

6.1 ENVIRONMENT AND POLLUTION IN PLASTIC INDUSTRY

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RATIONALE

The objective of this subject is to create awareness in the students about the pollution aspects related to the plastic solid waste disposal, air pollution by plastics waste, incineration, reusability and reprocessing of plastics and bio-degradation of plastics.

DETAILED CONTENTS

1. Environment (6 hrs)
Environment and its components; water, soil, air and living things. Ecosystems, ecological balance, interaction of environment with humans. Cause of ecological imbalance
2. Classification of Plastic Materials (8 hrs)
Natural and synthetic polymer and their compatibility with surroundings (starch and proteins, silicons and other man made fabrics). Life expectancy of different plastics in environment and thermal degradation, biodegradation and photo degradation. Agents for increasing life expectancy of polymers
3. Pollution and Hazards related to Plastics (8 hrs)
Pollution caused by plastics, loading of toxic chemicals from plastics into soil and water (including additives, flame retardants, chonnated additives etc.)
ISI Standards regarding limits of these chemicals in effluents
4. Reusability and Reprocessing of Plastics (10 hrs)
Need and importance of reprocessing. Stages in recycling (primary, secondary and tertiary), Advantages and disadvantages of recycling
5. Plastic Waste Management (8 hrs)
Public awareness regarding hazards caused by indiscriminate use of plastics, proper disposal of plastics. Collection of recyclable plastics. Landfill. Incineration of plastics

6. Use of Plastics in Conservation of Natural Resources (8 hrs)

Mulching, waste water recovery by membrane separation, use of plastics in rain water harvesting, plastic pipes for transportation of potable water (as compared to iron pipes) and canal lining.

LIST OF PRACTICALS

Demonstration/operation of the following practicals (5 experiments)

1. To conduct recyclability test
2. Collection of different plastic wastes and their segregation in various groups
3. Conversion of collected samples into plastic granules
4. Property modification of plastic granules by adding natural material like cellulose
5. Determination of BOD and COD of given samples of effluents of plastic industry
6. Mixing of virgin polymers with recycled polymers (both by melt method and solvent method)
7. To carry out plastic waste management of at least one department/section of the polytechnic

RECOMMENDED BOOKS

1. Plastic Waste Management by Nabil Mustufa; Marcel Dekker
2. Chemistry of Waste Management by Clark
3. Elements of Polymer Degradation by Leo Rich and Stivala; McGraw Hill Company
4. Environmental Sanitation by Baljeet S Kapoor; S Chand and Company, New Delhi
5. Introduction to Environmental Engineering and Science by Gilbert M Masters; Prentice Hall of India, New Delhi
6. Recycling and Recovering of Plastics by Brandrup (Hanser Publications)

6.2 (a) REINFORCED PLASTICS

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RATIONALE

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

DETAILED CONTENTS

1. Types of Reinforcements (2 hrs)

Fiber; types, long and short fibers and particulates. Why to use reinforcements?

2. Classification of Reinforced Plastics (4 hrs)

- FRP (fiber reinforced plastics)
- Particulate reinforced plastics
- Laminates/panels

3. Fiber Reinforced Plastics (13 hrs)

Types of Fibers: carbon, glass fibers (E-glass), natural fibers (jute, aramid etc.), man made fibers (acrylic, nylon, (PAN)

FRPs; Preparation, properties and applications of FRPs including

- Glass fiber reinforced polyesters
- Glass fiber reinforced epoxies
- Glass fiber with polyurethanes
- Carbon fiber reinforced epoxies, polyesters
- Nature fiber reinforced polyesters, polypropylene

4. Particulate Reinforced Plastics (PRP) (17 hrs)

Different types of particulates; carbon black, silica, fly ash, talc, mica, CaCO₃, Metallic powder)

Preparation, properties and applications of PRPs

- Fly ash, reinforced epoxies, polyesters, metal particles filled polyurethanes, epoxies

- Silica reinforced polyurethanes and epoxies
- Talc reinforced silicones

Introduction to Nanoparticles and Nanocomposites based on Nano clay

5. Types of laminates (12 hrs)

- Rigid and flexible laminates
- Plastic – plastic laminates
- Plastic – other material (plastic–wood, plastic-paper, plastic-metal etc.)

