> <li>• Skills</li> <li>• Observing</li> <li>• Comparing manufacturing</li> </ul>	<ul style="list-style-type: none"> <li>• The learner will be able to Describe the tyre curing and post cure operations</li> <li>• The learner will be able to Describe the manufacture solid tyres and cycle tyres</li> <li>• The learner will be able to Describe the different steps in the manufacture of automobile tubes and flaps</li> <li>• The learner will be able to Describe different steps involved in the tyre retreading process. Perform the retreading of tyres</li> </ul>	<ul style="list-style-type: none"> <li>• Interactive lecture</li> <li>• Field visit</li> <li>• Video show</li> <li>• Interactive lecture</li> <li>• Field visit</li> <li>• Video show</li> <li>• Interactive lecture</li> <li>• Field visit</li> <li>• Video show</li> <li>• Interactive lecture</li> <li>• Field visit</li> <li>• Video show</li> </ul>	<ul style="list-style-type: none"> <li>• Field visit report</li> <li>• Interactive lecture</li> <li>• Chart</li> <li>• Field visit report</li> <li>• Interactive lecture</li> <li>• Chart</li> <li>• Field visit report</li> <li>• Interactive lecture</li> <li>• Chart</li> <li>• Field visit report</li> <li>• Interactive lecture</li> <li>• Chart</li> </ul>

Module 2 : RUBBER PROCESSING		Unit : TESTING AND QUALITY CONTROL IN RUBBER INDUSTRY (30 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<ul style="list-style-type: none"> <li>Latex testing - DRC, TSC, NH3 Content, Coagulum content, Sludge content, VFA, MST, Skills</li> <li>Observing Analytical Experimental</li> <li>Dry Rubber Testing - Dirt content, P0 -PRI, Ash content, Volatile matter, Mooney viscosity</li> <li>Skills Observing Analytical Experimental</li> <li>Rubber compound testing -Density - Zinc chloride method, Mooney viscosity, Cure characteristics using rheometer.</li> <li>Skills Observing Analytical Experimental</li> <li>Test on rubber vulcanisates Hardness, Tensile strength, Modulus, elongation at break, tear resistance, abrasion resistance, Compression set, Flex resistance - crack initiation and crack growth resistance, Rebound resilience, Skills</li> <li>Observing Analytical Experimental</li> </ul>	<ul style="list-style-type: none"> <li>The learner will be able to Perform various tests rubber latex such as - DRC, TSC, NH3 Content, Coagulum content, Sludge content, VFA, and MST</li> <li>The learner will be able to Perform various tests related to raw rubber such as Dirt content, P0 - PRI, Ash content, Volatile matter, Mooney viscosity</li> <li>The learner will be able to Perform various tests on rubber compounds - Density - Zinc chloride method, Mooney viscosity, Cure characteristics using rheometer.</li> <li>The learner will be able to Perform Hardness, Tensile properties, tear resistance, abrasion resistance, Compression set, Flex resistance, Rebound resilience,</li> </ul>	<ul style="list-style-type: none"> <li>Demonstration in the lab Practical work Field visit</li> </ul>	<ul style="list-style-type: none"> <li>Lab work Viva</li> <li>Lab work Viva</li> <li>Lab work Viva</li> <li>Lab work Viva</li> </ul>

Module 2 : RUBBER PROCESSING		Unit : TESTING AND QUALITY CONTROL IN RUBBER INDUSTRY (30 periods)	
Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<ul style="list-style-type: none"> <li>Basic concepts of Quality management systems like Standard operating Procedures, Good manufacturing practices, 5S, Kaizen, ISO9000, QS9000, TS16949, TPM, TQM and ISO 14000</li> </ul> Skills Observing Analytical Experimental	<ul style="list-style-type: none"> <li>The learner will be able to Describe the advantages of following good quality management systems like 5S, Kaizen, ISO9000, QS9000, TS16949, TPM, TQM and ISO 14000</li> </ul>	<ul style="list-style-type: none"> <li>Interactive lecture with PPT, writing SOP, Case studies, Assignment</li> </ul>	<ul style="list-style-type: none"> <li>Participation in discussion</li> <li>Write ups</li> </ul>

## DETAILED UNIT ANALYSIS

### Module I BASIC POLYMER PROCESSING

#### Unit 1.1 Basic polymer science

The first unit deals with the basics of polymer science like what are polymers, how they are formed, characteristics of polymers and their applications. The study of basic polymer science gives the students a good foundation to learn the polymer processing in the coming modules.

