Uttarakhand Technical University, Dehradun
Scheme of Examination as per AICTE Flexible Curricula

Evaluation Scheme & Syllabus

for

B. Tech Second Year
(Plastic & Polymer Engineering)

W.E.F. Academic Session 2019-20

B Tech II Year
3rd and 4th SEMESTER

Bachelor of Technology (B. Tech.)
[PLASTIC & POLYMER ENGINEERING]

Uttarakhand Technical University, Dehradun
### Bachelor of Technology (B.Tech.) - III Semester
[Plastic & Polymer Engineering]
W.E.F Academic Session 2019 - 20

#### III Semester

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Subject Code</th>
<th>Category</th>
<th>Subject Name</th>
<th>Maximum Marks Allotted</th>
<th>Contact Hours per week</th>
<th>Total Credits</th>
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</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td>Theory</td>
<td>Practical</td>
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<td>End Sem.</td>
<td>Mid Sem. Exam.</td>
<td>Quiz/ Assignment</td>
</tr>
<tr>
<td>1.</td>
<td>BAST 301</td>
<td>BSC-5</td>
<td>Mathematics-III</td>
<td>100</td>
<td>30</td>
<td>20</td>
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<tr>
<td>2.</td>
<td>BMET 302</td>
<td>DC-1</td>
<td>Basic Thermodynamics</td>
<td>100</td>
<td>30</td>
<td>20</td>
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<tr>
<td>3.</td>
<td>BMET 303</td>
<td>DC-2</td>
<td>Materials Science &amp; Technology</td>
<td>100</td>
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<td>20</td>
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<tr>
<td>4.</td>
<td>BCST 305</td>
<td>DC-3</td>
<td>Object Oriented Programming &amp; Methodology</td>
<td>100</td>
<td>30</td>
<td>20</td>
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<tr>
<td>5.</td>
<td>BPPT 301</td>
<td>DLC-3</td>
<td>Programming Practices</td>
<td>100</td>
<td>30</td>
<td>20</td>
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<tr>
<td>6.</td>
<td>BCSP 307</td>
<td>DLC-3</td>
<td>Virtual Lab Experiments related to III semester Labs</td>
<td>-</td>
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<td>7.</td>
<td>BPPP 302</td>
<td>DLC-1</td>
<td>Evaluation of Internship-I completed at I Year Level</td>
<td>-</td>
<td>-</td>
<td>-</td>
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<td>8.</td>
<td>BASP 107</td>
<td>DLC-4</td>
<td>90 hrs Internship based on using various software’s - Internship -II</td>
<td>To be completed anytime during Third/ fourth semester. Its evaluation/credit to be added in fifth semester.</td>
<td>50</td>
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<tr>
<td>9.</td>
<td>BPPP 302</td>
<td>DLC-4</td>
<td>90 hrs Internship based on using various software’s - Internship -II</td>
<td>To be completed anytime during Third/ fourth semester. Its evaluation/credit to be added in fifth semester.</td>
<td>50</td>
<td>50</td>
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<tr>
<td>10.</td>
<td>BCSP 308</td>
<td>MC</td>
<td>Cyber Security</td>
<td>Non Credit Course</td>
<td>500</td>
<td>150</td>
</tr>
</tbody>
</table>

#### IV Semester

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Subject Code</th>
<th>Category</th>
<th>Subject Name</th>
<th>Maximum Marks Allotted</th>
<th>Contact Hours per week</th>
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<tr>
<td></td>
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<td></td>
<td>End Sem.</td>
<td>Mid Sem. Exam.</td>
<td>Quiz/ Assignment</td>
</tr>
<tr>
<td>1.</td>
<td>BECT 402</td>
<td>DC</td>
<td>Energy &amp; Environmental Engineering</td>
<td>100</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>2.</td>
<td>BPPT 401</td>
<td>DC</td>
<td>Polymer Chemistry</td>
<td>100</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>3.</td>
<td>BPPT 402</td>
<td>DC</td>
<td>Thermoplastic Materials</td>
<td>100</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>4.</td>
<td>BPPT 403</td>
<td>DC</td>
<td>ThermoSET Materials</td>
<td>100</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>5.</td>
<td>BMET 404</td>
<td>DC</td>
<td>Fluid Mechanics</td>
<td>100</td>
<td>30</td>
<td>20</td>
</tr>
<tr>
<td>6.</td>
<td>BPPP 404</td>
<td>DC</td>
<td>Virtual Lab Experiments related to IV semester Labs</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7.</td>
<td>BMEP 407</td>
<td>DLC</td>
<td>90 hrs Internship based on using various software’s - Internship -II</td>
<td>To be completed anytime during fourth semester. Its evaluation/credit to be added in fifth semester.</td>
<td>500</td>
<td>150</td>
</tr>
<tr>
<td>8.</td>
<td>BCST 408</td>
<td>MC</td>
<td>Cyber Security</td>
<td>Non -credit course</td>
<td>1 Hr Lecture</td>
<td>1 Hr Tutorial</td>
</tr>
</tbody>
</table>
BAST 301  Mathematics – III  3L-1T-0P  4 Credits