Laminates; preparation, properties and applications of following laminates:

- Packing material of potato chips and biscuits
- Plywood

RECOMMENDED BOOKS

1. Handbook of Plastics, Elastomers and Composites by Charles A. Harper; Published by McGraw Hill Company, New Delhi
2. Polymer Engineering Composites by McW Richardson; Published by Applied Science Publishers, London
3. Micro Component Polymer Systems by IS Miller and S Rostame

6.2 (b) RUBBER TECHNOLOGY

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RATIONALE

This course is designed to enable the students to acquire the basic knowledge of natural and synthetic rubber which will enable them to understand the fabrication of rubber articles. This specialized subject will help the students to keep abreast with the latest technological developments.

DETAILED CONTENTS

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| 1. | Sources | (6 hrs) |
| | Historical background of natural and synthetic rubber, production of different grades of natural rubber from latex, smoke sheet and pale creep, rubber elasticity; basic concept and behaviour | |
| 2. | Synthetic rubbers | (6 hrs) |
| | Definition, classification, scope, advantages over natural rubber | |
| 3. | Raw material for synthetic rubbers like polybutadiene rubber, poly isoprene, butyl rubber, chloroprene rubber, nitrile rubber, SBR, EPDM rubber, polyacrylic rubber, silicone rubber, polyurethane rubber | (6 hrs) |
| 4. | Chemistry and technology of vulcanization, sulphur vulcanization, non-sulphur vulcanization, physical aspects of vulcanization | (6 hrs) |
| 5. | Compounding and Reinforcement | (8 hrs) |
| | Carbon black and non-black fillers, plasticizers, softeners, extenders, antioxidants, antiozonants, special purpose additives, textiles | |
| 6. | Processing | (8 hrs) |
| | Mixing, two roll mills, banbury mixer, extrusion, calendaring, coating of textile fabrics, moulding techniques. Injection moulding, transfer molding, batch curing and continuous vulcanization. | |
| 7. | Manufacturing/fabrication of following rubber articles | (8 hrs) |
| | Tyres, belting, hose, cable, footwear | |

RECOMMENDED BOOKS

1. Rubber and Plastics Technology by Premamoy Ghosh, Tata McGraw Hill Publishers, New Delhi McGraw Hill
2. Rubber Technology by M Morton
3. Science and Technology of Rubbers by. Marks, Erman and Eirich
4. Rubber and Plastics Technology by. R Chandra and S Mishra, CBS Publishers and Distributors, New Delhi
5. Rubber Technology and Manufacture by M Blow and C Hopburn

6.2 (c) ADHESIVES AND COATING TECHNOLOGY

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RATIONALE

This course is designed to impart knowledge relating to adhesive and coatings to the students. Study of this course will enable them to learn about the types, raw materials, defects and testing of adhesive and coatings.

DETAILED CONTENTS

Adhesives

1. Introduction to Adhesives (5 hrs)
 Definition of adhesives, classification of adhesives, components of adhesives, various terms like glue line, setting time, solvent cementing etc.
 Effect of various factors on bond strength like pressure, temperature, surface energy, surface preparation, time given for adhesion.
2. Hot Melt Adhesives (4 hrs)
 Definition, applications, preparation, advantages and disadvantages (polyethylenes)
3. Various Resins used in Adhesives (8 hrs)
 Preparation, properties, advantages and limitation of:
 - Urea formaldehyde resin
 - Melamine formaldehyde
 - Epoxies
 - Polyurethanes
4. Types of Adhesives (3 hrs)
 Adhesives for wood, adhesives for metals, adhesives for polymers etc.
5. Testing of Adhesives (4 hrs)
 Mechanical testing, water resistance, water and chemical resistance, oils resistance, fire resistance etc.

Coating Technology

6. Introduction to Coatings (6 hrs)
- Definition, components of coatings (solvent, resin, pigments, stabilizers, additives, filters)
 - Types of coatings - water borne (latex), oil borne coatings, varnishes with and without solvent (elastomeric coatings)
7. Water Soluble Coatings (4 hrs)
- Raw materials, manufacturing, properties and applications
8. Solvent Based Coatings (6 hrs)
- Raw materials, manufacturing, properties of varnishes and applications of epoxy coatings, polyurethane, silicone, polyester coatings
9. Varnishes (4 hrs)
- Raw materials, resin used in varnishes, properties and applications
10. Defects in Coatings (4 hrs)
- Cratering, allytoring, moisture inhepment, peel off, fading, yellowing etc.

