## ANNA UNIVERSITY: CHENNAI
### NON-AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY
#### REGULATIONS 2021
#### M.TECH. PLASTICS TECHNOLOGY
#### CHOICE BASED CREDIT SYSTEM
#### I TO IV SEMESTERS CURRICULUM AND SYLLABUS

### SEMESTER I

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**SUMMARY**

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SEMESTER I

MA4112 MATHEMATICS FOR PLASTIC TECHNOLOGY

L T P C  4 0 0 4

COURSE OBJECTIVES:

- To understand the basic concept of numerical methods in solving ordinary differential equations.
- To understand the basic concept of numerical methods in solving partial differential equations.
- To understand the basics of random variables with emphases on the standard discrete and continuous distributions.
- To introduce the basic concept of Markovian Queueing Systems.
- To apply small and large sample tests through tests of hypotheses.

UNIT I  NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS  12
Solution of first order ordinary differential equation - Taylor’s method - Euler's method - Runge-Kutta method of fourth order - Predictor – Corrector Methods - Milne’s and Adam's – Bashforth methods - Introduction to numeric use of the above techniques in plastics engineering and calculations.

UNIT II  NUMERICAL SOLUTION OF PARTIAL DIFFERENTIAL EQUATIONS  12

UNIT III  PROBABILITY AND STATISTICS  12
Probability – Addition theorem - Multiplication theorem - Conditional probability – Baye’s theorem - Distribution functions - Binomial distribution - Poisson distribution - Normal distribution - Uniform distribution - Curve fitting – Fitting a straight line and second degree curve - Fitting a non linear curve - Correlation and regression.

UNIT IV  QUEUEING MODELS  12
Poisson process – Markovian queues – Single and multiserver models – Little’s formula – Steady state analysis – Self service queue.

UNIT V  TESTING OF HYPOTHESIS  12
Sampling distribution – Large sample and small samples - Testing of null hypothesis - Type I and Type II errors - "t" test and Chi square test - Goodness of fit - Fisher’s "F" test.

TOTAL :  60 PERIODS

COURSE OUTCOMES:

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

CO1  Develop a good understanding of the various methods used for the numerical solution of scientific problems.
CO2  Learn various numerical methods of solving partial differential equations.
CO3  Analyze the performance in terms of probabilities and distributions achieved by the determined solutions.
CO4  Formulate the various kinds of Non-Markovian, Markovian Queueing Models.
CO5  Apply the basic principles underlying statistical inference.(estimation and hypothesis testing)
REFERENCES:

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PA4101 PLASTICS MATERIALS TECHNOLOGY LTPC 3003

COURSE OBJECTIVES:
- To understand the mechanism of polymerization, techniques of polymerization and the significance of different molecular weight averages.
- To provide in depth knowledge about different kinds of plastic materials based on their structure and properties
- To make the student familiar about properties and end application of different plastics materials
- To apply knowledge of thermoplastics for industrial applications.
- To understand the role of polymer blends & alloys in current scenario

UNIT I POLYMER CHEMISTRY 9
Introduction to polymers- homopolymers, Copolymers. Different types of polymerizations - addition, condensation and stereoregular polymerization. Initiators, important steps involved, kinetics and mechanism of addition, condensation and stereoregular polymerizations. Copolymerization and its kinetics. Polymerization techniques- emulsion, bulk, solution and suspension, Molecular weight & its determination.

UNIT II COMMODITY THERMOPLASTICS 9
Introduction, source of raw materials, Manufacture, General Properties, processing and applications of Olefine Polymers such as Polyethylene - Polypropylene and their copolymers-Styrene Polymer such asPolystyrene and Copolymers (Styrene Acrylonitrile, Acrylonitrile Butadiene Styrene) -Vinyl polymers such as Poly Vinyl Chloride, Poly vinyl acetate- Acrylic and copolymers-Cellulose Polymers.

UNIT III ENGINEERING AND HIGH PERFORMANCE THERMOPLASTICS 9
Introduction, source of raw materials, Manufacture, General Properties, processing and applications of engineering thermoplastics such as-Acetal–Homopolymer& Co-polymer , polycarbonates, polyamides-Nylon 6, 66, 610, 11 and 12,Polysters (Poly Ethylene Terephthalate & Poly Butylene Terephthalate) polyimides, Poly (benzimidazoles), polyphenylene oxide, Poly(aryl ether ketone), Poly(ether ketone), Poly(aryl ether sulfone), poly (phenylene sulfides), Polysulfones-Fluoropolymers (PolyVinyl Fluoride,
Poly Vinyleden Fluoride, Poly Tetra Fluoro Ethylene, Polychloro TriFluoro Ethylene), Liquid crystalline polymers and Thermoplastic Polyurethane.

