# CONCEPTS OF HEAT TRANSFER

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| CODE PL 201 / CH 201 | 2 | -- | 2 |

## RATIONALE

This subject is very important for chemical engineering students because every chemical industry use heat transfer equipments like heat exchangers, condensers, evaporators etc., so knowledge of this subject helps them a lot.

## CONTENTS

**1. Introduction:**

1.1 Definition
1.2 Analogy between flow of heat and electricity
1.3 Modes of heat transfer.

**2. Conduction:**

2.1 The thermal conductivity
2.2 Fourier's law of heat conduction
2.3 Unsteady state equation
2.4 Steady state equation
2.5 Heat flow equation for composite walls
2.6 Composite cylinders
2.7 Spheres
2.8 Optimum insulation thickness

**3. Dimensional Analysis:**

3.1 Criteria of Similitude
3.2 Buckingham $\pi$ theorem
3.3 Advantages and limitations of dimensional analysis
3.4 Dimensionless number for heat transfer and their physical significance

**4. Temperature:**

4.1 True temperature difference
4.2 Log mean temperature difference
4.3 Difference between normal temperature difference and Log mean temperature difference

**5. Convection:**

5.1 Natural and forced convection
5.2 Energy transfer mechanism through the boundary layer
5.3 Thermal and hydrodynamic boundary layer

**6. Double pipe heat exchanger:**

6.1 Constructional detail and working
6.2 Overall and surface heat transfer coefficient
6.3 Process instrumentation drawing

**7. Shell and tube heat exchanger:**

7.1 Construction detail and working
7.2 Temperature profiles of 1-1 cocurrent and counter current.
7.3 1-2 parallel and counter flow exchanger
7.4 Process instrumentation drawing

**8. Plate type heat exchanger:**

8.1 Construction detail and working
8.2 Uses and application

**PRACTICALS**

1. To study the heat transfer between hot and cold fluids in a double pipe heat exchanger.
2. To determine individual and overall heat transfer coefficient of a double pipe heat exchanger.
3. To study heat transfer through lagged pipe.
4. To study heat transfer through composite wall
5. To study heat transfer through composite sphere l
6. To study heat transfer through forced convection apparatus.
7. To study shell and tube heat exchanger
8. To verify the temperature profiles of 1-1 co-current and counter-current heat exchanger
9. To study plate type heat exchanger

**REFERENCE BOOKS :**

1. Heat Transfer — Kern. D.Q.
2. Unit Operation in Chemical Engg. — Mc cabe & Smith.
3. Introduction to Chemical Engg. — Badger & Banchero

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## MASS TRANSFER

CODE PL 202 L T P
CH 202 2 -- 2

**RATIONALE**

This subject intends to equip the students with the concept and principles of mass transfer operation, which are of prime importance in any chemical industry. Mass transfer equipments are an integral part of any chemical plant. This subject will help the students to operate and design various mass transfer equipments.

**CONTENTS**

**1. Introduction :**

1.1 Analogy between momentum, heat and mass transfer
1.2 Fick's law of diffusion
1.3 Diffusion of A through non-diffusing B
1.4 Equimolar counter diffusion

**2. Vapour Liquid Equilibrium :**

2.1 Introduction
2.2 Importance of distillation
2.3 Vapour liquid equilibrium diagram
2.4 Partial pressure
2.5 Dalton's, law
2.6 Henry's law
2.7 Raoult's law
2.8 Partial vaporization and partial condensation
2.9 Relative volatility

**3. Distillation :**

3.1 Methods of distillation

3.1.1 Differential Distillation
3.1.2 Flash Distillation
3.1.3 Continuous rectification

3.2 Reflux ratio and it's significance
3.3 Optimum reflux ratio
3.4 Methods of calculating number of plates by Mc Cabe Thiele method
3.5 Equation of Q-line and its importance

**4. Distillation Equipments :**

4.1 Construction and utility
4.2 Bubble cap column
4.3 Sieve plate
4.4 Packed column

**5. Batch Distillation :**

5.1 Azeotropic distillation
5.2 Extractive distillation
5.3 Steam distillation
5.4 Meaning and importance of height equivalence to theoretical plate (HETP).

