4.1 RUBBER PROCESSING TECHNIQUES - 1

L	T	P
4	-	6

RATIONALE

The students will be required to understand the principle of basic rubber processing and rubber products.He must be familiar with different rubber machineries like mills, internal mixer, extruder, calendar and moulding operation and safe working practices. He have ability to use mathematics as a tool to solve problems of mixing batch weight, calender gauge weight, extruder die swell, calculation of density of mixed batch, different heating systems and hydraulic process.

DETAILED CONTENTS

1. Storage and handling of materials (6hrs)

   Storage life, FIFO, handling and weighing/batching systems

2. Processing and Processability (8 hrs)

   Review of methods of determining the processability of a rubber mix by different equipment and their application in process control including description, Rapid Plastimeter, Mooney Viscometer - viscosity, scorch time, Rheometer.

3. Extrusion : (20 hrs)

   Basic principles involved;Types of Extruders - Ram/Screw & their comparison.Variations of rubber extruders viz. hot feed, cold feed, pin barrel, vacuum and their comparison, screw design and fee arrangements,Extruder head construction - straight head & cross-head; temperature control unit. Die and Die-swell;Function and layout of ancillary equipment for standard extrusion operations;Trouble shooting of extruder operation.

4. Calendering : (20 hrs)
   Construction, Types and function of calendaring machine;Calendaring processes;
   - frictioning, skim coating & sheeting; Roll floating, roll binding and calendar gauze control devices;Function and layout of ancillary equipment for standard calendaring operation. Trouble shooting of calendaring operation.Other methods of textile coating viz. spreading, dipping - their usefulness, limitation and comparison.

5. Continuous Vulcanisation Methods : (10 hrs)

   General description of methods currently used in industrial practices such as roto-cure, fluidized bed, electron beam and continuous vulcanization by RF, LCM and Hot air, IR and their comparison.

LIST OF PRACTICALS

1. Calculation of density of compound from the rubber compound formulation.
2. Determination of density of raw compound and cured compound.
3. Determination of Rheological property of mixed compound by Rheometer.
4. Curing of rubber compound at different temperature and time.
5. Measurement of properties of cured compound.
6. To produce rubber pipe of 3 different diameters on extruder
7. To study the specification of extruder available in the lab
8. To produce sheets of 3 different thickness on calender.

INSTRUCTIONAL STRATEGY

In rubber industry, this is the basic subject to give knowledge about rubber products, processing behaviour and applications. Hence, in addition to classroom teaching, a visit to local rubber industry should be organized.

RECOMMENDED BOOKS

1. Rubber Technology and Manufacturing by C.M. Blow
2. Rubber Technology Handbook by Werner Hoffmann
3. Introduction of Polymer Sc. & Rubber Technology, Vol I, Ed. by Dr. R. Mukhopadhyay
4. Rubber Engineering, Ed by K.S. Logonathan
5. Rubber Technology, Ed. by Maurice Morton
6. Rubber Processing: An Introduction by Peter S. Johnson

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	06	10
2	08	15
3	20	30
4	20	30
5	10	15
Total	**64**	**100**

4.2 RUBBER TESTING, CHARACTERIZATION AND QUALITY CONTROL

L	T	P
3	-	3

RATIONALE

The diploma holders in Rubber Technology are expected to have knowledge about testing of different rubber products like tyre, tube, belts, footwear, hoses and cables. In addition, they are supposed to have the ability to solve problems of related to Product testing and evaluation. Hence this subject.

DETAILED CONTENTS

1. **Testing methods** (16 hrs)

Testing metods and their significance with respect to product performance, Stress/Strain properties:Tensile strength, Elongation, Modulus, Hardness, Compression set under constant stress/strain – original and after accelerated ageing conditions.Effect of environment and ageing of rubbers; swelling tests, oxidative and thermal ageing, ozone cracking tests.Electrical properties of rubber; determination of resistivity and dielectric strength.Thermal Properties; Thermal Conductivity, Heat Diffusivity - their importance and measurement. Time dependent properties; determination of Creep and Stress relaxation; determination of rebound resilience, effect of temperature on resilience, determination of heat build-up by Goodrich flexometer, effect of temperature frequency and amplitude of vibration on dynamic properties; forced and free vibration machines, determination of loss modulus.