RECOMMENDED BOOKS

1. Adhesive Technology by John Delmonk
2. Coatings by Swaraj Paul

6.3 PLASTICS PROCESSING TECHNIQUES - III

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RATIONALE

After fabrication of the product post processing operations are necessary to make the product commercially presentable. Finishing and other decorating and printing operations are instrumental in enhancing the aesthetics and visual appeal of the product. The emphasis is given especially on printing, lamination, coating techniques, compression and transfer moulding and rotational moulding.

DETAILED CONTENTS

1. Compression molding (12 hrs)
 General principles and working of compression molding machine. Types of compression molding machine – hand operated, automatic, single and multi daylight machines, bulk factor, preheating of molds, cycle time ,process variables and their control. Effect of process variables on product properties, compression molding of Semiconductor and DMC compounds
2. Transfer Molding (10 hrs)
 Principles of transfer molding. Types of transfer molding machines, molding cycle ,theoretical calculation of line pressure, injection ram pressure, clamping pressure, pot capacity, compression of transfer molding and compression molding
3. Introduction to Pultrusion, hand lay up technique (4 hrs)
4. Forming (10 hrs)
 Basic principles, method of forming – straight forming, free forming, plug assist forming, drape forming, matched mold forming, slip forming, snap back forming, reverse draw forming, limitations and advantages of forming, materials for thermoforming, types of heating systems
5. Casting (6 hrs)
 Introduction, casting of PMMA, unsaturated polyesters and phenolic resins

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| 6. | Calendering | (6 hrs) |
| | Introduction to calendering, types of calenders, advantages, limitations of calendering and major applications | |
| 7. | Rotational molding of large containers | (4 hrs) |
| 8. | Foam Molding | (4 hrs) |
| | Definition of molding, processes, blowing agents, applications | |
| 9. | Finishing of Plastics | (8 hrs) |
| | Cutting, turning, drilling, sanding, polishing different types of welding | |

LIST OF PRACTICALS

1. To produce small components on hand operated compression molding machine
2. To produce components on automatic/semi automatic compression molding machine
3. To produce articles on vacuum forming machine
4. To do casting of polyester resin
5. To do casting of PMMA
6. Exercises on high frequency PVC welding machine
7. Preparation of FRP sheet by hand lay up technique

RECOMMENDED BOOKS

1. Basic Engineering Handbook by Michael L Berins
2. Plastic Processing Data Handbook by Rosato and Rosato

6.4 ENTREPRENEURSHIP DEVELOPMENT AND MANAGEMENT

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RATIONALE

Entrepreneurship Development and Management is one of the core competencies of technical human resource. Creating awareness regarding entrepreneurial traits, entrepreneurial support system, opportunity identification, project report preparation and understanding of legal and managerial aspects can be helpful in motivating technical/vocational stream students to start their own small scale business/enterprise. Based on the broad competencies listed above, following detailed contents are arrived to develop the stated competencies.

DETAILED CONTENTS

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| (1) | Entrepreneurship | (4 hrs) |
| | 1.1 Concept/Meaning | |
| | 1.2 Need | |
| | 1.3 Competencies/qualities of an entrepreneur | |
| (2) | Entrepreneurial Support System | (6 hrs) |
| | 2.1 District Industry Centres (DICs) | |
| | 2.2 Commercial Banks | |
| | 2.3 State Financial Corporations | |
| | 2.4 Small Industries Service Institutes (SISIs), Small Industries Development Bank of India (SIDBI), National Bank for Agriculture and Rural Development (NABARD), National Small Industries Corporation (NSIC) and other relevant institutions/organizations at State level | |
| (3) | Market Survey and Opportunity Identification (Business Planning) | (6 hrs) |
| | 3.1 How to start a small scale industry | |
| | 3.2 Procedures for registration of small scale industry | |
| | 3.3 List of items reserved for exclusive manufacture in small scale industry | |
| | 3.4 Assessment of demand and supply in potential areas of growth | |
| | 3.5 Understanding business opportunity | |
| | 3.6 Considerations in product selection | |
| | 3.7 Data collection for setting up small ventures | |
| (4) | Project Report Preparation | (6 hrs) |
| | 4.1 Preliminary Project Report | |
| | 4.2 Techno-Economic feasibility report | |
| | 4.3 Project Viability | |