**6. Humidification :**

6.1 Definition
6.1.1 Saturated gas
6.1.2 Relative humidity
6.1.3 Percentage humidity
6.1.4 Humid heat
6.1.5 Humid volume
6.1.6 Dew point
6.1.7 Total enthalpy
6.1.8 Adiabatic saturation temperature
6.1.9 Wet bulb temperature

6.2 Measurement of humidity from humidity chart
6.3 Constructional details and working

6.3.1 Humidifier's
6.3.2 Dehumidifier's

**7. Adsorption:**

7.1 Introduction
7.2 Types
7.3 Equipment and methods

**PRACTICALS**

1. Study of distillation in bubble cap column.
2. To study flash equilibrium distillation
3. To draw instrumentation scheme of distillation column
4. Study of cooling water and steam consumption in bubble cap column
5. Operation of cooling tower
6. To study Reyleigh equation for batch distillation
7. To study packed distillation column.
8. To study adsorption column
9. To study working of dehumidifier

**REFERENCE BOOKS :**


1. Mass Transfer Operation — Treybel
2. Chemical Engineering Vol. II — Richardson & Coluson
3. Unit Operation of Chemical Engg. — Mc Cabe & Smith
4. Introduction to Chemical Engg. — Badger & Bancheoro


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# POLYMER TECHNOLOGY

CODE PL 203

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## RATIONALE

Preliminary knowledge of polymer technology is essential to understand the advance subject to plastic technology. This subject covers basic ideas of various types of plastics.

## CONTENTS

**1. Introduction to Polymers :**

- 1.1 History of polymers
- 1.2 Nature of polymers
- 1.3 Classification of polymers - plastics, rubbers and fibres
- 1.4 Thermosetts and thermoplastics, their comparison
- 1.5 Hetro, Homo and Copolymer
- 1.6 Reinforced and engineering plastics
- 1.7 Classification of linear, branched and cross linked polymers
- 1.8 Random alternate blocks and graft copolymers
- 1.9 Various natural polymers

**2. Types of Polymerisation :**

- 2.1 Stepwise and addition polymerisation, (free radical, cationic and anionic)
- 2.2 Comparison of step and addition polymerisation
- 2.3 Methods of polymerisation : bulk, solution, suspension and emulsion.

**3. Various Types of Molecular Weights of Polymers :**

- 3.1 Molecular weight distribution
- 3.2 Determination of molecular weight of polymer by viscometry and osmometry
- 3.3 Introduction to light scattering and ultracentrifuse methods
- 3.4 Effect of molecular weight and viscosity on properties of polymers

**4. Physical State of Polymers :**

- 4.1 Crystalline and amorphous behaviour
- 4.2 Determination of crystallinity, mechanical strength and structure of polymers
- 4.3 Thermal transition of polymers
  - 4.3.1 Glass transition temperatures

**5. Monomer, Polymer Chemical Structure, Properties and Application of Various Polymers :**

- 5.1 Polyethylene - LDPE, LLDPE, HDPE, HMHDPE
- 5.2 Polypropylene
- 5.3 Polystyrene and HIPS

5.4 ABS
5.5 PTFE
5.6 PMMA
5.7 Nylon-6
5.8 Nylon-66
5.9 PET
5.10 Phenol Formaldehyde

**6. Degradation of Polymers :**

6.1 Types of polymer degradation
6.2 Mechanism of degradation

**7. Advantage of Plastics in Areas of Electrical, Power Transmission, General House Hold, Medical Applications etc.**

**REFERENCE BOOKS :**


1. Text Book of Polymer Chemistry — Billmeyer
2. Physical Chemistry of Polymers — A. Tagor
3. Polymer Science — V.R. Gowariker
4. Properties and structure of polymer — Tobolsky


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## ADDITIVES AND COMPOUNDING OF PLASTICS

CODE PL 204

| L | T | P |
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**RATIONALE**

Compounding of plastics needs basic knowledge about common ingredients used in the processes. The formulation of these ingredients directly affects the quality of plastic products.