2. **Destructive Tests** (6hrs)

Tensile and Abrasion resistance tests; crack initiation and crack growth by the De Mattia method and Ross Flexing machine, flexural fatigue failure in rubber fabric composite.

3. **Testing of Tyres** (6hrs)

Pulley wheel and plunger testing for endurance Pulley wheel testing for mileage and temperature build up. Measurement of stiffness Rolling resistance Ply to ply adhesion, sidewall to ply adhesion. Breaker / belt to ply adhesion

4. **Testing of Tubes** (4 hrs)

Air permeability testing, growth , set and swelling

5. T**esting of Power Transmission Belt and Conveyor Belt** (2 hrs)

Drum friction test

6 **Testing of Hoses**, (4 hrs)

Leakage test, Bursting strength, Impulse test, Oil resistance, Flame resistance etc

7 **Testing of Cables** : Permittivity, resistivity, die electric strength (4 hrs)

8 **Quality Control** (4 hrs)

Basic concept of statistical quality control, Visual inspection, Testing of a finished product, Analysis of test data to control finished product in relation to service requirement, Special tests on individual products to improve the quality

9. Introduction to Material characterization techniques e. g. NMR, DSC, TGA, XRD (2hrs)

LIST OF PRACTICALS

1. Determination of Mooney viscosity and moony scorch of rubber compound.
2. Determination of Rheometric properties by Rheometer.
3. Determination of hardness of rubber vulcanizate.
4. Determination of stress - strain property of rubber vulcanizate.
5. Determination of ageing property of rubber vulcanizate
6. Determination of textile to rubber adhesion (H-Adhesion)
7. Determination of metal to rubber adhesion (T- Pull Adhesion)
8. Determination of Abrasion resistance of tyre, belt, footwear, hoses etc.
9. Determination of swelling resistance of tyre and tube.
10. To carry outs Environmental stress cracking resistance test on rubber sample.

INSTRUCTIONAL STRATEGY

Different type of rubber articles or products should be given to the student for testing and quality control.

RECOMMENDED BOOKS

1. Rubber Technology and Manufacturing by C.M. Blow
2. Vanderbilt's Rubber Technology Handbook
3. Introduction of Polymer Sc. & Rubber Technology, Vol I, Ed. by Dr. R. Mukhopadhyay
4. Rubber Engineering, Ed. by K.S. Logonathan

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	16	30
2	06	12
3	06	12
4	04	10
5	02	06
6	04	08
7	04	08
8	04	08
9	02	06
Total	**48**	**100**

4.3 UNIT OPERATIONS – II

L	T	P
4	-	3

RATIONALE

A thorough knowledge of unit operations is essential for the study of polymer science and plastic processing. This course acquaints the students with the fundamentals of justify the text thermodynamics, heat transfer and mass transfer.

DETAILED CONTENTS

1. Thermodynamics (24 hrs)

Thermodynamic system, surrounding, property, process, cycle, homogenous and heterogeneous system, thermodynamic equilibrium, ideal gas.

- Correlation and estimation of physical properties;, specific heat at constant pressure and constant volume, heat of reaction, heat of combustion etc.

- First law of thermodynamics: various forms of energy, internal energy, enthalpy, potential energy, kinetic energy, Heat and work.
  Isometric, isothermal, isobaric, isentropic, adiabatic and polytropic processes. Simple problems

  Second law of thermodynamics: Entropy change and its calculations for open and closed systems, carnot cycle, simple problems for calculation of entropy change.

2. Heat Transfer (24 hrs)

- Concept of heat transfer.

- Modes of heat transfer. Conduction, Convection and Radiation; conduction through single, plane walls, composite walls, conduction through cylinders, calculation of heat' load; Fourier's law, thermal conductivity (without heat generation)

- Convection: Natural and forced convection, concept of heat transfer coefficient, LMTD, importance and significance of Reynolds number, Prandtl number, Nusselt number and Grashoff number.

