Uttarakhand Technical University, Dehradun

New Scheme of Examination as per AICTE Flexible Curricula

Plastic and Polymer Engineering, III-Semester

3rd SEM

Uttarakhand Technical University, Dehradun

New Scheme of Examination as per AICTE Flexible Curricula

Plastic and Polymer Engineering, III-Semester

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 theirapplications.
- The idea of Fourier transform of functions and theirapplications.
- To evaluate roots of algebraic and transcendental equations.
- Interpolation, differentiation, integration and the solution of differentialequations.
- The basic ideas of statistics including measures of central tendency, correlation, regression and theirproperties.

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 lifeproblems.
2. Understand the concept of Fourier transform to evaluate engineeringproblems
3. Understand to evaluate roots of algebraic and transcendentalequations.
4. Understand interpolation, differentiation, integration and the solution of differential 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 differentialequations.

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'sformula.

Unit 4: Numerical differentiation, Integration &Solution of ODE (8 hours)
Numerical Differentiation, Numerical integration: Trapezoidal rule, Simpson's 1/3rd and 3/8 rule Runge- Kutta method of fourth order for solving first order linear differential equations. Milne's predicator-corrector method.

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-linearregression.

Reference Books:

1. E. Kreyszig: Advanced Engineering Mathematics; John Wiley &Sons
2. B.V. Ramana: Higher Engineering Mathematics; Tata McGraw- Hill Publishing Company Limited, New Delhi.
3. Peter V.O' Neil. Advanced Engineering Mathematics, Thomas (Cengage)Learning
4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition,2000.
5. T.Veerarajan : Engineering Mathematics (for semester III), Tata McGraw-Hill, NewDelhi.
6. R.K. Jain and S.R.K. Iyenger: Advance Engineering Mathematics; Narosa Publishing House, NewDelhi.
7. P. Kandasamy, K. Thilagavathy, K. Gunavathi, Numerical Methods, S. Chand& Company, 2nd Edition, Reprint2012.
8. S.S. Sastry, Introductory methods of numerical analysis, PHI, 4th Edition,2005.
9. N.P. Bali and Manish Goyal, Computer Based Numerical and Statistical Techniques , Laxmi Publications, Reprint,2010.
10. J.N. Kapur: Mathematical Statistics; S. Chand & Sons Company Limited, NewDelhi.
11. D.N.Elhance,V. Elhance& B.M. Aggarwal: Fundamentals of Statistics; KitabMahal Distributers, NewDelhi.

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Plastic and Polymer Engineering, III-Semester

BMET-302	**Basic Thermodynamics**	**3L:1T:0P**	**4 credits**

OBJECTIVES:

1. To learn about work and heat interactions, and balance of energy between system anditssurroundings
2. To learn about application of I law to various energyconversion devices
3. To evaluate the changes in properties of substances invarious processes
4. To understand the difference between high grade and low grade energies and IIlaw. limitations on energyconversion

COURSE OUTCOMES(COs):

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

1. Fundamental knowledge of laws and principles of thermodynamics.
2. Knowledge of heat and work transfer and their effect, application of first law of thermodynamics to different machines as well as second law ofthermodynamics.
3. Knowledge of steady flow energy equation and its use in compressor, turbines, nozzles, evaporatorsetc.
4. Knowledge of quality of energy and itsbalance

Unit-1 : FUNDAMENTALCONCEPTS 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 , EXERGYAND ENRTOPY 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 sothermal 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'schart.

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:

1. Sonntag, R. E, Borgnakke, C. and Van Wylen, G. J., 2003, 6th Edition, Fundamentals of Thermodynamics, John Wiley andSons.
2. Jones, J. B. and Duggan, R. E., 1996, Engineering Thermodynamics, Prentice-Hall ofIndia
3. Moran, M. J. and Shapiro, H. N., 1999, Fundamentals of Engineering Thermodynamics, John Wiley andSons.
4. Nag, P.K, 1995, *Engineering Thermodynamics, Tata McGraw-Hill Publishing Co.Ltd.*

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Plastic and Polymer Engineering, III-Semester

BMET 303 & BMEP 303	**Materials Science & Technology**	**3L:0T:0P**	**4 credits**

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 insolid.
- Mechanical properties and testing, micro structural exam, phase diagram, equilibrium diagram and brief introduction to ferrous material, heattreatment.
- Magnetic and electric properties along with introduction to ceramics, plastic and other materials arestudied.