**CONTENTS**

**1. Introduction :**

1.1 Purpose of compounding
1.2 Types of compounding ingredients
1.3 Industrial importance of compounding

**2. Antioxidants :**

2.1 Introduction
2.2 Types of antioxidants
2.3 Auto-oxidation action
2.4 Physical and chemical requirements

**3. Metal Deactivators:**

3.1 Introduction
3.2 Mechanism of inhibition by metal deactivators
3.3 Chemical structures
3.4 Stabilization of polyolefins in contact with copper

**4. Stabilizers:**

4.1 Light stabilizer
4.1.1 Photo-degradation of synthetic polymers

4.1.2 Mechanism of U.V. stabilization for U.V. absorbers, Quenchers, Hydroperoxide decomposers and free radical scavengers

4.2 Heat Stabilizers for PVC

4.2.1 Various type of PVC stabilizers such as inorganic metal salts, metal soaps, metal complexes, organotin compounds, epoxy-type stabilizers and organic phpsphides

4.2.2 Influence of heat stabilizers on weather and light stability

**5. Plasticizers :**

5.1 Introduction
5.2 Types of plasticizers
5.3 Theory, methods and steps in plasticization
5.4 Effects of plasticizers on physical properties such as hardness, tensile strength, elongation, low temperature resistance and electrical properties.

**6. Fillers and Reinforcements :**

6.1 Introduction
6.2 Properties of filed and reinforced plastics
6.3 Various types of fillers and reinforcements and their economic importance.

**7. Chemical Blowing Agents :**

7.1 Introduction
7.2 Required properties
7.3 Various types of blowing agents such as azo compounds, hydrazine derivatives, semicarbazides and tetrazoles.
7.4 Extrusion of foamed P.E.
7.5 Expandable P.S. beads

**8. Colourants :**

8.1 Introduction
8.2 Pigments and dyes
8.3 General properties of coloured plastic such as thermal stability, light fastness, weather resistance, migration, plate-out and theological properties.
8.4 Various types of colourants such as titanium dioxide, carbon black, inorganic colour pigments and organic colour pigments.

**9. Introduction to other additives, viz. :**

9.1 Lubricants
9.2 Processing Aids
9.3 Flame Retardants
9.4 Antistatic agents

**10. Constructional details and working of mixing and blending equipments used for compounding**

10.1 High speed mixer
10.2 Internal mixer (banbury minxer)
10.3 Ribbon blender
10.4 Dry colour blender
10.5 Two roll mixing mill
10.6 Compounding extruder

**REFERENCE BOOKS :**


1. Compounding Materials for the Polymer Industry — John S Dick
2. Plastic Additives Hand book — Gaster & Muller
3. Plasticisers, Fillers and Stablisers — Ritchie & Critchely
4. Plastic finishing & Decoration — Satas
5. Thermoplastic polymer additives (Theory & Practice) — J T Lutz


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## POLYMERISATION ENGINEERING

CODE PL 205

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### RATIONALE

This subject covers the Chemistry, manufacturing processes, properties, uses and application of various polymers.