- (5) Managerial Aspects of Small Business (8 hrs)
- 5.1 Principles of Management (Definition, functions of management viz planning, organisation, coordination and control)
 - 5.2 Operational Aspects of Production
 - 5.3 Inventory Management
 - 5.4 Basic principles of financial management
 - 5.5 Marketing Techniques
 - 5.6 Personnel Management
 - 5.7 Importance of Communication in business
- (6) Legal Aspects of Small Business (6 hrs)
- 6.1 Elementary knowledge of Income Tax, Sales Tax, Patent Rules, Excise Rules
 - 6.2 Factory Act and Payment of Wages Act
- (7) Environmental considerations (6 hrs)
- 7.1 Concept of ecology and environment
 - 7.2 Factors contributing to Air, Water, Noise pollution
 - 7.3 Air, water and noise pollution standards and control
 - 7.4 Personal Protection Equipment (PPEs) for safety at work places
- (8) Miscellaneous (6 hrs)
- 8.1 Human relations and performance in organization
 - 8.2 Industrial Relations and Disputes
 - 8.3 Relations with subordinates, peers and superiors
 - 8.4 Motivation – Incentives, Rewards, Job Satisfaction
 - 8.5 Leadership
 - 8.6 Labour Welfare
 - 8.7 Workers participation in management

RECOMMENDED BOOKS

1. A Handbook of Entrepreneurship, Edited by BS Rathore and Dr JS Saini; Aapga Publications, Panchkula (Haryana)
2. Entrepreneurship Development by CB Gupta and P Srinivasan, Sultan Chand and Sons, New Delhi
3. Environmental Engineering and Management by Suresh K Dhamija, SK Kataria and Sons, New Delhi

4. Environmental and Pollution Awareness by Sharma BR, Satya Prakashan , New Delhi
5. Thakur Kailash, Environmental Protection Law and policy in India: Deep and Deep Publications, New Delhi
6. Handbook of Small Scale Industry by PM Bhandari
7. Marketing Management by Philip Kotler, Prentice Hall of India, New Delhi
8. Total Quality Management by Dr DD Sharma, Sultan Chand and Sons, New Delhi.
9. Principles of Management by Philip Kotler TEE Publication

6.5 MAINTENANCE OF PLASTIC PROCESSING MACHINERY

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RATIONALE

Most of the diploma holders get employment in plastic processing industry, where they operate processing machinery and manage production. The purpose of this subject is to equip the students with the knowledge of repair and maintenance of such machines and equipments.

DETAILED CONTENTS

1. Maintenance, objective of maintenance, importance of maintenance, preventive maintenance, breakdown maintenance, predictive maintenance, schedule maintenance, maintenance planning (10 hrs)
2. Factors to be considered by installation/erection and commissioning of plastic processing machinery. Vibrations and foundation. General method of alignment/levelling (10 hrs)
3. Repair and maintenance of following electrical equipments (22 hrs)
 - Electrical induction motors (slipping motors and squirrel cage motors), variable speed motors, their characteristics and speed control
 - Starters, circuit breakers (air circuit breakers, oil circuit breakers and miniature circuit breakers)
 - Brief introduction to limit switches timers, relays, temperature controllers, and thermocouples, heaters (ordinary and ceramic type)
 - Study of safety rules and regulations
4. Repair and maintenance of following components used in plastics processing machinery (22 hrs)
 - Barrel, screw, thrust unit, primary gearboxes, calender roll, mill roll
 - Pumps – gear pump, piston pump, radial/axial pump and screw pump
 - Valves, valve sequences, valve counted balance, break valve, pressure reducing valve throttle valve, different control valves, solenoid valves
 - Hydraulic motors, hydraulic actuators, filters, compressors, oil seeds, o-rings
 - Lubrication system-central lubrication system
 - Transmission system i.e. gears, v-belts, chains