Unit -1 :Introduction to Materials and their Defects

Introduction: Material Science & its objective, importance of materials. Different Types of Materials Physical, Chemical Properties, Ductile & brittle material, Stress vs. Strength. Toughness, Hardness, Fracture, Fatigue and Creep. Stress strain diagram

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

Ferrous Materials: Introduction to Ferrous Materialsandtheir importance. Iron an Iron Ores. Flow Diagram for Production of Ferrous Materials,Production of Cast Iron and Steel, Classification of Cast Iron, Steel their properties and Importance. Iron Carbon Equilibrium Diagram and Phase Transformation

Heat Treatment: Various types of heat treatment such as Annealing, Normalizing, Quenching, Tempering and Case hardening.TimeTemperature Transformation (TTT)diagrams

Unit -3:Non Ferrous Metals. Testing and Microstructure Examine of Materials

Non-Ferrous metals 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, Impacttastings, Fatigue testing Creep testing, Non-destructive testing(NDT)

Micro structural Exam: Microscope principle and methods. Preparation of samples and Microstructureexam 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

Magnetic Properties: Concept of magnetism - Dia, para, Ferro Hysteresis. Soft and hard magnetic materials, Magnetic storages, Electric properties: Energy band concept of conductor, insulator and semi-conductor, Super conductivity and its applications. Messier effect. Type I & II superconductors

Unit -5:Non Metallic Materials

Plastics: Introduction to Plastics, Various types of polymers/plastics and its applications, Difference between Thermoplastics and Thermosetting Plastics.

Other materials: Heat Insulating Materials, Electrical Insulating Materials, Refractory Materials Ceramics Materials, Composite Materials, Adhesive, Paint, Varnish, Putty, Nano Materials and Smart Materials, Corrosion and its control

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

1. Preparation of plastic mould for small metallicspecimen.
2. Specimen preparation for micro structural examination-cutting, grinding, polishing,etching.
3. Grain size determination of a given specimen.
4. Comparative study of microstructures of different material specimens (mild steel, graycast iron, brass, copperetc.)
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 abox.
7. Faradays law of electrolysisexperiment.
8. Study of corrosion and itseffects.
9. Study of microstructure of welded component and HAZ. Macro and MicroExamination.
10. Suitable experiment on Magnetic/ Electrical/ Electronicmaterials

Text Books:

1. *Callister/Balasubramaniam – Callister"s Material Science & Engineering WileyIndia*
2. *Van Vlack - Elements of Material Science & Engineering John Wiley &Sons.*
3. *Material Science byR.K.Rajput.*
4. *Raghvan - Material Science, PrenticeHall*

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Plastic and Polymer Engineering, III-Semester

BCST 305	Object Oriented Programming & Methodology	3L:1T: 2P	5 credits

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 objectidentity.
3. Name and apply some common object-oriented design patterns and give examples of theiruse.
4. Design applications with an event-driven graphical userinterface.

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

Java Programming: Introduction, Operator, Data types, Variables, Methods & Classes, Multithread Programming, I/O, Java Applet.

Module IV

Java Library: String Handling, Input / Output exploring Java.io, Networking, Exception Handling, Event Handling, Introduction to AWT, Working with window, Graphics, AWT Controls, Layout Manager and Menus, Images.

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 HELLOINDIA.
2. To write a java program that takes in command line arguments as input and print the number ofarguments.
3. To write a java program find the division ofstudent.
4. To write a program implements the concept ofinheritance.
5. To write a java program methodoverloading.
6. To write a java program for method overriding.
7. To write a java program exceptionhandling.
8. To write a java program to run applet for drawing variousshapes.
9. To write a java program to design a login usingJFrame.
10. To write a java program to validate the logging details of user using JDBCconcept.
11. To write a Java program Insertionsort.
12. To write a Java program mergesort.
13. To write a Java program first n primenumbers.

Text Books:

1. Herbert Schieldt, "The Complete Reference: Java", TMH, 7thEdition.
2. E. Balagurusamy, "Programming in JAVA", TMH, 4th Edition.
3.James Rumbaugh etal, "Object Oriented Modelling and Design",PHI
4. Barbara Liskov, *Program Development in Java*, Addison-Wesley, 2001

References:

1. Bjarne Stroustrup, "C++ Programming Language", Addison Wesley, 3rdEdition.
2. E. Balagurusamy, "Object Oriented Programming with C++", TMH,2008.