### CONTENTS

**A. Chemistry, Monomer Preparation, Various Polymerisation Processes, Flow Sheet, Properties and Application of Following Polymers :**

**1. High density polyethylene and high molecular high density polyethylene**

1.1 Philips process
1.2 Hoechst process

**2. Low density polyethylene and linear low density polyethylene**

2.1 High pressure process
2.2 Autoclave process

**3. Polypropylene**

3.1 Batch process
3.2 Continuous process

**4. Polyvinyl chloride**

4.1 Emulsion polymerisation
4.2 Suspension polymerisation

**5. Polystyrene**

5.1 Mass polymerisation
5.2 Solution polymerisation
5.3 Suspension polymerisation
5.4 HIPS

**6. Cellulose Acetate**
**7. Cellulose Nitrate**
**8. Epoxy Resin**

8.1 Liquid epoxy resin
8.2 Solid epoxy resin

**9. Phenol formaldehyde**

**B. Chemistry, Properties and Applications of Following Polymers :**

1. ABS
2. NYLON 6 and 66
3. PAN
4. Silicon
5. Polyurethane
6. PMMA
7. UF and MF

**PRACTICALS**

1. To identify the given polymers by following methods -

   1.1 Visual examination
   1.2 Burning test
   1.3 Solubility test
   1.4 Softening and melting test
   1.5 Odour test
   1.6 Chemical test
   1.7 Specific gravity test

2. To purify the given monomer (Styrene/methyl methacrylate) and to find out its percentage purity
3. To find out percentage purity of initiator (Benzoyl peroxide/potassium sulphate)
4. To determine refractive index of given monomer
5. To determine specific gravity of the given monomer
6. To prepare polystyrene/PMMA by bulk polyn
7. To prepare polystyrene/PMMA by solution polyn
8. To prepare phenolformaldehyde resins and to determine its gel time
9. To depolymerise polystyrene
10. To determine K-value and molecular weight of the given polymer by Ostwald viscometer
11. To determine the bulk density of the given polymer
12. To determine the pH value of given monomer with the help of pH meter.

**REFERENCE BOOKS:**


| | | |
|---|---|---|
| 1. | Manufacture of Plastics Vol I & II | W. Mayosmith |
| 2. | Modern Plastics | Harry Barron |
| 3. | Polymers and Resins | Golding |
| 4. | Polyolefins Resins Processes | M Sitting |
| 5. | Plastic Materials | Brydson |
| 6. | Polymer Technology | Miles & Briston |
| 7. | Engg. Thermoplastics, Properties and Applications | J.M. Margolis |
| 8. | Encyclopedia of Polymerisation Engg. and Science | H.Mark |
| 9. | Polymer Manufacturing | Radian. |


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## FIBRE TECHNOLOGY

CODE PL 206

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**RATIONALE**

This subject provides the detailed knowledge of production of various synthetic fibres form basic raw materials. This covers the properties, uses, testing of various fibres, which is one of the essential parts of plastic technology.

**CONTENTS**

**1. Fibres :**

1.1 Introduction
1.2 Classification

1.3 Structural principles of fibre forming polymers
1.4 Orientation(X-ray Analysis), Recurrence Symmetry and crystallinity of fibres
1.5 Effect of orientation on fibre properties

**2. Various Textile Terms :**

2.1 Denier
2.2 Cotton count
2.3 Tex and Millitex
2.4 Tenacity
2.5 Breaking strength
2.6 Elasticity
2.7 Percentage elongation
2.8 Twist
2.9 Moisture content and moisture regain
2.10 Crimp
2.11 Birefringence (Double refraction)
2.12 Dichroism

**3. Fundamental and General Manufacturing Techniques of Fibres :**

3.1 Spinning processes - Melt Spinning, Dry Spinning and Wet spinning
3.2 General techniques of drawing of fibres
3.3 Texturising of Fibres
3.4 Various techniques of Texturising - False twist, Air texturising, Gear Crimping, Stuffer box crimping and knife edge, crimping process.

**4. Finishing of man-made fibres:**

4.1 General principles of finishing
4.2 Various types of finishes- shape retention, firming, softening, water repellent, stain repellent, antistatic soil-release, antimicrobial and fire-resistant finishes.