#### Unit Detailing

Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<ul style="list-style-type: none"> <li>Introduction to polymers - Define - Monomers, Polymers, Functionality of monomers, repeating units, Polymerisation, Addition and condensation Polymerisation Skills Observing, Communicating,</li> <li>Classification of polymers - Natural, Synthetic, organic, inorganic, homo polymer, copolymer, linear and branched polymers, thermosets and thermoplastics, Rubbers, Plastics, Fibres and Resins etc, Skills Observing, Communicating Classifying</li> <li>Molecular weight of polymers - Concept of Average Molecular weight, Degree of Polymerisation, Molecular Weight Distribution, Practical significance of polymer molecular weight and molecular weight distribution Skills Observing, Communicating, Inferring</li> </ul>	<ul style="list-style-type: none"> <li>The learner will be able to Explain monomers, polymers, polymerisation, functionality of monomers, addition and condensation polymers</li> <li>The learner will be able to Identify polymers based on their origin, monomers, molecular structure, type of Polymerisation, response to heat and application.</li> <li>The learner will be able to Realise the concept of average molecular weight, degree of polymerisation and molecular weight distribution of polymers</li> </ul>	<ul style="list-style-type: none"> <li>General discussion PPT, molecular models and Polymer Product samples</li> <li>Chart General discussion with polymer samples</li> <li>Charting Interactive lecture with PPT, Numerical problems</li> </ul>	<ul style="list-style-type: none"> <li>Participation in discussion Chart</li> <li>Participation in discussion Chart</li> <li>Participation in discussion Solving numerical problems</li> </ul>

1.1.1 Explain monomers, polymers, Polymerisation, functionality of monomers, addition and condensation polymers.

### **Suggested strategy**

1. Interactive lecture with, molecular models, and polymer product samples.

The teacher initiates a discussion in the class on the topic "polymers and polymerisation" by showing some polymer product samples. The students are encouraged to participate in the discussion.

The teacher can use the following points to ensure students participation

1. Ask the students to name the polymers they know.
2. How the polymers are formed
3. Monomers and their functionality
4. Degree of polymerisation
5. Addition and condensation polymerisation

Students prepare a chart of commonly polymers, their monomers and application.

### **Assessment**

Participation in discussions

Chart (portfolio)

1.1.2 Classify polymers based on their origin, chemical structure, monomers, application, Polymerisation, and response to heat.

### **Suggested Strategy**

The teacher starts a general discussion in the class on the on the Classification of polymers. The teacher asks the students to prepare a list of different polymers. The students group the polymers into different groups and present it as a chart.

The teacher can use the following points to ensure students participation

1. Classification based on origin - natural and synthetic polymers
2. Organic and Inorganic polymers
3. Homopolymers and copolymers
4. Linear and branched polymers
5. Thermoplastic and thermoset polymers
6. Rubbers, plastics and fibres

Teacher consolidates the classification of polymers

## Assessment

Participation in discussion

Chart

1.1.3 Describe the concept of average molecular weight, degree of Polymerisation and molecular weight distribution

## Suggested Strategy

Initiate a discussion in the class with power point presentation on molecular weight, degree of polymerization and molecular weight distribution of polymers.

The teacher can use the following points to ensure students participation

1. Comparison of molecular weight of NaCl and Polyethylene
2. Solving numerical problems related to molecular weight
3. Molecular weight distribution
4. Significance of Molecular weight and its distribution.

## Assessment

Participation in discussions

Solving numerical problems

### Repository of CE possibilities

Process	Portfolio	Unit Based Evaluation
Discussion related to polymers and polymerisation	Chart	Oral Assessment
Discussion related to classification of polymers	Chart	Performance assessment
Discussion related to molecular weight of polymers	Problems	

## Sample question

- 1) "Most materials softens on heating where as some polymers becomes hard when heated" Which of the following polymer becomes hard on heating?  
a) PE,      b) PP,      c) PF Resin      d) PS
- 2) Calculate the molecular weight of a Polyethylene polymer with a degree of polymerization 10000 given the molecular weight of PE monomer is 28?

- 3) Some statements about polymers are given below. Identify the following statements as true or false
- a) All polymers are produced polymerisation of monomers
  - b) To undergo polymerisation a monomer should have a functionality of at least two.
  - c) Polymers have a specific molecular weight.