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Plastic and Polymer Engineering, III-Semester

BPPT 301	Introduction To Polymer Science	3L:1T:0P	4 Credits

- **Objectives**: To familiarize the students about the fundamental theories of polymerscience.
- **Course Outcomes:**On completion of the course, students will understand the basic fundamentals ofpolymer
  1. Different kind of polymers and theirproperties.
  2. Concept of Molecular Weight and distribution.
  3. Variation of properties of polymer by crystallinity and glass transitiontemperature.
  4. Process of polymerdegradation.
  5. Behvious of polymer solution at differentconcentrations.

Unit	Topics	Lectures
I	**Basic Concepts of Polymers** 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,	8
II	**Molecular Weight And Molecular Weight Distribution** Average Molecular Weight, Number Avg. Molecular Weight, Weight Avg. Molecular Weight, Viscosity Avg. Molecular Weight, Degree of Polymerisation and molecular weight, Poly dispersity and Molecular Weight Distribution in polymers.	9
III	**Crystallinity** Crystalline and amorphous structure of polymers, Degree of Crystallinity, Polymer crystallization, Effect of Crystallinity on Polymer property **Glass Transition Temperature (Tg)** Tg and its associative properties, Factors affecting Tg, Relation between Tg and Melting Temperature Tm, Importance of Tg, Tg and polymer properties relationship	8
IV	**Polymer Degradation and Stability** Introduction, Types of Degradation – Thermal Degradation, Mechanical Degradation, Oxidative Degradation, Photo Degradation, Chemical degradation	8
V	**Polymer Solution:** The process of polymer solution, nature of polymer molecules in solutions, size and shape of macro molecules in solution.	7

Reference Books:

1. Plastics Materials by J. A. Brydson, Butterworth Heinemann(1999).
2. Textbook of Polymer Science by Fred W. Billmeyer, Wiley, India(2007).
3. Polymer Crystillization, by Schultz, American Chemical Society(2001).
4. Polymer Chemistry, by Seymour R. B. and Carraher, Marcel Dekker(2000).

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Plastic and Polymer Engineering, III-Semester

BCSP 307	**Programming Practices (Introduction to MATLAB)**	**0L:0T:4P**	**2 Credits**

Course Objectives:

1. The course is intended to assist undergraduates in learning the basics of programming in general and programming MATLAB inparticular.
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 programmingpurposes
2. Learn and explore MATLAB further on theirown
3. Use this learning experience to learn other programminglanguages.

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, MathematicalFunctions.

UNIT 2: PROGRAMMING IN MATLAB

Script and Function: Decision Making, Loops, branches, Functions, Working on Script File (Creating, Saving and Executing), MATLAB I/O, Formatted I/O Method.

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:

1. Delores M. Etter, David C. Kuncicky, Holly Moore, "*Introduction to MATLAB 7.0*", Pearson, 2013.
2. Rudra Pratap, "*Getting Started with MATLAB*", OXFORD University Press,2010.
3. Agam Kumar Tyagi, "*MATLAB and Simulink for Engineers*", University Press,2012.

WEB REFERENCES - https://ocw.mit.edu/courses/mathematics/18-s997-introduction-to-matlab-programming- fall-2011/syllabus/

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BCST 308	Cyber Security	Non- Credit Course

Course Objectives:

1. Understand the basic concept of CyberSecurity.
2. Understand the basic concept ofViruses.
3. Understand the basic concept of DigitalAttacks.
4. Understand the basic concept ofPhishing.
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 cybersystems
2. Know about how to prevent digitalattacks
3. Know about how to prevent PhishingAttacks
4. Know about how to do securetransactions

UNIT-1

Introduction to information systems, Types of information Systems, Development of Information Systems, Introduction to information security, Need for Information security, Threats to Information Systems, Information Assurance, Cyber Security, and Security RiskAnalysis.

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

Developing Secure Information Systems, Application Development Security, Information Security Governance & Risk Management, Security Architecture & Design Security Issues in Hardware, Data Storage & Downloadable Devices, Physical Security of IT Assets,

Access Control, CCTV and intrusion Detection Systems, Backup Security Measures.

UNIT-4

Security Policies, Why Policies should be developed, WWW policies, Email Security policies, Policy Review Process-Corporate Policies-Sample Security Policies, Publishing and Notification Requirement of the Policies.

