DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY LUCKNOW

STUDY & EVALUATION SCHEME WITH SYLLABUS

FOR

B. TECH 2nd YEAR
MECHANICAL ENGINEERING

(Plastics Engineering)

(EFFECTIVE FROM THE SESSION: 2019-20)
## SEMESTER- III

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<th>Periods</th>
<th>Evaluation Scheme</th>
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*The Mini Project or internship (3-4 weeks) conducted during summer break after II semester and will be assessed during III semester.

## SEMESTER- IV

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Total 900 21
SEMESTER-III

THERMODYNAMICS OF POLYMERS

Objectives:
To familiarize the students with concepts of basic thermodynamics and polymer systems.

UNIT-I:
Fundamental concepts and definitions, Temperature and zeroth law of thermodynamics, Equation of states, P-V-T- relationships and application, First law of thermodynamics: Application of first law to different processes in close and open systems, Limitations of first law.

UNIT-II:
Second law of thermodynamics, entropy concept, entropy and lost work calculations, Microscopic interpretation of entropy, Mathematical statement of second law, Carnot cycle for an ideal gas, Refrigeration cycle, criterion of irreversibility, Third law of thermodynamics and its applications, free energy functions and their significance.

UNIT-III:

UNIT-IV:

UNIT-V:

Course Outcomes:
After completion of this subject student is able to learn polymer features in thermodynamics.
Books and References:
RHEOLOGY OF POLYMERS

Objectives:
To familiarize the students with the basics of polymer deformation and flow properties.

UNIT-I:
Units and dimensions-Properties of fluids-mass density, specific weight, specific volume, specific gravity, viscosity, surface tension and capillarity-Terminologies of fluid flow-Laminar and turbulent flow of Newtonian fluids-Power law-Reynolds number and its significance.

UNIT-II:
Introduction to polymer rheology, Newtonian and non-Newtonian fluids, shear stress, shear strain and shear rate, shear modulus, bulk modulus, Zero shear viscosity, Dependence of viscosity with temperature, shear stress, Viscoelasticity - effect of rate of strain, temperature and time on mechanical behavior of polymeric materials.

UNIT-III:

UNIT-IV:
Rheology of polymeric liquids: polymer chain conformation, zero shear viscosity, rheology of dilute polymer solutions, entanglement, effect of long chain branching, effect of molecular weight distribution. Measurements of rheological properties.

UNIT-V:
Rheology in polymer processing operations: Calendaring and two roll mill, Twin screw extruders, Blow molding, Wire coating, Thermoforming, Sheet extrusion, Internal mixers, Rubber extrusion.

Course Outcomes:
On completion of the course, students will understand the basics of fluid mechanics and Rheology. Will be able to analyses the rheological properties of polymer systems using rheometers.

Books and References:
4. Vishu Shah “Plastics testing technology hand book”.
FUNDAMENTALS OF POLYMER SCIENCE

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Objectives:
To familiarize the students about the fundamental theories of polymer science.

UNIT-I:

UNIT-II:
Introduction, Chain & step growth polymerization, Polymerization techniques, Kinetics of Polymerization (Free radical, Cationic, Anionic polymerization, Polycondensation).

UNIT-III:
Molecular weight, Number average and weight average molecular weight, Sedimentation and Viscosity average molecular weight, Molecular weight and degree of polymerization, Polydispersity, Size of polymer molecules.

UNIT-IV:
Glass transition temperature, Transitions, significance and factors influencing the Tg. Effect of Plasticizers on Tg. Glass transition of copolymers. Morphology and order of Polymers, Crystallinity in polymers, Degree of crystallinity and Polymer crystallization. Effect of crystallinity on properties of Polymers.

UNIT-V:

Course Outcomes:
On completion of the course, students will understand the basic fundamentals of polymer.

Books and References:
1. Plastics Material, Brydson, J.A
2. Text Book of Polymer Science, Billmeyer, Fred W.
3. Principles of Polymer Systems By Ferdinand Rodriguez
4. Principles of Polymer Chemistry By A. Ravve
5. Introduction of Polymer Science By Hans-Georg Elias
6. Polymer Science & Technology By Joel R. Fried.
MATERIAL TESTING LAB

Objectives:
- To understand the principles and performance characteristics of different materials.
- To know about material properties.

List of Experiments: (At least 8 of the following)

1. Strength test of a given mild steel specimen on UTM with full details and stress versus strain plot on the machine.
2. Other tests such as shear, bend tests on UTM.
3. Impact test on impact testing machine like Charpy, Izod or both.
5. Spring index test on spring testing machine.
6. Fatigue test on fatigue testing machine.
7. Creep test on creep testing machine.
8. Experiment on deflection of beam, comparison of actual measurement of deflection with dial gauge to the calculated one, and or evaluation of young’s modulus of beam.
10. Study of NDT (non-destructive testing) methods like magnetic flaw detector, ultrasonic flaw detector, eddy current testing machine, dye penetrant tests.

Course Outcomes:
The students who have undergone the course will be able to measure various properties of materials.
RHEOLOGY OF POLYMERS LAB

Objectives:
- To understand the polymer rheology
- Determination of viscosity and related properties of polymer fluids.

List of Experiments: (At least 8 experiments)

1. Determination of viscosity of various thermoset and thermoplastic polymers by Brookfield viscometer.
2. Determination of “gel time” of various adhesives and polymers by Gelation Timer.
3. Determination of viscosity of PVC polymers by Ostwald viscometer.
4. To determine the viscoelastic properties of the given samples.
5. To determine the resistance to peel from a given samples.
6. Determination of molecular weight by viscosity.
7. Determination of rheology of Thixotropic polymers by Couette Viscometers.
8. Determination of rheology of Dilatants/Shear Thickening polymers by Couette Viscometers.
9. To determine the Viscosity Index of a given samples.