Students Should have the knowledge of Mathematics I and Mathematics II

Course Objective:
The objective of this course is to familiarize the students with Laplace Transform, Fourier Transform, techniques in numerical methods & some statistical techniques. It aims to present the students with standard concepts and tools at B.Tech first year to superior level that will provide them well towards undertaking a variety of problems in the concern discipline.

The students will learn:
- The idea of Laplace transform of functions and their applications.
- The idea of Fourier transform of functions and their applications.
- To evaluate roots of algebraic and transcendental equations.
- Interpolation, differentiation, integration and the solution of differential equations.
- The basic ideas of statistics including measures of central tendency, correlation, regression and their properties.

COURSE OUTCOMES(s):
At the end of this course, the students will be able to:
1. Remember the concept of Laplace transform and apply in solving real life problems.
2. Understand the concept of Fourier transform to evaluate engineering problems
3. Understand to evaluate roots of algebraic and transcendental equations.
5. Understand the concept of correlation, regression, moments, skewness and kurtosis and curve fitting.

Unit 1: Fourier Transforms: (8 hours)
Fourier integral, Fourier Transform, Complex Fourier transform, Inverse Transforms, Convolution Theorem, Fourier sine and cosine transform, Applications of Fourier transform to simple one dimensional heat transfer equations.

Unit 2: Laplace Transform: (8 hours)
Definition of Laplace transform, Existence theorem, Laplace transforms of derivatives and integrals, Initial and final value theorems, Unit step function, Dirac- delta function, Laplace transform of periodic function, Inverse Laplace transform, Convolution theorem, Application to solve linear differential equations.

Unit 3: Solution of Algebraic and Transcendental equations & Interpolation (8 hours)
Number and their accuracy, Solution of algebraic and transcendental equations: Bisection method, Iteration method, Newton-Raphson method and Regula-Falsi method. Rate of convergence of these methods (without proof), Interpolation: Finite differences, Relation between operators, Interpolation using Newton’s forward and backward difference formula. Interpolation with unequal intervals: Newton’s divided difference and Lagrange’s formula.

Unit 4: Numerical differentiation, Integration & Solution of ODE (8 hours)
Unit 5: Statistical Techniques (8 hours)
Introduction: Measures of central tendency, Moments, Moment generating function (MGF), Skewness, Kurtosis, Curve Fitting: Method of least squares, Fitting of straight lines, Fitting of second degree parabola, Exponential curves. Correlation and Rank correlation, Regression Analysis: Regression lines of y on x and x on y, regression coefficients, properties of regressions coefficients and non-linear regression.

Reference Books:
OBJECTIVES:

▪ To learn about work and heat interactions, and balance of energy between system and its surroundings

▪ To learn about application of I law to various energy conversion devices

▪ To evaluate the changes in properties of substances in various processes

▪ To understand the difference between high grade and low grade energies and II law.

COURSE OUTCOMES (COs):

At the end of this course, the students will be able to

▪ Fundamental knowledge of laws and principles of thermodynamics.

▪ Knowledge of heat and work transfer and their effect, application of first law of thermodynamics to different machines as well as second law of thermodynamics.

▪ Knowledge of steady flow energy equation and its use in compressor, turbines, nozzles, evaporators etc.

▪ Knowledge of quality of energy and its balance

Unit-1: FUNDAMENTAL CONCEPTS AND DEFINITIONS-1

Definition of thermodynamics, System, Surrounding and universe, Phase, Concept of continuum, Macroscopic & microscopic point of view. Density, Specific volume, Pressure, Temperature scales; Various Thermometers. Thermodynamic equilibrium, Property, State, Path, Process, Cyclic and non cyclic processes, Reversible and irreversible processes, - Thermodynamic definition of work; examples; Displacement work; Path dependence of displacement work and illustrations for simple processes Quasi static process, Energy and its forms

Unit-2: LAWS OF THERMODYNAMICS

Zeroth law Definition of thermal equilibrium.