**5. Dyeing of synthetic fibres**

5.1 Introduction
5.2 High temperature dyeing
5.3 Acid and base dyeing

**6. Chemistry, Manufacturing Process, Properties and Uses of Following Synthetic Fibres :**

6.1 Polyester
6.2 Nylon-6
6.3 Nylon-66
6.4 Acrylic

**7. Elementary Knowledge, Properties and Uses of Following Fibres :**

7.1 Polyvinyl alcohol
7.2 Polypropylene
7.3 Carbon
7.4 Metallic

**REFERENCE BOOKS :**

1. Man made Fibres Vol. I and II — H.Marks & Atlas
2. Man Made Fibres — Moncrief
3. Production of Synthetic Fibres — A.A. Vaidya

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# HIGH POLYMER CHEMISTRY

CODE PL 207

| L | T | P |
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## RATIONALE

The knowledge of this subject is helpful to understand the mechanism of various types of polymerisation quality of the polymers and cost variation of plastic products. This subject also provides kinetic study of various polymerisation techniques and effects of the substituents on polymer properties.

## CONTENTS

**1. Condensation Polymerisation :**

- 1.1 Concept of functionality
- 1.2 Kinetics of condensation polymerisation
- 1.3 Carother's equation
- 1.4 General conditions of polymerisability

**2. Addition Polymerisation :**

- 2.1 Effect of substituents on addition polymerisation
- 2.2 Structure of Vinyl polymers
- 2.3 Types of Initiators
- 2.4 Principal and kinetics of free radical polymerisation
- 2.5 Inhibition and retardation
- 2.6 Degradation and Chain transfer
- 2.7 Auto acceleration

**3. Polymerisation Depolymerisation Equilibria :**

- 3.1 Ceiling temperature
- 3.2 Significance of ceiling temperature in addition polymerisation

**4. Copolymerisation :**

- 4.1 Copolymer equation
- 4.2 Monomer reactivity ratios
- 4.3 Types of co-polymerisation behaviours, block and graft copolymerisation

**5. Kinetics of Cationic Polymerisation**

**6. Kinetics of Anionic Polymerisation**

- 6.1 Living polymers

**REFERENCE BOOKS :**


| | | |
|---|---|---|
| 1. | Text Book of Polymer Science | Bill Meyer |
| 2. | Principles of Polymerisation | George Odian |
| 3. | Polymer Science | V.R. Gowariker |
| 4. | Principles of High Polymers, Theory & Practice | Schmidt & Marlies |
| 5. | Polymer Chemistry an Introduction | Sey Mour |
| 6. | Polymer Science & Technology of Plastics & Rubbers | P. Ghosh |
| 7. | Introductory Polymer Chemistry | G.S. Mishra |
| 8. | Text Book of Polymer Science | P.L.Nayak & Lenka |


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# TESTING OF POLYMERS

CODE PL 208

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## RATIONALE

For checking quality of the manufactured plastic materials, physical and chemical methods of testing are required. The students having knowledge of Rheology/Testing will prove useful in the industrial atmosphere.

## CONTENTS

**Constructional details of apparatus used and working procedure of following polymeric tests**

**1. Mechanical Properties:**

1.1 Tensile strength
1.2 Impact strength (Izod, Charpy and Falling Dart)
1.3 Flexural strength
1.4 Hardness (Rockwell, Shore A and Shore D)
1.5 Abrasion resistance
1.6 Environmental stress cracking resistance (ESCR)
1.7 Burst strength
1.8 Tear strength
1.9 Creep