Course Outcomes:
The students who have undergone the course will be able to measure various rheological properties of polymer systems.
Objectives:
To understand the basics of polymer identification

Minimum eight experiments out of the following:
1. Identification of unknown polymer using heating, burning, solubility.
2. Confirmatory chemical tests for Identification of unknown polymer.
3. Quantitative estimation of the basic raw materials and auxiliaries used in polymer such as phenol, urea, formaldehyde.
4. Quantitative estimation of the basic raw materials and auxiliaries used in polymer such as glycerol, plasticizer's initiators.
5. Quantitative estimation of the basic raw materials and auxiliaries used in polymer industries such as antioxidants, etc
6. Determination of purity of solvents, monomers and other auxiliaries.
7. Determination of physical properties - boiling point using standards techniques.
8. Determination of physical properties - melting point.
9. Determination of physical properties - refractive index.
10. Determination of physical properties - specific gravity of polymer materials.

Course Outcomes:
The students will be able to identify and determine the physical properties of different polymers.
Objectives:
To enable the students, understand the preparation properties and applications of different classes of polymers.

UNIT-I:

UNIT-II:
Introduction- Sources and manufacture of raw materials- basic chemistry- Methods of manufacture-Flow behavior- General properties and applications of Olefin Polymer and Co-polymers Vinyl chloride polymers and co-polymers.

UNIT-III:

UNIT-IV:
Introduction- Sources and manufacture of raw materials- basic chemistry- Methods of manufacture-Flow behavior- General properties and applications of Epoxy Plastics, Polyurethane (PU), Silicones.

UNIT-V:

Course outcomes:
Upon completion of the course, the students will have the knowledge of manufacturing, properties and applications of variety of plastics.
Books and References:
1. Brydson, J.A “Plastics Material”.
2. Schwartz & good man “Plastics materials and processing”.
PLASTICS PROCESSING-I

Objectives:
To impart knowledge of plastics processing to the students.

UNIT-I:
Introduction to polymer processing – Plastics processing techniques. General description of extrusion processes, type of extruders, screw and their output in terms of drag, leakage and pressure flow, influence of screw dimensions and output, die and screw characteristics. Design of barrel and screw for commodity, heat sensitive and engineering polymers. Barrier Screws.

UNIT-II:
Individual extrusion systems, Dies, Sizing and Downstream equipments, Faults, Causes and Remedies for film, pipe, lamination, profiles, cables, sheet, Box Strapping.

UNIT-III:

UNIT-IV:
General description of Compression and Transfer moulding and its application in processing of thermosetting materials. Faults, Causes & Remedies.

UNIT-V:

Course Outcomes:
Upon completion student will have the knowledge of extrusion process, calendaring, compression and transfer molding.

Books and References
4. Lyesew, A.I “Compression molding”.
5. BOBB “COMPRESSION & TRANSFER THEORY & TECHNOLOGY”.
Objectives:
To impart knowledge of all polymerization techniques.

UNIT-I:
Industrial methods of polymerization such as bulk, solution, suspension, emulsion. Layout and arrangement of polymer plant. Types of polymer production processes and reactors. Safety and plant automation.

UNIT-II:
Concept of stereo-chemistry of polymers, stereo-specific polymerization. Catalyst – their utility in polymer manufacture, Zeigler Natta, Metalloocene and other catalyst systems.

UNIT-III:

UNIT-IV:
Manufacturing details, properties and applications of various thermosetting resins such as phenol-formaldehyde, urea-formaldehyde and melamine-formaldehyde and preparation of molding powders.

UNIT-V:
Production technology, properties and application of Polystyrene, Polyvinylchloride, and their copolymer grades.

Course Outcomes:
Upon completion student will have the knowledge of Polymerization techniques.

Books and References:
SYNTHESIS AND POLYMERIZATION LAB

Objectives:
The student will have an understanding of the polymer synthesis by different techniques.

Minimum eight experiments out of the following:
1. Synthesis of a polymer by Bulk polymerization Techniques
2. Synthesis of a polymer by solution polymerization Techniques
3. Synthesis of a polymer by suspension polymerization Techniques
4. Synthesis of a polymer by emulsion polymerization Techniques
5. Determination of molecular weight by viscosity.
6. Preparation of phenol formaldehyde resin
7. Preparation of urea. formaldehyde resin
8. Preparation of unsaturated polyester resin
9. Determination of acid value in unsaturated polyester resin
10. Preparation of saturated polyester resin
11. Determination of acid value in saturated polyester resin
12. Synthesis of a copolymer based on any common monomers like styrene, acrylates, maleic anhydride, acrylic acid and methacrylic acid
13. Modification of epoxy resin modification of any natural polymer such as cellulose, rosin, naturalrubber, etc.
14. Depolymerization of waste thermoplastics such as polystyrene or polymethylmethacrylate.

Course Outcomes:
Upon completion student will have the knowledge of Polymerization & Synthesis techniques.
Objectives:
The student will have an understanding of the polymer processing by different processing techniques.

2. Twin screw extrusion process, Study of Parts & their function. Practice on Die setting, Cycle time analysis, Start up and shut down Procedure.
10. Calendering process.
11. Two –roll mill process.

INDUSTRIAL VISIT

The student will have to visit the plastic processing and testing industries and record their observations in the same semester. The students will be evaluated on the basis of viva and technical report.