## **Module 2 RUBBER PROCESSING**

### **Unit 1.1 Natural Rubber**

Natural rubber is one of the major agricultural produce of Kerala. Natural rubber is obtained from a tree called *Hevea Braziliensis* by tapping. Originally a native of Brazil and is brought to India by the British. Today India ranks fourth in the production of Natural rubber in the world. Natural rubber cultivation and production is one of the top job creating activities in Kerala. This unit deals with production and processing of natural rubber into different marketable forms like, RSS, crepe rubber, centrifuged latex and technically specified rubber.

**Unit : Natural Rubber**

<b>Ideas/Concepts/Skill</b>	<b>Learning Outcomes</b>	<b>Suggested Activities</b>	<b>Assessment</b>
<ul style="list-style-type: none"> <li>History and development of Natural Rubber. Role of Columbus, Henry Wickham, Joseph Priestly, H.N. Ridley, Charles Goodyear, Thomas Hancock and JJ Murphy. World Production / Consumption statistics, Large Plantations in India, Geographical distribution, Climatic requirements and activities of Rubber board Skills Observing, communication Relating Evaluating</li> <li>Harvesting and preservation of Natural rubber latex - Tapping, Tappability, tapping systems, Tapping utensils, knives, tapping task, tapping rest, yield stimulants and rain guarding. Puncture tapping, slaughter tapping, Field crops.</li> <li>Composition of latex, spontaneous coagulation. Preservation of latex-ammonia as a preservative, merits and demerits of ammonia. LATZ system Skills Observing, communication, Experimenting, Inferring</li> </ul>	<ul style="list-style-type: none"> <li>The learner will be able to Describe the history and development of Natural Rubber Identify the important sources of natural rubber Relate the climatic requirements and geographical distribution of rubber India. Discuss the impact of Natural rubber on Kerala's Economy</li> </ul>	<ul style="list-style-type: none"> <li>General discussion on the History and development of Natural Rubber. Data collection Assignment</li> </ul>	<ul style="list-style-type: none"> <li>Participation in discussion Data collection Assignment</li> </ul>
<ul style="list-style-type: none"> <li>Harvesting and preservation of Natural rubber latex - Tapping, Tappability, tapping systems, Tapping utensils, knives, tapping task, tapping rest, yield stimulants and rain guarding. Puncture tapping, slaughter tapping, Field crops.</li> <li>Composition of latex, spontaneous coagulation. Preservation of latex-ammonia as a preservative, merits and demerits of ammonia. LATZ system Skills Observing, communication, Experimenting, Inferring</li> </ul>	<ul style="list-style-type: none"> <li>The learner will be able to Describe different tapping methods, Tappability, tapping rest, tapping knives, tapping systems, directions etc Discuss the profile of a rubber tapper in Kerala's society Identify the different forms of rubber crop from the field Explain the composition and spontaneous coagulation of latex. Realise the need for preservation of latex Perform the preservation of natural rubber latex using ammonia and LATZ systems.</li> </ul>	<ul style="list-style-type: none"> <li>Interactive lecture Video Show Field Visit to a rubber plantation Lab practical Lab lectures</li> </ul>	<ul style="list-style-type: none"> <li>Participation in the discussion Oral test Field visit report Lab record</li> </ul>

## Unit : Natural Rubber

Ideas/Concepts/Skill	Learning Outcomes	Suggested Activities	Assessment
<ul style="list-style-type: none"> <li>Concentration of NR Latex Need for concentration of latex, DRC, Different concentration methods, Creaming process - creaming agents, theory, factors affecting the efficiency of creaming</li> <li>Centrifuging, - Process - Machines - skim latex and cenex, comparison of centrifuging and creaming Skills</li> <li>Observing, communication, Experimenting, Inferring</li> <li>Preparation of Ribbed Smoked Sheets - Various steps, dosage of chemicals and acids, Same day and next day sheeting, drying in smoke houses, Grading Skills</li> <li>Observing, communication, Experimenting, Inferring</li> <li>Manufacture of pale latex crepe and estate brown crepe - processing and machineries</li> <li>Manufacture of TSR - Need for TSR, Comparison of TSR and sheet rubber. Different grades and technical specifications.</li> <li>Manufacturing process - equipment and testing. Skills</li> <li>Observing, communication, Experimenting, Inferring</li> </ul>	<ul style="list-style-type: none"> <li>The learner will be able to Describe the different latex concentration techniques and the need for concentration of latex Prepare concentrated latex by creaming Compare creaming and centrifuging methods</li> <li>The learner will be able to Describe the preparation of Ribbed Smoked Sheets and its grading Prepare Ribbed Smoked Sheets</li> <li>The learner will be able to Describe the manufacture of different grades of Crepe Rubber. Describe the manufacture and testing of different grades of Technically Specified rubber Compare Sheet rubber and Technically specified rubber</li> </ul>	<ul style="list-style-type: none"> <li>Interactive Discussion with PPT, Video Show Field Visit Lab practical</li> <li>Interactive Discussion, Video Show Field Visit Lab Practical</li> <li>Interactive Discussion, Video Show Field Visit</li> </ul>	<ul style="list-style-type: none"> <li>Participation in the discussion Oral test Field visit report Lab record</li> <li>Participation in the discussion Oral test Field visit report</li> <li>Participation in the Oral test Field visit report</li> </ul>