Information Security Standards-ISO, IT Act, Copyright Act, Patent Law, IPR. Cyber Laws in India; IT Act 2000 Provisions, Intellectual Property Law: Copy Right Law, Software License, Semiconductor Law and Patent Law.

References:

1. Charles P. Pfleeger, Shari LawerancePfleeger, “Analysing Computer Security ”, Pearson Education India.
2. V.K. Pachghare, “Cryptography and information Security”, PHI Learning Private Limited, Delhi India.
3. 3.Dr. Surya Prakash Tripathi, Ritendra Goyal, Praveen kumar Shukla ,”Introduction to Information Security and Cyber Law” Willey DreamtechPress.
4. Schou, Shoemaker, “ Information Assurance for the Enterprise”, Tata McGraw Hill. 5. CHANDER, HARISH,” Cyber Laws And It Protection ” , PHI Learning Private Limited ,Delhi,India

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Plastic and Polymer Engineering, III-Semester

BPPP 302	**Virtual Lab Experiments related to III semester Labs**	**0L:0T:2P**	**1 Credits**

- Students have to perform, understand and experience the experiments related to thissemester on virtual environment and submit areport.
- The report must be evaluated carefully to award themarks
- University may check anytime by appointing someexperts

Uttarakhand Technical University, Dehradun
New Scheme of Examination as per AICTE Flexible Curricula
Plastic and Polymer Engineering, IV-Semester

4th SEM

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Plastic and Polymer Engineering, IV-Semester

BCET 402	**Energy and Environmental Engineering**	**3L:1T:0P**	**4 Credits**

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 energyprojects
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 futureenergy.
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 climatechange.

Course Outcomes

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

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

Energy Sources - Overview of energy systems, sources, transformations, efficiency, and storage. Fossil fuels (coal, oil, oil-bearing shale and sands, coal gasification) - past, present & future, Remedies & alternatives for fossil fuels - biomass, wind, solar, nuclear, wave, tidal and hydrogen; Sun as Source of Energy, Availability of Solar Energy, Nature of Solar Energy, Solar Energy & Environment. Various Methods of using solar energy. Commercial and noncommercial forms of energy, Fossil fuels, Renewable sources including: Nuclear Energy, Hydel Energy, Storage of Hydrogen, Hydrogen Production, Hydrogen Energy Geothermal, Tide and Wave Energy, Bio-fuels inIndia.

UnitIII

Energy Efficiency and Conservation - Introduction to clean energy technologies and its importancein 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 Researchpolicy.

Unit IV

Energy & Environment - Environment**:** Introduction, Multidisciplinary nature of environmental studies- Definition, scope and importance, Need for public awareness. Ecosystem: Concept, Energy flow, Structure and function of an ecosystem. Food chains, food webs and ecological pyramids, Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems, Ecological succession. Environmental Pollution: Definition, Cause, effects and control measures of - Air pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, Thermal pollution and Nuclear hazards , solid wasteManagement.

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:

1. Schaeffer, John. 2007. Real Goods Solar Living Sourcebook: The Complete Guide to Renewable Energy Technologies and Sustainable Living (30th anniversary edition).Gaiam.
2. Boyle, Godfrey, Bob Everett, and Janet Ramage (eds.) 2004. Energy Systems and Sustainability: Power for a Sustainable Future. Oxford University Press, 619 pages (ISBN: 0-19-926179-2)
3. Energy Management Principles: C.B.Smith (PergamonPress)
4. Renewable Sources of Energy and Conversion Systems: N.K.Bansal andM.K.Kleeman.
5. EnergyManagement: W.R.Murphy, G.Mckay(Butterworths)
6. Ristinen, Robert A. Kraushaar, Jack J. AKraushaar, Jack P. Ristinen, Robert A. (2006)Energy and the Environment, 2nd Edition, JohnWiley
7. Ravindranath, N. H., & Hall, D. O. (1995). Biomass, energy and environment: adeveloping country perspective from India. Oxford UniversityPress.
8. Popp, D., Newell, R. G., & Jaffe, A. B. (2010). Energy, the environment, and technological change. In Handbook of the Economics of Innovation (Vol. 2, pp. 873-937).North-Holland.

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Plastic and Polymer Engineering, IV-Semester

BPPT 401 & BPPP 401	Polymer Chemistry	3L:1T:2P	5 Credits

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 ofpolymers.
2. Kinetics, mechanism of condensation polymerization & methodology used of controlmolecular weight of polymers.
3. Kinetics, mechanism of free radical polymerization & methodology used of controlmolecular weight of polymers.
4. Phenomena of auto-acceleration & role of chain transfer agents, retarders, inhibitorsfor controlling molecular weight and shelf life ofpolymer.
5. Utility of copolymerization reaction mechanism & preparation techniques for block & graft copolymers.