First law of thermodynamics : Enthalpy First Law for Flow Processes(SFEE) , Derivation of SFEE; Steady flow processes including throttling; Unsteady processes; Limitations of first law of thermodynamics, PMM-I, Steady flow energy equation for various devices

Second law of thermodynamics : Thermal reservoirs, Energy conversion, Heat engines, Heat pump & Refrigerator, Coefficient of Performance(COP), Kelvin Planck & Clausius statement, Equivalence of the two statements., Carnot cycle and Carnot engine, Carnot theorem and it’s corollaries, PMM-II.

Entropy: Clausius inequality, Concept of Entropy, Entropy change of pure substance in different thermodynamic processes, Reversible and irreversible processes , Tds equation, Principle of entropy
increase, T-S diagram, Statement of the third law of thermodynamics

Unit-3: AVAILABILITY, EXERGY AND ENTROPY GENERATION

Irreversibility and Availability, Availability functions for systems and Control volumes undergoing different processes, Lost work. Second law analysis for a control volume. Exergybalance equation and Exergy analysis. Thermodynamic relations: Conditions for exact differentials. Maxwell relations. Clapeyron equation, Joule-Thompson coefficient and Inversion curve, Coefficient of volume expansion, Adiabatic and soothermal compressibility

Unit-4: PURE SUBSTANCE

Definition of Pure substance, Ideal Gases and ideal gas mixtures, Real gases and real gas mixtures, Const. temperature and Const. pressure heating of water; Ideal Gas, Equations of states, Definitions of saturated states; P-v-T surface; Use of steam tables; Saturation tables; Superheated tables; Identification of states & determination of properties, Mollier’s chart.

Unit-5: THERMODYNAMIC CYCLES

Carnot cycle, Air standard cycles, Otto cycle, Diesel cycle, Limited pressure cycle or Dual cycle, comparison of Otto, Diesel and Dual cycles, Brayton cycle, Aircraft propulsion, Basic Rankine cycle.

Text Books:

OBJECTIVES:
The course should enable the students to:

☐ To Understand about the Different types Of Materials and their Properties
☐ To understand the various ferrous materials and their production process and Properties
☐ To study and examine the Non Ferrous metals and Testing of Materials
☐ To study the magnetic and electric properties of materials
☐ To understand the various Non-Metallic Materials and their uses.

COURSE OUTCOMES (COs):
At the end of this course, the students will be able to

- Introduction and importance of materials, concept of unit cell space lattice, imperfection and defect in solid.
- Mechanical properties and testing, micro structural exam, phase diagram, equilibrium diagram and brief introduction to ferrous material, heat treatment.
- Magnetic and electric properties along with introduction to ceramics, plastic and other materials are studied.

Unit – 1: Introduction to Materials and their Defects
Crystallography and Imperfections: Concept of unit cell space lattice, Crystalline and Non Crystalline Structure Bravais lattices, Atomic packing factor and density. Miller indices. X-ray crystallography techniques. Imperfections, Defects & Dislocations in solids

Unit – 2: Ferrous Materials and their Properties
Heat Treatment: Various types of heat treatment such as Annealing, Normalizing, Quenching, Tempering and Case hardening. Time Temperature Transformation (TTT) diagrams

Unit -3: Non Ferrous Metals. Testing and Microstructure Examine of Materials
Non-Ferrous Materials and alloys: Introduction to Various Non-Ferrous Metals and their properties, Alloys, Importance of Copper and its, Alloys, Brass and Bronze, Aluminum and its Alloys Testing Tastings such as Strength tastings, Hardness testing, Impact tastings, Fatigue testing Creep testing, Non-destructive testing (NDT)
Micro structural Exam: Microscope principle and methods. Preparation of samples and Microstructure
exam and grain size determination. Comparative study of microstructure of various metals & alloys such as Mild steel, CI, Brass

**Unit -4 : Magnetic and Electric Properties of Materials**

**Unit -5: Non Metallic Materials**
Plastics: Introduction to Plastics, Various types of polymers/plastics and its applications, Difference between Thermoplastics and Thermosetting Plastics.

