



UTTARAKHAND BOARD OF TECHNICAL EDUCATION
JOINT ENTRANCE EXAMINATION AND TRAINING, RESEARCH DEVELOPMENT CELL, DEHRADUN
STUDY AND EVALUATION SCHEME FOR DIPLOMA PROGRAMME

BRANCH NAME – CHEMICAL TECHNOLOGY (RUBBER & PLASTIC)

SEMESTER – V

Subject Code	Subject	L	T	P	T	O	EVALUATION SCHEME						Total Marks	Credit Point
							Internal			External				
							Theory Max Marks	Practical Max Marks	Theory Hrs.	Theory Max Marks	Practical Max Marks	Practical Hrs.		
285002	Quality Control and Testing of Rubber and Plastic	5	-	4	9		40	30	50	2.5	50	3.0	170	7
285003	Rubber and Plastic Processing	6	-	4	10		40	30	50	2.5	50	3.0	170	7
285001	Composite Technology	6	-	4	10		40	20	50	2.5	50	3.0	160	6
015001	Mass Transfer Operations**	6	-	4	10		50	50	50	2.5	50	3.0	200	7
015002	Reaction Engineering **	5	-	-	5		50	-	50	2.5	-	-	100	5
285052	Industrial Exposure (assessment at Institute level)	-	-	-	-		-	25	-	-	-	-	25	1
285053	Industrial Training (4 week industrial training perform in 4th semester in summer vacation)	-	-	-	-		-	50	-	-	100	3.0	150	1
015054	General Proficiency #	-	-	4	4		-	25	-	-	-	-	25	1
	Total	28	-	20	48		220	230	250	-	300	-	1000	35

** Common with diploma programme in Chemical Technology (Paint) and Chemical Technology (Rubber & Plastic).

General Proficiency will comprise of various Co-curricular activities like games, hobby clubs, seminars, declamation contests, extension lectures, field visits, NCC, NSS and cultural activities, G.K., general study, elementary math and discipline.

++ Industrial visit compulsory at minimum two industries or departments.

Note- 1- Each period will be of 50 minutes. 2- Session will be of 16 weeks. 3- Effective teaching will be of at least 12.5 weeks.

Branch Code - 28



**FIFTH SEMESTER
CHEMICAL TECHNOLOGY (RUBBER & PLASTIC)**



QUALITY CONTROL AND TESTING OF RUBBER & PLASTIC

Subject Code : 285002

L	T	P
5	-	4

RATIONALE

It is necessary to test the new materials and the product during various stages of their manufacture to control the quality. The subject provides the essential knowledge and skills for the tests to measure variation and determination of plastic and rubber. This enables the students to take corrective action to be taken in factory to improve the uniformity and serviceability of the finished articles.

DETAILED CONTENTS

1. Over view of various testing methods and organization such as ASTM, BIS, DIN& ISO **(08 hrs)**
2. Test preparation methods: milling, punching, template, cutting from sheets and film products. **(08 hrs)**
3. Amino plastics-introduction ,Urea formaldehyde resin ,. Melamine formaldehyde resin-introduction, theories of resinification. Melamines phenolic resins, aniline –formaldehyde resins. curing of glycedaple resin Poly ester resin-introduction , theories of resinification. epoxide resin-introduction, theories of resinification. Preparation of resin from bis Phenol A.Preparation of Epichlorohydrin. Application of urea formaldehyde resin, Melamine formaldehyde resin Poly ester resin and Epichlorohydrin **(22 hrs)**
4. **Tests for Plastic**
 - (a) Physical properties: Visual burning and heating, specific gravity, water absorption, Moisture content analysis. **(08 hrs)**
 - (b) Test for readily detectable elements and group analysis **(08 hrs)**
 - (c) Physical Testing of Plastics: Mechanical properties: Short term mechanical properties: Tensile strength, impact strength (izod & Charpy) flexural strength, fatigue resistance, compression strength,. Short term mechanical properties: Creap and stress relaxation **(10 hrs)**

LIST OF PRACTICALS

1. Study and design impact strength (izod and charpy).
2. Study stress and creep relation via curve.
- 3 Study the Melt Flow Index (MFI).
- 4 Study flexural strength.