## Detailing of Activities

### UNIT - 2.1

#### Concept - History and development of Natural Rubber

#### Suggested strategy

1. General discussion with the help of power point presentation

Teacher shows a PowerPoint presentation containing world map, photographs of Columbus, Henry Wickhalm, etc. and discusses the history and development of natural rubber

The teacher can use the following points to ensure students participation

1. Where the rubber originated?, How it came to India?
2. How the Rubber got the name Rubber
3. Important discoveries in the history of Rubber like mastication, vulcanisation, Tapping etc
4. Sources of natural rubber

2. Data collection

The teacher issues recent issues of rubber journals to the students. The students are asked to collect and present the data regarding the production statistics of Natural rubber. The teacher consolidates the above data

3. Assignment

The students are asked to submit an assignment on the climatic requirements for the optimum growth of rubber trees and the geographic distribution of rubber in India

#### Assessment

Participation in discussion

Oral Assessment

Data collection

Assignment

#### Concept : Harvesting of Natural rubber

#### Suggested strategy

1. Multimedia presentation - Students are shown a Video on rubber tapping. Followed by discussion and consolidation

Consolidation points

Tapping utensils, tapping direction, tapping time, tapping rest, tapping task, tapping systems, rain guarding, yield stimulants

2. Group discussion - on Rubber tapping and the job role of a rubber tapper.

Teacher inputs: Remuneration per tree for tapping  
 Factors affecting the rubber price  
 Future trends

### Assessment

Participation in discussion  
 Oral Assessment

**Concept: Preservation of Natural rubber latex**

### Suggested strategy

The teacher gives a Lab Lecture - on the composition of the latex and spontaneous coagulation

Lab work - Observe the natural coagulation of Natural rubber latex by keeping it over night without preservatives. Add ammonia to fresh latex, observe and record their inferences the next day.

Consolidation points - Composition of latex, protein layer, negative charge on rubber particles, Reason for spontaneous coagulation, requirement of a preservative, Ammonia as a preservative, High ammonia and Low ammonia systems

### Assessment

Participation in discussion  
 Oral Assessment

**Concept: Latex concentration**

### Suggested strategy

1. General discussion with power point - The teacher discusses the need for latex concentration and different latex concentration techniques with PPT.
2. A video show on latex concentration is carried out in the class - The teacher consolidates the student queries
3. Field visit - A field visit to a latex centrifuging / creaming unit is arranged. Students observes the centrifuging/ creaming process and prepares the field visit report - The teacher consolidates the field visit report

Consolidation points

Need for latex concentration, evaporation, electro decandation, creming and cdentrifuging

### Assessment

Participation in discussion  
 Oral Assessment  
 Field visit report

**Concept: Preparation of concentrated latex by creaming****Suggested Strategy**

Lab practical - Teacher conducts a lab lecture on latex creaming and conducts a demonstration of the latex creaming. Students are then asked prepare creamed latex. - The teacher then consolidates the creaming process.

**Consolidation points**

Principle of creaming, creaming agents, Factors affecting creaming

**Assessment**

Participation in discussion

Oral Assessment

Lab record

**Concept : Compare creaming and centrifuging methods of latex concentration**

Comparison chart - The teacher draws two columns on the black board for creaming and centrifuging process and asks the students to contribute to complete the comparison chart. The teacher then consolidates the comparison

**Concept: Preparation of Ribbed Smoked Sheets and its grading****Suggested strategy**

1. Seminar - One student who knows or makes rubber sheets is asked to make a presentation on the preparation of ribbed smoked sheets.
2. Interactive Discussion with video show - Video Show. Teacher consolidates the student queries.
3. Field Visit - Students are divided into groups and are asked to visit a rubber sheet making unit observe the preparation of sheets and their grading.