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

1. Preparation of plastic mould for small metallic specimen.
2. Specimen preparation for microstructural examination-cutting, grinding, polishing, etching.
3. Grain size determination of a given specimen.
4. Comparative study of microstructures of different material specimens (mild steel, gray cast iron, brass, copper etc.)
5. Heat treatment experiments such as annealing, normalizing, quenching, case hardening and comparison of hardness before and after heat treatment.
6. Material identification of, say, 50 common items kept in a box.
7. Faradays law of electrolysis experiment.
8. Study of corrosion and its effects.
9. Study of microstructure of welded component and HAZ. Macro and Micro Examination.
10. Suitable experiment on Magnetic/Electrical/Electronic materials

**Text Books:**

1. Callister/Balasubramaniam – Callister”s Material Science & Engineering Wiley India
4. Raghvan - Material Science, Prentice Hall
Objectives of the course:
The course will introduce standard tools and techniques for software development, using object-oriented approach, use of a version control system, an automated build process, an appropriate framework for automated unit and integration tests.

Course Outcomes:
After taking the course, students will be able to:
1. Specify simple abstract data types and design implementations, using abstraction functions to document them.
2. Recognise features of object-oriented design such as encapsulation, polymorphism, inheritance, and composition of systems based on object identity.
3. Name and apply some common object-oriented design patterns and give examples of their use.
4. Design applications with an event-driven graphical user interface.

Course contents:

Module I
Object Modelling: Objects and classes, links and association, generalization and inheritance, aggregation, abstract class, multiple inheritance, meta data, candidate keys, constraints. Dynamic Modelling: Events and states, operations, nested state diagrams and concurrency, advanced dynamic Modelling concepts, a sample dynamic model.

Module II
Functional Modelling: Data flow diagram, specifying operations, constraints, a sample functional model. OMT (object Modelling techniques) methodologies, examples and case studies to demonstrate methodologies, comparisons of methodologies, SA/SD, JSD.

Module III

Module IV

Module V
Software Development using Java: Java Swing, Migrating from C++ to java, Application of java, JDBC.

Experiments
1. To write a Java program to print HELLO INDIA.
2. To write a java program that takes in command line arguments as input and print the number of arguments.
3. To write a java program find the division of student.
4. To write a program implements the concept of inheritance.
5. To write a java program method overloading.
6. To write a java program for method over riding.
7. To write a java program exception handling.
8. To write a java program to run applet for drawing various shapes.
9. To write a java program to design a login using JFrame.
10. To write a java program to validate the logging details of user using JDBC concept.
11. To write a Java program Insertion sort.
12. To write a Java program merge sort.
13. To write a Java program first n prime numbers.

Text Books:
4. Barbara Liskov, Program Development in Java, Addison-Wesley, 2001

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

**Course Outcomes:** On completion of the course, students will understand the basic fundamentals of polymer
1. Different kind of polymers and their properties.
2. Concept of Molecular Weight and distribution.
3. Variation of properties of polymer by crystallinity and glass transition temperature.
5. Behaviour of polymer solution at different concentrations.

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<tr>
<th>Unit</th>
<th>Topics</th>
<th>Lecture(s)</th>
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</thead>
<tbody>
<tr>
<td>I</td>
<td>Basic Concepts of Polymers</td>
<td>8</td>
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<tr>
<td></td>
<td>Introduction – Monomer, oligomer, Polymer and Polymerisation, Functionality, Repeating units Nomenclature of polymers, classification of polymers (Natural vs Synthetic), Polymer structure (a)Linear, Branched and Cross-linked (b) Amorphous or crystalline (c) Homopolymer or Copolymer (d) Fibres, Plastics or Elastomers,</td>
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<tr>
<td>II</td>
<td>Molecular Weight And Molecular Weight Distribution</td>
<td>9</td>
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<tr>
<td></td>
<td>Average Molecular Weight, Number Avg. Molecular Weight, Weight Avg. Molecular Weight, Viscosity Avg. Molecular Weight, Degree of Polymerisation and molecular weight, Polydispersity and Molecular Weight Distribution in polymers.</td>
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<tr>
<td>III</td>
<td>Crystallinity</td>
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<td></td>
<td>Crystalline and amorphous structure of polymers, Degree of Crystallinity, Polymer crystallization, Effect of Crystallinity on Polymer property</td>
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<td>Glass Transition Temperature (Tg)</td>
<td>8</td>
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<td></td>
<td>Tg and its associative properties, Factors affecting Tg, Relation between Tg and Melting Temperature Tm, Importance of Tg, Tg and polymer properties relationship</td>
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<tr>
<td>IV</td>
<td>Polymer Degradation and Stability</td>
<td>8</td>
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<tr>
<td></td>
<td>Introduction, Types of Degradation – Thermal Degradation, Mechanical Degradation, Oxidative Degradation, Photo Degradation, Chemical degradation</td>
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<tr>
<td>V</td>
<td>Polymer Solution:</td>
<td>7</td>
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<tr>
<td></td>
<td>The process of polymer solution, nature of polymer molecules in solutions, size and shape of macro molecules in solution.</td>
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</table>

**Reference Books:**
Students have to perform, understand and experience and submit a report.  
The report must be evaluated carefully to award the marks  
University may check anytime by appointing some experts

Course Objectives:
1. The course is intended to assist undergraduates in learning the basics of programming in general and programming MATLAB in particular.
2. Basics of programming in MATLAB will be covered, with the goal of having students become comfortable enough to continue learning MATLAB and other programming languages on their own.