- 5 Study compressive strength..
- 6 Study fatigue resistance.

INSTRUCTIONAL STRATEGY

It is a practical oriented subject which should be taught along with practicals like those for mechanical properties and physical characteristics.

RECOMMENDED BOOKS

1. Testing of Plastic by Roger Brown
2. Plastics Testing: Vishu Shah
3. Rubber Technology & Alexander S. Craig, liver & boyd Publsihers
4. Rubber Technology and Manufacture by G.P. Maurya SBP Publishers
5. Polymer Science and Technology, Premamoy Ghosh (2nd Ed.), Tata McGraw

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	08	15
2	08	15
3	22	40
4	08	10
5	08	10
6	10	10
Total	64	100

RUBBER AND PLASTIC PROCESSING

Subject Code : 285003

L	T	P
6	-	4

RATIONALE

The purpose of this subject is to equip the students with the knowledge of Extrusion Process, Blow Moulding and Calendaring Operations. This subject develops the competence of the students in major industrially practical processing techniques.

DETAILED CONTENTS

1. Extrusion Process (33 hrs)

- Introduction to extrusion process Different types of extrusion (Ram, Single Screw, Twin Screw, Vented Barrel Extruder). General/principle of operation, functions of various parts of extruder (barrel, screw, screen, die, breaker plate, and adapter)
- Types of screws For use of different plastics, heating systems and different zones (feed, compression and metering)
- L/D ratio, compression Ratio, and processing output calculation .
- Blown film production, pipe, wire and cable coating , cooling rings, guessetting device, bubble casing, winding equipment, stretching and orientation, effect of variables on product quality.

2. Co – Extrusion Process – Blow moulding (21 hrs)

- Principles, process parameters, description of blow moulding machines, types of materials used and limitation of blow mould, and its significance.
- Blow moulding of irregular containers.
- Decoration of Blow Moulding products

3. Calendaring (10 hrs)

Process, material used, advantages of calendaring over extrusion, coating by calendaring.

LIST OF PRACTICALS

- Study of single screw extrusion
- Study the calendaring process

3. Study of pipe and wire coating
4. Study of blow moulding machine.
5. Study of bag making process.
6. Study of feed ,compression and transmission zone of extruder.
7. Study of blow moulding parameter.

INSTRUCTIONAL STRATEGY

As the subject involves lot of processing, field visit is must to give details about various processing techniques used in rubber as well as plastic industries. Small and simple experiments/practicals will give idea about operational aspect of rubber and plastic industries.

LIST OF RECOMMENDED BOOKS

1. Plastic Engineering Handbook by Michael L. Berins
2. Plastic Extrusion Technology by Griff, Reinhold Book Corporation., London
3. Plastic Processing Data Handbook by DV Rosato
4. Extrusion of Plastics by Fischer, Itiffe London Publication.
5. Blow moulding by Fischer, Itiffe London Publication.

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	33	55
2	21	40
3	10	15
Total	64	100

L	T	P
6	-	4

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. Introduction to composites .Advantages over virgin materials (06 hrs)**

Principle of Composite Reinforcement

2. Classification of Composites (Properties and advantages) (06 hrs)

- Particulate reinforced
- Fibre reinforced (FRP)
- Laminates

3. Particulate Reinforced Composites (16 hrs.)

- (a) Different types of particulates; carbon black,. High Silica, Mica, graphite fibre, quartz, comparison of high silica and quartz on the basis of property. CaCO₃, metallic powder, nano particulates.
- (b) Preparation, and properties of particulate reinforced plastics
- (c) Application of particulate reinforced composites

4. Fibre reinforced plastics (20 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)

Properties and application of FRPs including

- Glass fibre reinforced polyesters
- Glass fibre reinforced epoxies

- Glass fiber polyurethanes
- Carbon fibre reinforced epoxies and polyesters
- Nature fibre reinforced polyesters, polypropylene.