**2. Thermal Properties:**

2.1 Softening point
2.2 Heat distortion temperature (HDT)

**3. Rheological Properties:**

3.1 Melt flow index (MFI)
3.2 K-value
3.3 Cup flow test

**4. Electrical Properties:**

4.1 Dielectric strength
4.2 Arc resistance
4.3 Volume and surface resistivity

**5. Optical Properties:**

5.1 Light transmittance
5.2 Haze

**6. Flammability Test:**

6.1 Introduction
6.2 Flammability Test for Flexible Plastics
6.3 Oxygen Index
6.4 Smoke Generation Test

**7. Weathering Properties:**

8.1 Effect of fungi
8.2 Effect of Bacteria
8.3 Water absorption
8.4 Accelerated Weathering test

**PRACTICALS**

1. To find out the tensile strength and elongation at break of the given polymer with the help of tensile testing machine.
2. To determine shore A hardness of the given plastics
3. To determine shore D hardness of the given plastics
4. To determine the melt flow Index of the given Polymer by MFI Tester
5. To determine thickness of the given plastic film/sheet by dial thickness gauge
6. To determine Refractive index of the given plastic film/sheet by Abbe Refractometer
7. To determine burst strength of the given plastic film
8. To determine melting point of the given polymer
9. To determine water absorption of various plastics
10. To determine Abrasion resistance of the given polymer by DIN abrasion tester
11. To find out the tensile strength and elongation at break of the given polymer sample at accelerated Weathering conditions.

**REFERENCE BOOKS:**


| | | |
|---|---|---|
| 1. | Principle of High Polymers, Theory & Practice | Schemidt & Marlies |
| 2. | Properties & Structure of Polymers | Tobolsky |
| 3. | Polymer Science & Engg. | Wilkinson |
| 4. | Polymer Melt Rheology | F.N. Gogabell |
| 5. | Mechanical Testing of Plastics | S. Turner |
| 6. | Testing Polymers | J.V. Schemitz & Browen |
| 7. | Properties & Testing of Plastic Materials | A.E. Leves & J. A. Rhys. |
| 8. | Hand Book of Plastic Test Methods | Ives, Mead & Reley |
| 9. | Hand Books of Plastics Testing Technology | Vishu Shah |


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## PLASTIC PROCESSING - I

CODE PL 209

| L | T | P |
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**RATIONALE**

The purpose of this subject is to equip the students with the knowledge of equipments and processes utilised in plastic processing and operational safety.

**CONTENTS**

**1. Introduction to Plastic Processing Techniques.**

**2. Injection Moulding Processes :**

2.1. Construction and working of various types of machineries used

- 2.1.1 Hand injection-moulding machine
- 2.1.2 Semi automatic injection moulding machine
- 2.1.3 Automatic injection moulding machine
- 2.1.4 Plunger and screw type injection-moulding machine
- 2.1.5 Merits and demerits of each machine

2.2 Elements of injection moulding machine

- 2.2.1 Injection unit
- 2.2.2 Clamping unit
- 2.2.3 Mould

2.3 Machine Controls

2.4 Moulding cycles

2.5 Nozzles
2.6 Mould temperature control
2.7 Specifications of machines
2.8 Moulding defects and their remedies

**3. Reaction injection moulding**

3.1 Introduction
3.2 Materials used
3.3 Process and equipments used

**4. Extrusion Concepts :**

4.1 Introduction
4.2 Extruders and their classification
4.3 Single screw extruders
4.4 Multiple screw extruders
4.5 Extruder components

4.5.1 Screws and their types
4.5.2 Barrel
4.5.3 Hopper
4.5.4 Die
4.5.5 Adapter

4.6 L/D ratio
4.7 Compression ratio
4.8 Extruder performance and their curves

4.8.1 Screw characteristic curves
4.8.2 Die characteristic curves

4.9 Cooling and take-off systems
4.10 Co-extrusion
4.11 Static, drag and pressure flow

**5. Manufacturing of:**

5.1 Blown films
5.2 Pipe and tubes
5.3 Wire and cable coating
5.4 Sheets
5.5 Profiles
5.6 Process defects and their remedies

**6. Construction and Working of following machines:**

6.1 Scrap Grinder
6.2 Bag Cutting and Sealing Machine
6.3 Hot Stamping Machine
6.4 High Frequency PVC Welding Machine

**PRACTICALS**

1. To produce articles on 0.5 OZ hand injection moulding machine
2. To produce articles on 1.0 OZ hand injection moulding machine
3. To produce articles on 1.5 OZ hand injection moulding machine
4. To produce articles on 2.0 OZ hand injection moulding machine