- Radiation : Kirchoffs law, emmissive power, Wein's displacement law, StefanBoltzman's Law; emissivity, absorptivity, black body and grey body radiation, simple problems.

- Boiling, condensation and evaporation.

- Introduction to heat exchangers and its types, Parallel flow and counter flow heat exchangers.

- Evaporators, condensers - their construction, working and applications.

3. Mass Transfer (16 hrs)

Introduction , Modes of mass transfer, Concentrations, Velocities, Fluxes, Fick's Law, Mass Transfer Coefficient, Convective Mass Transfer, Mass transfer through boundary layer, Analogy between Momentum, Heat and Mass transfer, Forced convection mass transfer in laminar flow through tube, Forced convection mass transfer in turbulent flow through tube, Principal of drying and drying equipment, Introduction to humidification and dehumidification

LIST OF PRACTICALS

1. To measure the thermal conductivity of insulating materials
2. To determine overall heat transfer co-efficient in, a double pipe heat exchanger in parallel and counter flow heat exchange modes
3. Measurement of emissivity of test surfaces
4. To prove Stefan- Boltzman's Law
5. To measure diffusivity of solids in liquid or gas
6. To perform an experiment on batch distillation unit and calculate xf, xd and effectiveness
7. To perform an experiment on humidification column
8. To determine the drying characteristics of a given substance (drying rate measurement) and draw the drying curve.
9. To carry out the calibration of a temperature measuring device on temperature calibration test rig
10. To calibrate Bourdon gauge on pressure calibration test rig.

INSTRUCTIONAL STRATEGY

Polymer based industrial problems (numerical) should be given as assignments to make students acquaint with basic principles of unit operations.

RECOMMENDED BOOKS

1. Unit Operations - Vol. I by Chattopadhya, Khanna Publishers, New Delhi.
2. Unit Operations - Vol. II by Chattopadhya, Khanna Publishers, New Delhi.
3. Chemical Engineering Thermodynamics by Dodge, McGraw Hill Publication New Delhi.
4. Introduction to Chemical Engineering Thermodynamics by Smith and Vanness. Published by Tata McGraw Hill Co., New Delhi.
5. Heat Transfer by Kreith published by McGraw Hill Publication New Delhi.
6. Heat Transfer by DQ Kern published by McGraw Hill Publication New Delhi.
7. Mass Transfer Operations by Treybal published by McGraw Hill Publication New Delhi.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	24	40
2	24	40
3	16	20
Total	**64**	**100**

4.4 LATEX TECHNOLOGY

L	T	P
3	-	-

RATIONALE

This subject is designed to enable the students to acquire basic knowledge of latex characteristics and latex compounding for better understanding of rubber related applications. This will help the students to identify different materials to be processed in industry based on their properties.

DETAILED CONTENTS

1. Latex characteristics and Concentration Methods (10 hrs)

Definition of Latex, Classification, Latex particle size and distribution, stability and destabilization of latices, Comparison between Latices and polymer solution. Natural rubber latex –origin, tapping, bulking and preservation, composition of field latex, properties, preservation, methods of concentrating latex- creaming, centrifuging, & evaporation,– Specification and testing- (National and ISO) for latex grades (ASTM D1076)

2. Latex Compounding (10 hrs)

Latex compounding - Ingredients, Preparation of Dispersions, Emulsion, Slurries, Machineries- Ball mill, Pearl mill. Preparation of latex compound and maturation. Prevulcanized latex, MG Latex, -Preparation, properties and application. Evaluation of the latex compound- Chloroform number, swelling index test. Design for latex products
formulation.

3. Dipping Process (10 hrs)

Principle and types of dipping process, Principles of formulations, Dipping plant details, formers, sequence of operation, post processing-Protein allergy. Manufacture of Condoms, Gloves, catheters, Balloons- formulations, process, Specification and testing and troubleshooting.