5. Processing techniques like hard lay-up, spray-up, bag moulding, filament winding, etc. (16 hrs)

Types of Laminates

- Rigid and flexible laminate
- Plastic – plastic laminates

Preparation and properties and application of following laminates

- Packing material of food materials

Introduction to packaging, packaging of food material, scope of packaging and function of packaging.

LIST OF PRACTICALS

1. Study particulate reinforce composite
2. Study fibre reinforced plastics..
3. Study man made fibre and their articles.
4. Study jute and nylon fibre article and their article.
5. Study jute and acrylic fibre and their articles.
6. Study laminates through packaging material and packaging materials.
7. Study bag moulding technique.
8. Study filament winding technique and the articles who are made by this techniques.

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.

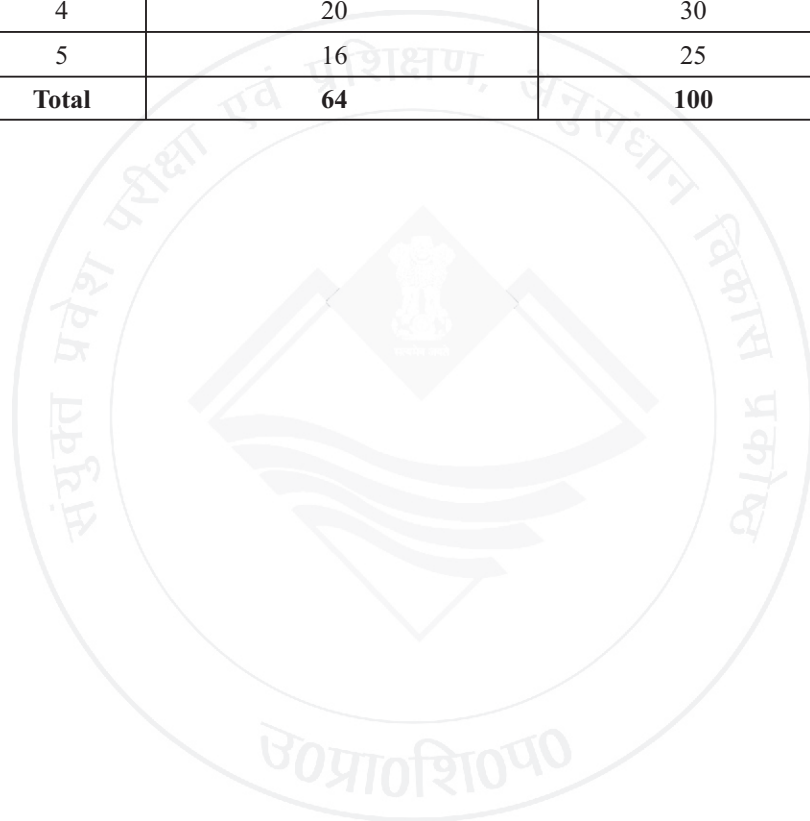
RECOMMENDED BOOKS

1. Handbook of plastics, elastomers and composites Charles A. Harper (Mc Graw Hill Co. New Delhi)
2. Polymer Engineering Composites by Richardson Mcw, 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	06	10
2	06	10
3	16	25
4	20	30
5	16	25
Total	64	100



L	T	P
6	-	4

RATIONALE

In this subject the basic concepts of mass transfer are covered to enable the students to understand working of various mass transfer equipment like distillation column, gas absorption column, dryers, cooling towers and extraction column etc. which are used in industries for purification of products.