Course Outcomes:
At the end of the course, students will be able to
1. Use MATLAB for programming purposes
2. Learn and explore MATLAB further on their own
3. Use this learning experience to learn other programming languages.

UNIT 1: INTRODUCTION
Data types and variables: Introduction to MATLAB, Data Types, Inter-conversion of Data types, MATLAB Variables, Keywords and Constant, Session Command. MATLAB Operators and Operations: Operators (Arithmetic, Relational, Logical, Bitwise), Set Operations, Operator Precedence, Mathematical Functions.

UNIT 2: PROGRAMMING IN MATLAB

UNIT 3: ARRAYS AND GRAPHICS
Matrices and Arrays: Introduction to Matrices, Operations on Arrays/Matrices, Manipulations of Arrays/Matrices, Expansion of Matrix Size, Reduction of Matrices/Arrays order, Graphics: Introduction to plot, Basic 2-D Plots (Style options, Labels, Axis control, etc.), specialized 2-D Plots, drawing multiple plots. Using MATLAB for fractals and chaos and Conway game of life

UNIT 4: FILE HANDLING AND DEBUGGING
File Handling: Introduction to file handling, working on files, accessing of Text File, Saving/ Loading MATLAB Variables, reading data without opening file, reading and writing Excel. Debugging: Introduction to debugging, Break points, debugger, stepping, watching variable values, debugging commands.

REFERENCES:

WEB REFERENCES - https://ocw.mit.edu/courses/mathematics/18-s997-introduction-to-matlab-programming- fall-2011/syllabus/
Course Objectives:
1. Understand the basic concept of Cyber Security.
2. Understand the basic concept of Viruses.
3. Understand the basic concept of Digital Attacks.
4. Understand the basic concept of Phishing.
5. Understand the basic concept of Cyber Law.

Course Outcomes:
After the completion of this course the student will able to:

1. Know about various attacks and viruses in cyber systems
2. Know about how to prevent digital attacks
3. Know about how to prevent Phishing Attacks
4. Know about how to do secure transactions

UNIT-1

UNIT-2
Application security (Database, E-mail and Internet), Data Security Considerations-Backups, Archival Storage and Disposal of Data, Security Technology-Firewall and VPNs, Intrusion Detection, Access Control.

Security Threats -Viruses, Worms, Trojan Horse, Bombs, Trapdoors, Spoofs, E-mail viruses, Macro viruses, Malicious Software, Network and Denial of Services Attack, Security Threats to E-Commerce-Electronic Payment System, e- Cash, Credit/Debit Cards. Digital Signature, public Key Cryptography.

UNIT-3

UNIT-4


References:
3. 3.Dr. Surya Prakash Tripathi, Ritendra Goyal, Praveen kumar Shukla ,”Introduction to Information Security and Cyber Law” Willey Dreamtech Press.
➢ Students have to perform, understand and experience the experiments related to this semester on virtual environment and submit a report.
➢ The report must be evaluated carefully to award the marks
➢ University may check anytime by appointing some experts
Course Objectives:
The objective of this course is to apply knowledge of mathematics, science, technology and engineering appropriate to energy science and engineering degree discipline and to enhance the understanding of conventional and non-conventional energy sources and its relationship with the ecology and environment. More precisely the objectives are:

1. Use mathematical or experimental tools and techniques relevant to the energy and energy-related environmental disciplines along with an understanding of their processes and limitations.
2. Equip the students with knowledge and understanding of various possible mechanisms about renewable energy projects.
3. To produce graduates strong in understanding on energy resources, technologies and systems, energy management fundamentals, and capable in innovative technological intervention towards the present and potential future energy.
4. To identify, formulate and solve energy and energy-related environmental problems by pursuing development of innovative technologies that can generate clean and sustainable energy to address energy scarcity and combat pollution and climate change.

Course Outcomes

1. Apply advanced level knowledge, techniques, skills and modern tools in the field of Energy and Environmental Engineering.
2. Distinguish the different energy generation systems and their environmental impacts.
3. Respond to global policy initiatives and meet the emerging challenges with sustainable technological solutions in the field of energy and environment.