4. Latex Foam, Sheeting and Spraying (10 hrs)

Principle and Manufacture of Foam-Dunlop and Talalay process, Compound design- Process details, Foam properties, testing and defects, foam applications. Latex sheeting, latex binders and carpet backing - Basics and processes.

5. Extrusion and Products Based onn Synthetic Latex (8 hrs)

Principle and Manufacture of latex elastic threads, latex tubing, toys by casting-process, specification and testing, defects. Synthetic latex-Types, properties, and application-Basics-surface coatings, adhesives, paper industries.

INSTRUCTIONAL STRATEGY

Industrial visit or a laboratory scale process should be shown to the students for better understanding of this subject.

RECOMMENDED BOOKS

1. High Polymer Latices, Volume 1 and 2, by Blackley, D.C.; Maclaren & Sons
2. The Vanderbilt Latex Handbook 3rd edition by Mausser, R.F.
3. Vanderbilt Latex Book on Process and Compounding Ingredients by Waterman, R., Mausser R.F., and Miller, E.E., Published by R T Vanderbilt

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	10	20
2	10	20
3	10	20
4	10	20
5	8	20
Total	48	100

4.5 POLYMER COMPOSITES

L T P
3 - 3

RATIONALE

This cotirse is designed to enable the students to acquire basic knowledge of reinforced rubber. The acquired knowledge will help the students in identifying the need for reinforcements, types of reinforcements and applications of reinforced rubber. Topics like nano-technology will help the students to keep abreast with the latest technological developments.

DETAILED CONTENTS

1. Introduction to composites . Advantages over virgin materials. Principle of Compsite Reinforcement. (02hrs)

2. Classification of Composites (02 hrs)

   - Properties and advantages
   - Particulate reinforced,
   - Fibre reinforced (FRP),
   - Laminates

3. Particulate Reinforced Composites (12 hrs)

   (a) Different types of particulates; carbon black,. Silica, Mica, flyash, talc, CaCo3, metallic powder, nano particulates.(clay, monocellulox etc.)
   (b) Preparation, properties and applications of particulate reinforced plastics including flyash reinforced epoxies and polyesters, nano particles, reinforced polymers .
   (c) Processing of particulate reinforced composites

4. Fibre reinforced plastics (16 hrs)

   Properties, composition and advantages of various types of fibers; Carbon, glass fibers (different types) natural fibers (jute, aramid) boron fibers, man made fibers (acrylic, nylon, polyacrylonitrile)

   Properties and application of FRPs including

   - Glass fibre reinforced polyesters
   - Glass fibre reinforced epoxies
   - Glass fiber with polyurethenes
   - Carbon fibre reinforced epoxies and polyesters

5 Processing and production techniques like hard lay-up, spray-up, bag moulding, filament winding, filtration etc. (10 hrs)

- Types of Laminates
- Rigid and flexible laminate, Plastic - plastic laminates ,
- Plastic - other material (plastic-wood, plastic paper, plastic metal etc.)

6. Polymer blends (6 hrs)

Importance, concept of missibility/compatibility, useful blends such as rubber – plastic rubber-rubber e.g. NBR/PVC,NR/SBR, NR/PBR etc.

LIST OF PRACTICALS

1. Preparation of flyash reinforced composites with polyester and measurement of the tensile strength
2. Preparation of metallic powder (aluminium powder) reinforced epoxy polycate and measurement of its electrical conductivity.
3. Isolation of natural fabrics from Jute
4. Preparation of glass fibre reinforced polyester composites using hand lay-up techniques
5. Determination of filters content in a composite sample
6. Comparison of various fibres like glass fibres and acrylic fibres for strength and other properties.

INSTRUCTIONAL STRATEGY

Industrial visit is highly recommended so as to make the student aware of working conditions in the industry as far as composite technology is concerned**.**

RECOMMENDED BOOKS

1. Handbook of Plastics, Elastomers and Composites Charles by A. Harper; MeGraw Hill Co. New Delhi)
2. Polymer Engineering Composites by Richardson Mew, Applied Sc. Publisher, London
3. Micro Component Polymer Systems, Miller I.S and Rostane S.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	02	06
2	02	06
3	12	24
4	16	34
5	10	20
6	06	10
Total	**48**	**100**

4.6 COMPUTER AIDED MOULD DESIGN

L	T	P
-	-	3

RATIONALE

In this practical subject, the students are required to learn the basics of software such as Mechanical Desktop, Mould Creater, Mould Flow etc. and further to design molds for given components using these software.