Unit	Topics	Lectures
I	Criteria for polymer synthesis. Classification of polymerization processes. Basic methods of polymerization and their mechanism: Addition, condensation, mass (bulk), suspension, emulsion and solution processes.	9
II	General characteristics of condensation polymerization, kinetics and mechanism, Molecular weight control and development of cross-linked structures. Step polymerization and its utility. General theory of chain- growth polymerization. Free radical polymerization, initiators, kinetics of free radical polymerization.	10
III	Auto-acceleration. Factors affecting molecular weight and molecular weight distribution. Chain-transfer reactions, retardars, inhibitors, Effect of temperature on polymerization, kinetics & mechanism	9
IV	Copolymerization reactions and its utility. Kinetics and copolymerization behavior. Block and graft copolymers.	8
V	Stereo-chemistry of polymerization. Ring-openingpolymerization. Different advanced catalyst systems: Ziegglar Natta catalyst & metallocene catalysts& their role inpolyolefins.	9

POLYMER CHEMISTRY LAB

1. Suspension polymerization ofStyrene/MMA.

2. Preparation and testing of UF/PF/MFresins.
3. Preparation and testing of Diglycidyl ether of bis phenol-A(DGEBA).
4. Bulk and solution polymerization of MethylMethacrylate/Styrene.
5. Emulsion polymerization of Styrene/ Methyl Methacrylate.
6. Copolymerization of styrene & MMA and determination of reactivityratios.
7. Preparation of Poly(vinylbutyral).
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:

1. Principles of Polymerization, by G.Odian, Wiley – Interscience(2004).
2. Plastics Materials by J. A. Brydson, Butterworth-Heinemann(1999).
3. Principles of Polymer Chemistry by P.J. Flory, Asian Books Private Limited(2006).
4. A Text book of Polymer Science by F.W. Billmeyer, John-Wiley and Sons(2011).
5. Polymer Chemistry by R. B. Seymour and C.E. Carraher, Marcel Dekker(2003).

Suggested Reading

(Ref. 1 for Chap.1), (Ref. 2 & 5 for Chap. 4), (Ref. 3 for Chap. 2), (Ref.4 for Chap. 3)

Uttarakhand Technical University, Dehradun

New Scheme of Examination as per AICTE Flexible Curricula

Plastic and Polymer Engineering, IV-Semester

BPPT 402 & BPPP 402	Thermoplastic Materials	3L:1T:2P	5 Credits

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 commodityplastics.
2. Preparation, properties & application of various Engineeringplastics.
3. Concept of improvement of impact strength of plasticmaterials.

Unit	Topics	Lectures
I	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 & filled polyolefins	8
II	Brief introduction to preparation, structure, properties and application of following thermoplastic materials: Engineering Polymers Polyesters such as PET, PBT, PTT, Polycarbonates, Polyacetals.	9
III	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	10
IV	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 & copolymers, Polyacrylamide, PMMA, Polyacrylonitrile.	8
V	Brief introduction to preparation, structure, properties and application of following thermoplastic materials: Polyvinyl chloride & its copolymers, Poly vinyl acetate, Polyvinyl alcohol Modified cellulosics: Cellulose esters and ethers such as Ethyl cellulose, CMC, HPMC, cellulose acetals.	9

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 givensolvent.
5. Determination of melting point of a given solid resin by capillarymethod.
6. Determination of refractive index of a liquidresin.
7. Determination of specific gravity of given resin bypycnometer.
8. Determination of solubility of a given polymer in differentsolvents.

Reference Books

1. Text book of Polymer Science by Billmeyer, John Wiley ans Sons,(1984).
2. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc(1988).
3. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc,(1990)
4. Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falcetta,Wiley – Interscience Publication, (1977)
5. Engineering Thermoplastics Polycarbonates Polyacetals Cellulose Esters, L.Bottenbruch, Hanser Publishers,(1996)

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New Scheme of Examination as per AICTE Flexible Curricula

Plastic and Polymer Engineering, IV-Semester

BPPT 403 & BPPP 403	THERMOSET MATERIALS	3L:1T:2P	4 Credits

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 formulationfor manufacturing, properties and applications of variety of thermoset plasticmaterials
2. Effect of variation in the quantities & type of curing agents & curing condition on the properties of thermosetmaterial.