DETAILED CONTENTS**1. Mass transfer (20 Periods)**

Definition of diffusion, Rate of diffusion in Mass Transfer, Fick's law, Maxwell law of diffusion, diffusivity, diffusion in the gas phase-Equimolecular counter diffusion and nondiffusing diffusion, diffusion in the liquid phase-Equimolecular counter diffusion and nondiffusing diffusion., Mass Transfer Coefficient. Film theory and penetration theory of Mass Transfer,

2 Gas Absorption (20 periods)

Condition of equilibrium between liquid and gas, mechanism of absorption two film theory. Diffusion of a gas through a stagnant gas, diffusion in liquid phase, rate of absorption, relation between film and overall coefficients, rate of absorption in terms of mole fraction, factors affecting transfer coefficients.

Packed Tower

Properties of tower packing, types of packing, Channeling, Minimum liquid gas ratio Loading and Flooding Capacity of packed tower Material balance and design equation, height of column based on conditions in gas film and liquid film, height of column based on overall coefficient, the operating line and graphical integration for height of column. Concept of transfer unit. H.E.T.P. for packed column of distillation, relation of H.T.U. to H.E.T.P... Derivation of the following relations

$$1. \frac{1}{K_{Ga}} = \frac{1}{k_{G,a}} + \frac{m}{k_{L,a}}$$

$$2. \frac{1}{K_{La}} = \frac{1}{k_{L,a}} + \frac{m}{k_{G,a}}$$

3. Distillation

(30 Periods)

a) Various distillation methods

- i) Equilibrium or flash distillation
- ii) Differential distillation
- iii) Batch distillation
- iv) Vacuum and Steam distillation
- v) Azeotropic and Extractive distillation.

b) Types of distillation columns

- i) Perforated plate or sieve plate column
- ii) Bubble cap plate column
- iii) Packed column and fractionating column accessories.

c) Boiling point diagrams

Raoult's law; Henry's law, Relative volatility, constant boiling mixtures, equilibrium diagram and construction of equilibrium diagram, Fractionating column calculation-Heat & material balance, Reflux ratio, equilibrium plate, Location of feed plate. Sub cooled reflux; effect of reflux ratio, Total reflux, Minimum reflux ratio Entrainment; McCabe Thiele diagram-section above and below feed plate; Intersection of operating line. Location of q-line, derivation of q line, optimum reflux ratio, calculation of no. of equilibrium plates by Mc-Cable Thiele diagram. Overall plate efficiency.

4. Extraction

(08 Periods)

- i) Applications of this extraction
- ii) Choice of solvent
- iii) Steps of extraction operation
- iv) Solid Liquid extraction, construction and description of
 - Moving solid bed Basket type oil seed extractor or Boll man extractor
 - Rotocel extractor
- v) Liquid extractor; description and construction of
 - Mixer settler extraction system
 - Spray and packed extraction tower

5. Humidification

(10 Periods)

Definition and calculation of

- i) Humidity

- ii) Percentage humidity
- iii) Relative humidity
- iv) Humid volume
- v) Humid heat
- vi) Enthalpy and its calculation
- vii) Dry bulb and wet bulb-temp
- viii) Adiabatic saturation temperature
- ix) Use of humidity chart. Dew point, simple numerical problem using humidity chart, construction and description of cooling towers (Natural and induced draft)

6. Drying

(08 Periods)

General drying behavior-Critical moisture content, equilibrium moisture contents, description and construction of dryer.

- i) Tray dryer
- ii) Screen conveyor dryer
- iii) Rotary dryer.