DETAILED CONTENTS

1) Surface Modeling

   Various types of surface creation like mesh, ruled surfaced, edged surface, tabulated surface etc. using MDT or AutoCAD.

2) Solid Modeling:

   Various commands like Extrude, Revolve, Blend, Helix, Sweep, Holes, Ribs and Bosses etc. and practice these command making 3D design of different plastics.

3) Analysis and Report generation :

   For calculating stresses on various designs and structures.

4) Interface with Mold-flow and Mold Creator software.

5) Design of various components used in plastic industries and lab exercise

INSTRUCTIONAL STRATEGY

Students should gather practical knowledge about designing of electrical switches, plastic bottles and other liquid packaging plastic containers.

RECOMMENDED SOFTWARE

1. Auto CAD latest version
2. Solid Works
3. Mold-flow/ Mold Creator

INDUSTRIAL TRAINING OF STUDENTS

(during summer vacation after IV Semester)

It is needless to emphasize further the importance of Industrial Training of students during their 3 years of studies at Polytechnics. It is industrial training, which provides an opportunity to students to experience the environment and culture of industrial production units and commercial activities undertaken in field organizations. It prepares student for their future role as diploma engineers in the world of work and enables them to integrate theory with practice. Polytechnics have been arranging industrial training of students of various durations to meet the above objectives.

This document includes guided and supervised industrial training of a minimum of 4 weeks duration to be organised during the semester break starting after second year i.e. after IV Semester examinations. The concerned HODs along with other teachers will guide and help students in arranging appropriate training places relevant to their specific branch. It is suggested that a training schedule may be drawn for each student before starting of the training in consultation with the training providers. Students should also be briefed in advance about the organizational setup, product range, manufacturing process, important machines and materials used in the training organization.

Equally important with the guidance is supervision of students training in the industry/organization by the teachers. A minimum of one visit per week by the teacher is recommended. Students should be encouraged to write daily report in their diary to enable them to write final report and its presentation later on.

An internal assessment of 50 and external assessment of 50 marks have been provided in the study and evaluation scheme of V Semester. Evaluation of professional industrial training report through viva-voce/presentation aims at assessing students understanding of materials, industrial process, practices in industry/field organization and their ability to engage in activities related to problem solving in industrial setup as well as understanding of application of knowledge and skills learnt in real life situations. The formative and summative evaluation may comprise of weightage to performance in testing, general behaviour, quality of report and presentation during viva-voce examination. It is recommended that such evaluations may be carried out by a team comprising of concerned HOD, teachers and representative from industry.

Some of the good industries for industrial training are suggested as follows:

1. Flex Industries, Noida
2. Revex Industries Ltd, Bhiwadi, Rajasthan
3. Apex Plastics Pvt. Ltd, Bhiwadi, Rajasthan
4. Revex Plasticizers Pvt.Ltd, Bhiwadi, Rajasthan
5. Haryana Plastic and Engineering Work, New Delhi
6. Vam Organic Chemical Ltd., Gajraula, Moradabad
7. Blow Plast Industries, New Delhi
8. Machino Plastic Ltd, Gurgaon
9. Minda Industries Ltd., Delhi
10. Super Cassettes Industries, Noida
11. Surya PET, New Delhi
12. Sumi Matherson Innovative Engineering Ltd., Noida
13. Evershine Moulders Ltd., Noida
14. Pramod Plastics Pvt. Ltd., New Delhi
15. Joshi Auto Industries Ltd., Mathura Road, Faridabad
16. Paradise Plastic Enterprises Ltd., Noida
17. Hitkari Industries Ltd., Parwanoo, Distt. Solan, HP
18. Polyplastics, Industrial Area, Yamunanagar, Haryana.