Detailed Content

Unit I:
Introduction to Energy Science - Introduction to energy systems and resources; Introduction to Energy, sustainability & the environment, Global Energy Scenario: Role of energy in economic development. Indian Energy Scenario: Introduction to Energy resources & Consumption in India. Common terminologies

Unit II

Unit III
Energy Efficiency and Conservation - Introduction to clean energy technologies and its importance in sustainable development; Carbon footprint, energy consumption and sustainability;
introduction to the economics of energy; How the economic system determines production and consumption; linkages between economic and environmental outcomes; How future energy use can be influenced by economic, environmental, trade, and Research policy.

Unit IV  

Unit V  
Environmental Protection and Ethics - Environmental Protection- Role of Government Initiatives by Non-governmental Organizations (NGO) Environmental Education. Ethics and moral values Objectives of ethics, Professional and Non-professional ethics Sustainable Development of the ecology and environment Codes of ethics and their limitations

Suggested reading material:

5. Energy Management: W.R.Murphy, G.Mckay (Butterworths)
Objectives:
To enable the students, understand the chemistry behind polymer formation, kinetics involved to polymerization.

Course Outcome: The student will understand
1. Different techniques of polymerization of polymers.
4. Phenomena of auto-acceleration & role of chain transfer agents, retarders, inhibitors for controlling molecular weight and shelf life of polymer.
5. Utility of copolymerization reaction mechanism & preparation techniques for block & graft copolymers.

<table>
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<tr>
<th>Unit</th>
<th>Topics</th>
<th>Lectures</th>
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<tbody>
<tr>
<td>I</td>
<td>Criteria for polymer synthesis. Classification of polymerization processes. Basic methods of polymerization and their mechanism: Addition, condensation, mass (bulk), suspension, emulsion and solution processes.</td>
<td>9</td>
</tr>
<tr>
<td>III</td>
<td>Auto-acceleration. Factors affecting molecular weight and molecular weight distribution. Chain-transfer reactions, retarders, inhibitors. Effect of temperature on polymerization, kinetics &amp; mechanism.</td>
<td>9</td>
</tr>
<tr>
<td>IV</td>
<td>Copolymerization reactions and its utility. Kinetics and copolymerization behavior. Block and graft copolymers.</td>
<td>8</td>
</tr>
<tr>
<td>V</td>
<td>Stereo-chemistry of polymerization. Ring-opening polymerization. Different advanced catalyst systems: Ziegglar Natta catalyst &amp; metallocene catylysts &amp; their role in polyolefins.</td>
<td>9</td>
</tr>
</tbody>
</table>

POLYMER CHEMISTRY LAB

1. Suspension polymerisation of Styrene/MMA.
2. Preparation and testing of UF/PF/MF resins.
4. Bulk and solution polymerisation of Methyl Methacrylate/Styrene.
5. Emulsion polymerisation of Styrene/ Methyl Methacrylate.
6. Copolymerization of styrene & MMA and determination of reactivity ratios.
7. Preparation of Poly(vinyl butyral).
8. Preparation of unsaturated polyester resin & determination of its acid value.
9. Preparation of saturated polyester resin and determination of its acid value.
10. Synthesis of copolymers based on any common monomers like styrene, acrylates.
Reference Books:

Suggested Reading
(Ref. 1 for Chap. 1), (Ref. 2 & 5 for Chap. 4), (Ref. 3 for Chap. 2), (Ref. 4 for Chap. 3)
**Objectives:** To enable the students, understand the preparation properties and applications of different classes of thermoplastic polymers.

**Course Outcomes:** The student will able to know
1. Preparation, properties & application of various commodity plastics.
2. Preparation, properties & application of various Engineering plastics.
3. Concept of improvement of impact strength of plastic materials.