NOTE: At least one question from each topic

LIST OF PRACTICALS

1. To study the rate of drying in a vacuum dryer
2. To determine the pounds of volatile compounds distilled per unit pounds of steam distilled in a steam distillation operation
3. To determine rate of setting of crystals in a crystallizer
4. To study the rate of drying in rotary dryer
5. To determine drying rate for a wet materials
6. To determine drying rate for a wet material in a tray dryer
7. To study packed tower in various industries
8. To study various extractors in solvent extraction plant
9. To study a spray pond in a sugar and other industries for cooling system
10. To find out the drying characteristics of given sample and draw drying rate curve by infra-red moisture meter and rapid moisture meter
11. To study sketch and operation of strip chart recorder and directing pen recorder

INSTRUCTIONAL STRATEGY

Field visit will make the students familiar with different types of column

(packed/tray) and different types of packings/trays used in the column. This will also make the students aware of auxiliary equipment/manholes/ supports used for the columns. Along with the theoretical part, emphasis should be given to problem solving and practices especially for distillation column, absorption and humidification.

RECOMMENDED BOOKS

1. Mass Transfer Operations by Trybal
2. Unit Operation by McCabe and Smith
3. Mass Transfer I & II by Bhattacharya
4. Mass Transfer by Gavhane
5. Mass Transfer by Badger

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	20	15
2	20	15
3	30	35
4	08	10
5	10	15
6	08	10
Total	96	100

Subject Code : 015002

L	T	P
5	-	-

RATIONALE

It is a core subject of chemical engineering and is essential for understanding the kinetics of various types of reaction vessels and the performance of reactive system used in industry.

DETAILED CONTENTS**1. Introduction****(5 periods)**

What is reaction engineering? Chemical kinetics & their dynamics classification of chemical reactions. Based on (i) Phases involved, (ii) Catalytic and non-catalytic reactions, (iii) Molecularity of a reaction, (iv) Heat effect, (v) based on order of reactions, (vi) reversible and irreversible reactions.

2. Homogeneous Reactions**(20 periods)**

Rate of chemical reaction, factors affecting the rate of reaction. Concentration dependent term of a rate equation. Rate constant, Elementary and non-elementary reaction. Difference between elementary and non-elementary reactions. Molecularity of a reaction, order of a reaction. Difference between molecularity & order of reaction. Representation of an elementary & non-elementary reaction. Temperature dependent term of a rate of equation, Temperature dependency from Arrhenius law, collision theory & thermodynamics. Activation energy & its significance, activation energy & temperature dependency. Simple numerical problems,

3. Interpretation of constant volume batch reactor data**(35 periods)**

Kinetic run, kinetic data or rate data, integral method of analyses of rate of data, differential method of analysis of rate of data. Integral V/s differential method, Constant volume batch reactor, conversion, relation of concentration and conversion for constant volume batch reactor.

Find out the concentration of component B, C & D in

(a) Chemical reaction of the type $aA + bB \rightarrow cC + dD$ and for

(b) For flow systems .

Analysis of total pressure data obtained in a constant volume system ,use of ideal gas law .To calculate C_{A0} .

Integral method of analysis of rate data ;integrated rate expression for different order of reactions :

(A) Irreversible unimolecular type first order reactions :

- i . Integrated rate equation or expression for the first order reaction in terms of concentration Relation between half life and rate constant .
- ii . Integrated rate equation or expression for the first order reaction in terms of conversion

(B) Irreversible bimolecular type second order reaction :

- i . Integrated rate equation or expression for the second order reaction in terms of concentration Relation between half life and rate constant and concentration .
- ii . Integrated rate equation or expression for the second order reaction in term of conversion .
- iii . Integrated rate equation for second order reaction with C_{A0} C_{B0} in terms of concentration .
- iv . Integrated rate equation or expression for second order reaction with C_{A0} C_{B0} In term of conversion .

(C) Zero order reaction : zero order reaction in terms of concentration & Conversion Characteristics of zero order reaction .

(D) Empirical rate equation of nth order . Determination of overall order of irreversible reaction from half life , Irreversible reaction in parallel series & homogeneous catalyzed reactions , Auto catalytic reactions , Reversible reactions : Reversible reactions of unimolecular type first order reactions , reversible unimolecular type second order reactions .