**Assessment**

Seminar report

Field visit report

Participation in discussion

**Concept: Describe the manufacture of different grades of Crepe Rubber**

1. Interactive discussion with PPT - The teacher discusses the preparation of pale latex crepe and estate brown crepe with the help of power point presentation.

2. Video Show - Teacher conducts a video show on the manufacture of crepe rubber and consolidates the student queries
3. Field visit - A field visit to a crepe manufacturing unit is arranged

### Assessment

Participation in the discussions

Oral Evaluation

Field visit report

### Concept: Manufacture and testing of different grades of Technically Specified rubber

### Suggested strategy

1. Interactive discussion with PPT - The teacher discusses the preparation technically specified rubber (TSR) with the help of power point presentation.
2. Video Show - Teacher conducts a video show on the manufacture of TSR and consolidates the student queries
3. Field visit - A field visit to a TSR manufacturing unit is arranged

### Assessment

Participation in the discussions

Oral Evaluation

Field visit report

### Repository of CE possibilities

Process	Portfolio	Unit Based Evaluation
Discussion related to History and development of natural rubber	Data collection Assignment	Unit test Performance assessment Oral assessment
Discussion related to harvesting of natural rubber latex	Activity log	
Discussion related to concentration of latex	Lab work	
Seminar related to the preparation of RSS	Seminar report	
Video show related the preparation of creep rubber	Activity log	
Video show related the preparation of Technically specified rubber	Activity log	

### Sample question

- 1) "90% of the natural rubber produced in India is from Kerala". Evaluate the climatic requirements for the optimum growth of rubber?
- 2) "Creaming and centrifuging are the widely used methods for the concentration of latex"  
Prepare a comparison chart of creaming and centrifuging process
- 3) "Natural rubber prices in Kerala are down for a while now". Discuss the impact of Natural rubber on Kerala's Economy

### LIST OF TOOLS AND EQUIPMENTS

Sl. No.	Name of Equipments	Quantity
1	Fusion tube	10 packets
2	China dish	30
3	tongs	30
4	Test tube	90
5	Boiling tube	10
6	Bunsen burner	10
7	Gas cylinder	1
8	Test tube stand	30
9	Test tube holder	30
10	hydrometer	1
11	Melting point apparatus	5
12	Universal testing machine	1
13	Mooney viscometer	1
14	Moving die rheometer	1
15	Mechanical stirrer	3
16	Petri dish	60
17	Electronic weighing balance .001 g	1
18	Electronic weighing balance .01 kg	1
19	Beaker 1000ml borosil	5
20	Beaker 500ml	60
21	Beaker 250 ml	6
22	Beaker 100ml	60
23	Beaker 50 ml	60

24	Plastic extruder with accessories .5-50kg/hr	1
25	Two roll mill 6"x12"	1
26	Hydraulic press	1
27	Mould for bush	1
28	Mould for paper weight	1
29	Mould for doormat	1
30	Hand injection moulding machine	1
31	Hand blow moulding machine	1
32	Thermoforming machine	1
33	Dipping tanks	4
34	scissors	5
35	Asbestos gloves	6
36	burette	12
37	Pipette 25ml	10
38	Tripod stand	10
39	Wooden former for balloons	30
40	Ball mill	1
41	Auto clave	1
42	Wooden former for finger cap	30
43	Gloves former	10
44	thermometer	5
45	Oswald viscometer	12
46	Specific gravity bottle 25 cc	24
47	Specific gravity bottle 50cc	6
48	Weighing bottle	30
49	VFA apparatus	48

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- Rubber Technology by Maurice Morton
- Plastic materials by JA Brydson
- Polymer Science and Technology by Joel R. Fried

- A text book of polymers by M. S Bhatnagar, Volume 1 and volume 2
- Rubber Engineering by Indian Rubber Institute
- The Vanderbilt Rubber Handbook by R.T Vanderbilt company
- Automobile Tyres by L. J. K Setright
- Tyre Technology by F. J. Kovac
- Rubber Growers hand book by Rubber board
- Plastics materials and processing by A. Brent Strong
- Additives for Plastics by John Murphy