<table>
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<tbody>
<tr>
<td>I</td>
<td>Brief introduction to preparation, structure, properties and application of following thermoplastic materials: Polyethylene; modified polyethylene, Polypropylene and copolymer of PP, modified Polyolefins like cross linked &amp; filled polyolefins</td>
<td>8</td>
</tr>
<tr>
<td>II</td>
<td>Brief introduction to preparation, structure, properties and application of following thermoplastic materials: Engineering Polymers Polyesters such as PET, PBT, PTT, Polycarbonates, Polyacetals.</td>
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<td>III</td>
<td>Brief introduction to preparation, structure, properties and application of following thermoplastic materials: Styrenic polymers - Polystyrene, HIPS, SAN, ABS, important copolymers of styrene maleic anhydride and styrene acrylics copolymers, toughening mechanism of impact modified plastics</td>
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<td>IV</td>
<td>Brief introduction to preparation, structure, properties and application of following thermoplastic materials: Polymamides- Nylon 6, Nylon 6,6, Nylon 11, aromatic polyamide such as Kevlar Acrylic polymers &amp; copolymers, Polyacrylamide, PMMA, Polyacrylonitrile.</td>
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<td>V</td>
<td>Brief introduction to preparation, structure, properties and application of following thermoplastic materials: Polyvinyl chloride &amp; its copolymers, Polyvinyl acetate, Polyvinyl alcohol Modified cellulosics: Cellulose esters and ethers such as Ethyl cellulose, CMC, HPMC, cellulose acetals.</td>
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</table>

**THERMOPLASTIC MATERIAL LAB**
1. Identification of unknown polymer using heating, burning, solubility.
2. Confirmatory chemical tests for Identification of unknown polymer.
3. Determination of water soluble matter in given pigment.
4. Determination of boiling point of a given solvent.
5. Determination of melting point of a given solid resin by capillary method.
6. Determination of refractive index of a liquid resin.
7. Determination of specific gravity of given resin by pycnometer.
8. Determination of solubility of a given polymer in different solvents.
Reference Books
**Objectives:** To enable the students, understand the preparation properties and applications of different classes of thermoset polymers.

**Course outcomes:**
1. Upon completion of the course, the students will have the knowledge of formulation for manufacturing, properties and applications of variety of thermoset plastic materials
2. Effect of variation in the quantities & type of curing agents & curing condition on the properties of thermoset material.

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topics</th>
<th>Lecture(s)</th>
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<tbody>
<tr>
<td>I</td>
<td>Epoxy Resins: Basic raw materials used, resin preparation, types of epoxy resins, Ratios of reaction component and their effect on properties of reaction product and molecular weight. Curing of resin: curing agents-amines, acids and anhydrides. Role of diluents and plasticizers in epoxy resin compositions. Application of epoxy resins.</td>
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<tr>
<td>II</td>
<td>Polyester Resins: Raw materials: polybasic acids, polyfunctional glycols. Resin preparation – saturated and unsaturated polyester resins, Curing of unsaturated polyester resin – curing system, catalyst and accelerators. Role of diluents and plasticizers in unsaturated polyester resin compositions. Applications of unsaturated polyester resins in moulding compositions such as Sheet Moulding Compounds and Dough Moulding Compounds.</td>
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<td>IV</td>
<td>Silicone Resins: Silicones: Thermoplastic and Thermoset: Preparation of intermediates, Grignard’s method, direct method, olefin addition method, sodium condensation method, rearrangement of organochlorosilanes. Nature and effect of Si-H, Si-O, Si-Si, and Si-C bond. Effect of different functional groups on properties, Silicone fluids, resins, elastomers, RTV silicones. Their compounding, processing, applications and properties.</td>
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<tr>
<td>V</td>
<td>Thermosetting acrylics: Synthesis of acrylic polymers and co-polymers, application of thermosetting acrylics, like anaerobic adhesives. Alkyd resins: Basic components like polyfunctional alcohols, poly-basic acids, vegetable oils/fatty acids. Different types of drying oils: drying, semi-drying and non-drying with examples. Influence of all these components in the synthesis and properties of the final alkyds obtained modification of alkyds: modification with rosin, maleic anhydride, acrylics, vinyls.</td>
<td>9</td>
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</table>
THERMOSET MATERIALS

1. Identification of unknown polymer using heating, burning, solubility of thermoset material.
2. Confirmatory chemical tests for Identification of unknown thermoset polymer
3. Quantitative estimation of the purity of phenol used in the manufacture of phenol formaldehyde resins.
4. Quantitative estimation of the aldehyde contents in formaldehyde used in the manufacture of phenol formaldehyde resins.
5. Determination of gel time of a thermoset materials at a given temperature.
6. Determination of viscosity of a resin by Ford Cup or Brook field viscometer.
7. Determination epoxy equivalent weight of epoxy resin.
8. Determination of Saponification number of polyester resin

Reference Books;
**BMET 404 BMEP 404 | FLUID MECHANICS | 3L:0T20P | 4 Credits**

**Course Objectives:**

1. To introduce and explain fundamentals of Fluid Mechanics, which is used in the applications of Aerodynamics, Hydraulics, Marine Engineering, Gas dynamics etc.
2. To give fundamental knowledge of fluid, its properties and behavior under various conditions of internal and external flows.
3. To develop understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.
4. To imbibe basic laws and equations used for analysis of static and dynamic fluids. 5. To inculcate the importance of fluid flow measurement and its applications in Industries.
6. To determine the losses in a flow system, flow through pipes, boundary layer flow and flow past immersed bodies.