Unit	Topics	Lectures
I	**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.	8
II	**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 resinsinmouldingcompositionssuchasSheetMouldingCompoundsandDough Moulding Compounds.	10
III	**Phenolic Resins:** Basic raw materials – phenol and formaldehyde. Resin preparation – Resol and Novolac type. Effect of the ratio of phenol to aldehyde on the nature and the property of polymer. Eeffect of pH on the reaction mechanism and the reaction products. Curing of phenolics. Phenolic moulding compounds, ingredients, compounding and applications.	9
IV	**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.	10
V	**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.	9

THERMOSET MATERIALS

1. Identification of unknown polymer using heating, burning, solubility of thermosetmaterial.
2. Confirmatory chemical tests for Identification of unknown thermosetpolymer
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 giventemperature.
6. Determination of viscosity of a resin by Ford Cup or Brook fieldviscometer.
7. Determination epoxy equivalent weight of epoxyresin.
8. Determination of Saponification number of polyesterresin

Reference Books;

5. Composite Polymeric Material, R. P. Sheldon, Applied Science Publishers,(1982).
6. Composite Material Handbook, M. M. Schwartz, McGraw-Hill company,(1984).
7. Polymer chemistry, Seymour and Carraher, Marcel Dekker,(2003).
8. Polymer and Resins; Their Chemistry and Chemical Engg, BrageGolding, D.Van Nostrand Company Inc,(1959).
9. Organic Coating: Science and Technology by Z. Wicks.WileyInterscience,(2007).

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New Scheme of Examination as per AICTE Flexible Curricula

Plastic and Polymer Engineering, IV-Semester

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 applicationsof Aerodynamics, Hydraulics, Marine Engineering, Gas dynamicsetc.
2. To give fundamental knowledge of fluid, its properties and behavior under various conditionsof internal and externalflows.
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 fluidflow.
4. To imbibe basic laws and equations used for analysis of static and dynamic fluids. 5. Toinculcate the importance of fluid flow measurement and its applications inIndustries.
6. To determine the losses in a flow system, flow through pipes, boundary layer flow and flowpast immersedbodies.

Course Outcomes:

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

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

Unit	Topics	Lectures
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	**FluidStatics:** 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 anaxis. **Dynamics of Fluid Flow:** Euler's Equation of motion along a streamline and its integration, Bernoulli's equation and its applications- Pitot tube, orificemeter, 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 andnetworks.	9
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.	8

List of Experiment:

1. To measure the surface tension of aliquid.
2. To determine the metacentric height of a ship modelexperimentally.
3. To study the transition from laminar to turbulent flow and to determine the lowercritical Reynoldsnumber.
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 ofelectrical analogy.
5. To find the velocity distribution in a pipe and hence to compute the discharge by integratingthe velocity profileobtained.
6. To verify the Bernoulli'stheorem.
7. To calibrate an orifice meter and venturimeter and to study the variation of the coefficientof discharge with the Reynoldsnumber.
8. To calibrate and to determine the coefficient of discharge for rectangular andtriangular notches.
9. To verify Darcy's law and to find out the coefficient of permeability of the givenmedium.
10. To verify the momentumequation.
11. To study the boundary layer velocity profile and to determine boundary layer thicknessand 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 pipefittings.
14. To study the flow behavior in a pipe bend and to calibrate the pipe bend fordischarge measurement.

Reference Books :

1. S Narasimhan: First Course in Fluid Mechanics, UniversityPress
2. Som, S.K. & Biswas G.: Introduction of fluid mechanics & Fluid Machines, TMH,2000, 2nd edition.
3. M M Das: Fluid Mechanics & Turbo machines, Oxford UniversityPress
4. Hunter Rouse, "Elementary Mechanics of Fluids", John Wiley & Sons. Omc.1946
5. Vijay Gupta and S.K.Gupta, " Fluid Mechanics and its Applications", Wiley Eastern Ltd,1984.

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Plastic and Polymer Engineering, IV-Semester

BPPP 404	**Virtual Lab Experiments related to IV semester Labs**	**0L:0T:2P**	**1 Credits**

- Students have to perform, understand and experience the experiments related to thissemester on virtual environment and submit areport.
- The report must be evaluated carefully to award themarks
- University may check anytime by appointing someexperts