(E) Differential method of analysis of data :

- I) Step by step procedure for analysis of the complete rate equation by differential method .
- II) Variable volume batch reactor : - Unimolecular type general reaction expression in which the volume is a liner function of conversion of a reactant . An integrated rate expression for first order reaction for variable volume system . Integrated rate expression for zero order reaction for a variable volume system .

Bimolecular type reactions : integrated rate expression for first & second order reactions Simple numerical problems .

4 . Ideal Reactors

20 periods)

Classification of reactors based on

- a . Shape & size
 - i . Tank reactors
 - ii . Tubular reactors
- b . Based on mode of operation
 - i . Batch reactors
 - ii . Semi batch reactors
 - iii Continuous flow reactors

Application advantages disadvantages and comparison of reactors .

Relation between CA & XA .Ideal batch reactor : -Performance design equation for batch reactor for constant volume constant density and for variable volume density reaction system .The performance measures of flow reactors : - Space time and space velocity .Steady state mixed flow reactors (CSTR) The performance equation for constant and variable volume density reaction system . Steady state plug flow reactor : Performance equation for plug flow reactor for first order reaction in case of constant density and variable density system . Holding time and space time for flow reactors .

INSTRUCTIONAL STRATEGY

Simple models can be made to show batch reactors ,plug flow reactors and continuous reactors .Emphasis should be laid on problem solving /numerical solving for rate constants and temperature dependence of rate constant .

RECOMMENDED BOOKS

- 1 . Chemical Reaction Engineering by Levenspiel ,Job Wiley Publications
- 2 . Chemical Engineering Kinetics by Smith ,McGraw Hill Publication
- 3 . Elements of Chemical Reaction engineering by Fogler ,Prentice Hall of India
- 4 . Reaction Kinetics for Chemical Engineering by Wales , McGraw Hill Publication
- 5 . Chemical Reactin Theory ? An Introduction by Denbigh and Turner ,Cambridge University Press Publication

SUGGESTED DISTRIBUTION OF MARKS

Topic No.	Time Allotted (Hrs)	Marks Allotted (%)
1	05	10
2	20	20
3	35	50
4	20	20
Total	80	100





LEARNING OUT COMES AND MEANS OF ASSESSMENT

BRANCH NAME – CHEMICAL TECHNOLOGY (RUBBER AND PLASTIC)

SEMESTER – V

S.No.	Title of Subject/Unit	Learning Outcomes	Means of Assessment
1	Quality Control and Testing of Rubber and Plastic-I	It provides the essential knowledge and skills for the test of new materials, measure variation and determination of rubber and plastic. Corrective actions to improve the uniformity and serviceability of finished articles.	Assignments, Quizzes, Seminars, Class Test, Power Point Presentation. Practical assessment is done through program result, practical files and Viva voce.
2	Rubber and Plastic Processing	It provides knowledge of processes like extrusion process, blow moulding and calendaring operations. With the help of this knowledge students made the articles in industries.	Assignments, Quizzes, Class Test, Mid Term Examination & Semester examination. Practical assessment is done through practical test results, practical files and Viva voce.
3	Composite Technology	Students acquire the basic knowledge of composites, identifying the need of reinforcement, types of reinforcement and applications of reinforced plastics. Processing techniques for the preparation of composites.	Assignments, Quizzes, Class Test, Mid Term Examination & Semester examination. Practical assessment is done through practical test results, practical files and Viva voce.
4	Mass Transfer Operations	It will be able to provide the basic concepts, working of mass transfer equipments like distillation column, gas absorption column, dryers, cooling towers, extractors etc.	Assignments, Quizzes, Seminars, Class Test, Mid Term Examination & Semester examination. Practical assessment is done through practical test results, practical files and Viva voce.
5	Reaction Engineering	This subject provides sufficient knowledge of understanding Reaction kinetics, Study and evaluation of various types of reaction vessels, Reactor design, Interpretation of data.	Assignments, Seminars, Class Test, Mid Term Examination & Semester examination.