LIST OF PRACTICALS

1. Installation, commissioning of plastics machines
2. To check the line alignment/levelling of various machinery like PVC pipe plant, injection molding machine and blow molding machine
3. Repair and maintenance of hydraulic system in machines such as injection molding, blow molding machines
4. Positive and hydraulic actuators and motors
5. Lubrication system, central lubrication system, o-rings, oil seals
6. To carry out break down maintenance of electrical equipments like induction motors, variable speed motors, circuit breakers used in plastics processing machinery
7. Temperature control and thermocouples
8. Heater repair
9. Transmission systems
10. To carry out the preventive maintenance of machines like injection molding machine, blow molding machine, PVC pipe plant, CNC injection molding machine
11. Repair and maintenance of various pumps

6.6 MAJOR PROJECT WORK

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Project work aims at developing skills in the students whereby they apply the totality of knowledge and skills gained through the course in the solution of particular problem or undertaking a project. The students have various aptitudes and strengths. Project work, therefore, should match the strengths of students. For this purpose, students should be asked to identify the type of project work, they would like to execute. It is also essential that the faculty of the respective department may have a brainstorming session to identify suitable project assignments. The project assignment can be individual assignment or a group assignment. There should not be more than 3 students if the project work is given for a group. The students should identify or given project assignment at least two to three months in advance. The project work identified in collaboration with industry may be preferred.

Each teacher is expected to guide the project work of 5-6 students.

- Projects related to designing new dies, moulds, jigs and fixtures
- Projects related to increasing productivity
- Projects related to quality assurance
- Projects related to estimation and economics of production
- Projects connected with repair and maintenance of plant and equipment
- Projects related to identification of raw material thereby reducing the wastage
- Projects related to suggesting substitutes of the polymer being used
- Any other related problems of interest of host industry

A suggestive criteria for assessing student performance by the external (personnel from industry) and internal (teacher) examiner is given in table below:

Sr. No.	Performance criteria	Max.** marks	Rating Scale				
			Excellent	Very good	Good	Fair	Poor
1.	Selection of project assignment	10	10	8	6	4	2
2.	Planning and execution of considerations	10	10	8	6	4	2
3.	Quality of performance	20	20	16	12	8	4
4.	Providing solution of the problems or production of final product	20	20	16	12	8	4
5.	Sense of responsibility	10	10	8	6	4	2
6.	Self expression/ communication skills	5	5	4	3	2	1
7.	Interpersonal skills/human relations	5	5	4	3	2	1
8.	Report writing skills	10	10	8	6	4	2
9.	Viva voce	10	10	8	6	4	2
Total marks		100	100	80	60	40	20

The overall grading of the practical training shall be made as per following table

	Range of maximum marks	Overall grade
i)	More than 80	Excellent
ii)	79 <> 65	Very good
iii)	64 <> 50	Good
iv)	49 <> 40	Fair
v)	Less than 40	Poor

In order to qualify for the diploma, students must get “Overall Good grade” failing which the students may be given one more chance of undergoing 8 -10 weeks of project oriented professional training in the same industry and re-evaluated before being disqualified and declared “not eligible to receive diploma”. It is also important to note that the students must get more than six “goods” or above “good” grade in different performance criteria items in order to get “Overall Good” grade.

Important Notes

- 1. This criteria must be followed by the internal and external examiner and they should see the daily, weekly and monthly reports while awarding marks as per the above criteria.**
- 2. The criteria for evaluation of the students have been worked out for 100 maximum marks. The internal and external examiners will evaluate students separately and give marks as per the study and evaluation scheme of examination.**
- 3. The external examiner, preferably, a person from industry/organization, who has been associated with the project-oriented professional training of the students, should evaluate the students performance as per the above criteria.**
- 4. It is also proposed that two students or two projects which are rated best be given merit certificate at the time of annual day of the institute. It would be better if specific nearby industries are approached for instituting such awards.**

The teachers are free to evolve another criteria of assessment, depending upon the type of project work.

It is proposed that the institute may organize an annual exhibition of the project work done by the students and invite leading Industrial organisations in such an exhibition. It is also proposed that two students or two projects which are rated best be given merit certificate at the time of annual day of the institute. It would be better if specific industries are approached for instituting such awards.