**Course Outcomes:**

On completion of the course, learner will be able to–

1. Use of various properties in solving the problems in fluids
2. Use of Bernoulli’s equation for solutions in fluids
3. Determination of forces drag and lift on immersed bodies

<table>
<thead>
<tr>
<th>Unit</th>
<th>Topics</th>
<th>Lectures</th>
</tr>
</thead>
</table>
| I    | **Introduction:**  
Fluid and continuum, Physical properties of fluids, Rheology of fluids.  
**Kinematics of Fluid flow:** Types of fluid flows: Continuum & free molecular flows, Steady and unsteady, uniform and non-uniform, laminar and turbulent flows, rotational and irrotational flows, compressible and incompressible flows, subsonic, sonic and supersonic flows, sub-critical, critical and supercritical flows, one, two and three dimensional flows, streamlines, continuity equation for 3D and 1D flows, circulation, stream function and velocity potential, source, sink, doublet and half-body. | 10 |
| II   | **Fluid Statics:**  
Pressure-density-height relationship, manometers, pressure transducers, pressure on plane and curved surfaces, centre of pressure, buoyancy, stability of immersed and floating bodies, fluid masses subjected to linear acceleration and uniform rotation about an axis.  
**Dynamics of Fluid Flow:** Euler’s Equation of motion along a streamline and its integration, Bernoulli’s equation and its applications- Pitot tube, orifice meter, venturi meter and bend meter, Hot-wire anemometer and LDA, notches and weirs, momentum equation and its application to pipe bends. | 11 |
| III  | **Dimensional Analysis and Hydraulic Similitude:**  
Dimensional analysis, Buckingham’s Pi theorem, important dimensionless numbers and their significance, geometric, kinematics and dynamic similarity, model studies | 9 |
### IV Laminar and Turbulent Flow:
Equation of motion for laminar flow through pipes, Stokes’ law, transition from laminar to turbulent flow, turbulent flow, types of turbulent flow, isotropic, homogenous turbulence, scale and intensity of turbulence, measurement of turbulence, eddy viscosity, mixing length concept and velocity distribution in turbulent flow over smooth and rough surfaces, resistance to flow, minor losses, pipe in series and parallel, power transmission through a pipe, siphon, water hammer, three reservoir problems and networks.

### V Boundary Layer Analysis:
Boundary layer thickness, boundary layer over a flat plate, laminar boundary layer, application of momentum equation, turbulent boundary layer, laminar sub layer, separation and its control, Drag and lift, drag on a sphere, a two dimensional cylinder, and an aero foil, Magnus effect.

### List of Experiment:
1. To measure the surface tension of a liquid.
2. To determine the metacentric height of a ship model experimentally.
3. To study the transition from laminar to turbulent flow and to determine the lower critical Reynolds number.
4. To determine the coefficients of velocity, contraction and discharge of an orifice (or a mouth piece) of a given shape. To plot the flow net for a given model using the concept of electrical analogy.
5. To find the velocity distribution in a pipe and hence to compute the discharge by integrating the velocity profile obtained.
6. To verify the Bernoulli’s theorem.
7. To calibrate an orifice meter and venturimeter and to study the variation of the coefficient of discharge with the Reynolds number.
8. To calibrate and to determine the coefficient of discharge for rectangular and triangular notches.
9. To verify Darcy’s law and to find out the coefficient of permeability of the given medium.
10. To verify the momentum equation.
11. To study the boundary layer velocity profile and to determine boundary layer thickness and displacement thickness. Also to determine the exponent in the power law of velocity distribution.
12. To study the variation of friction factor, ‘f’ for turbulent flow in smooth and rough commercial pipes.
13. To determine the loss coefficients for the various pipe fittings.
14. To study the flow behavior in a pipe bend and to calibrate the pipe bend for discharge measurement.

### Reference Books:
1. S Narasimhan: First Course in Fluid Mechanics, University Press
3. M M Das: Fluid Mechanics & Turbo machines, Oxford University Press
➢ Students have to perform, understand and experience the experiments related to this semester on virtual environment and submit a report.
➢ The report must be evaluated carefully to award the marks
➢ University may check anytime by appointing some experts