5. To study semi automatic vertical injection moulding machine (capacity 60 grams) and produce articles.
6. To make articles on fully automatic injection moulding machine (capacity 90 grams).
7. To make LDPE blown film on blown film extruder
8. To make flexible pipe/tube on extrusion plants and checks its qualities.
9. To study Bag cutting and sealing machine and make LDPE Bags of different lengths.
10. To make Diary covers and purse of PVC sheets on high frequency PVC welding machine.
11. Stamping on Plastic Sheets by Hot Stamping Machine
12. To Grind the Waste Plastics on Scrap Grinder and find out its efficiency.

**REFERENCE BOOKS :**


| | | |
|---|---|---|
| 1. | Processing of Thermo Plastic material | Bernhard |
| 2. | Extrusion of plastic | Fisher |
| 3. | SPI Engg Hand book | Frados |
| 4. | Plastic Processing | Radian |
| 5. | Plastic Extrusion Tech. | Allan L. Griff |
| 6. | Injection moulding | Athale A.S. |
| 7. | Moulding of Plastics | N.M. Bekalis |


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## 'C' PROGRAMMING

CODE PL 210 L T P
same in all branches except AR/CC/CE/CS/ EE /IT 2 -- 2

**RATIONALE**

'C' is computer programming language and also structured programming language. In 'C' programming language we consider various syntax used in programming. By having good knowledge of 'C', students can write modular application and system programs. 'C' can be used in the engineering applications. By acquiring a sound knowledge of 'C' students will be able to understand the concept of all the application areas. This course is specially designed for engineering students of all diploma streams.

**CONTENTS**

**1. Introduction:**
- 1.1 Scope of 'C' Language
- 1.2 Distinction and similarities with other HLLs
- 1.3 Special features and Application areas

**2. Elements of 'C' :**
- 2.1 Character set
- 2.2 Key words
- 2.3 Data types
- 2.4 Constants and Variables
- 2.5 Operators: unary, binary, ternary
- 2.6 Operator precedence

**3. Console Input-Output :**
- 3.1 Types of I-O
- 3.2 Console I-O
- 3.3 Unformatted console I-O: getchar(), putchar(), gets(), puts(), getch(), getche()
- 3.4 Formatted I-O: scanf(), printf()

**4. Control Flow :**
- 4.1 Statements and blocks
- 4.2 if
- 4.3 switch

4.4 Loops: for, while, do-while
4.5 goto and labels
4.6 break, continue, exit
4.7 Nesting control statements

**5. Arrays :**

5.1 Basic concepts
5.2 Memory representation
5.3 One dimensional array
5.4 Two dimensional array

**6. Functions :**

6.1 Basic concepts
6.2 Declaration and prototypes
6.3 Calling
6.4 Arguments
6.5 Scope rules
6.6 Recursion
6.7 Storage classes types
6.8 Library of functions: math, string, system

**7. Pointers :**

7.1 Basic concepts
7.2 &, * operator
7.3 Pointer expression: assignment, arithmetic, comparison
7.4 Dynamic memory allocation
7.5 Pointer v/s Arrays

**8. Structure and Enumerated Data Types :**

8.1 Basic concepts
8.2 Declaration and memory map
8.3 Elements of structures
8.4 Enumerated data types : typedef, enum
8.5 Union

**PRACTICALS**

1. Problems based on arithmetic expression, fixed mode arithmetic.
2. Problems based on conditional statements and control structures.
3. Problems based on arrays (1-D, 2-D), functions and pointers.
4. Problems based on Engineering applications.

**REFERENCE BOOKS :**


1. 'C' Programming — Stephen Kochan
2. Programming with 'C' — Schaum's Series
3. 'C' Programming — V.Balguru Swami
4. 'C' Programming — Kernighan & Ritchie
5. Let us 'C' — Yashwant Kanetkar


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