UNIT IV THERMOSETTING PLASTICS

UNIT V POLYMER BLENDS AND ALLOYS
Introduction to polymer blends and alloys- Definitions, compatibilization mechanism and methods, criteria for making polymer blends, Selection of polymer for blend, Types of polymer blends. Thermodynamics of polymer miscibility, Blend preparation techniques, Commercial polymer blends such as plastic-plastic, rubber-plastic, rubber-rubber blends, High performance polymer blends.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO1 Apply suitable polymerization technique to prepare the plastics as per the requirement.
CO2 Select the plastic materials for particular end use based on properties.
CO3 Predict the behavior of different kinds of plastics material based on their structure and property relationship.
CO4 Gain knowledge on manufacturing process of thermosetting Plastics
CO5 Classify the types of polymer blends & alloys

REFERENCES:

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1-low, 2-medium, 3-high, *- no correlation

PA4102 MANUFACTURE OF PLASTICS PRODUCTS

COURSE OBJECTIVES:
- To understand the functions of each of these additives, technical requirements, types & mechanism, and their effective evaluation are dealt with in this subject.
• To select suitable plastics material compounding and mixing techniques like two roll milling, internal blender, single / twin screw extruder, etc.
• To learn the fundamentals of compression moulding & transfer moulding.
• To impact knowledge on basic processing of thermoplastics.
• To analyze the various processing techniques of plastics materials

UNIT I COMPOUNDING OF THERMOPLASTICS
Compounding-Importance, ingredients, master batch, equipments- Twin screw extrusion, compression moulding and compounding lines -compounding of polyolefins, polystyrene and styrene copolymers, engineering polymers, natural fiber filled plastics, post compounding operations.

UNIT II INJECTION MOULDING AND EXTRUSION PROCESS

UNIT III BLOW MOULDING, COMPRESSION & TRANSFER MOULDING PROCESS
Basic principles of blow moulding–Injection Blow moulding, extrusion blow moulding, Parison programming, Advantage & disadvantage of blow moulding. Basic principles of compression and transfer moulding-Bulk factor-Curing time-Mould temperature and Pressure requirements-Prefe and preheating-Techniques of preheating- Machines used-Types of compression mould-Common moulding faults and their correction. Advantages of transfer moulding over compression moulding-Equipment used-Moulding faults—causes and remedies.

UNIT IV THERMOFORMING, CALENDERING AND ROTO MOULDING PROCESS
Basic principles–Raw materials & types of thermoforming processes, Thermoforming moulds processing parameters—faults, causes and remedies. Calendaring-Principle and process description, types of calendar units 2, 3 and 4 rolled calendars; Design of calendar roll, Heating and temp control, roll crown, roll crossing and roll bending, materials for calendaring, calendaring sheets and films, embossing, coating and lamination by calendar. Rotational moulding - Introduction-principle-process-machinery used-materials-molds process parameters-merits & demerits of rotomoulding.

UNIT V SELECTIVE LASER SINTERING (SLS) PROCESS
Principle, process, Indirect and direct SLS- powder structures, materials, post processing, surface deviation and accuracy. Applications; Laser Engineered Net Shaping (LENS): Processes, materials, products, advantages, limitations and applications. Other Additive Manufacturing Systems: Shape Deposition Manufacturing (SDM), Ballastic Particle Manufacturing (BPM), Selective Laser Melting, Electron Beam Melting;

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO1 Acquire knowledge of processing of plastic materials by injection moulding, extrusion, and blow moulding.
CO2 Understand processing techniques like compression molding and transfer moulding of thermoset plastics.
CO3 Acquire the knowledge of processing of plastics materials
CO4 Gain knowledge on extrusion & Laser sintering technique
CO5 Acquire knowledge on thermoforming, calendaring & roto moulding process.
REFERENCES:
8. Iyesew, A.I., Compression Molding
9. Bruins Basic Principle of Rotational Molding
10. Brycle, D.M, Basic Principle of Thermoforming

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PA4103 POLYMER CHARACTERIZATION LT P C

COURSE OBJECTIVES:
- To develop knowledge of National & International standards for testing methods.
- To create the knowledge about the conditioning of samples and sample preparation techniques for testing various properties of plastics materials.
- To enable the students to learn about the evaluation of mechanical & thermal properties of plastics materials.
- To enable the students to learn about the evaluation of electrical & optical properties of plastics materials.
- To enable the students to understand the testing of raw materials and components for evaluating various properties; testing the products for predicting product performance

UNITI STANDARDS AND IDENTIFICATION OF PLASTICS 9
UNIT II MECHANICAL PROPERTIES

UNIT III THERMAL PROPERTIES

UNIT IV OPTICAL AND ELECTRICAL PROPERTIES

UNIT V PRODUCT TESTING

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO1 Understand the various standards & specifications for different plastics material tests.
CO2 Analyse various plastics materials for its chemical & mechanical properties as per the standard.
CO3 Assess various plastics materials for their thermo-physical as well as thermomechanical properties as per the standard.
CO4 Test various plastics materials for their Optical & electrical properties as per the standard.
CO5 Evaluate the quality of plastics products by testing.

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RM4151 RESEARCH METHODOLOGY AND IPR L T P C 2 0 0 2

UNIT I RESEARCH DESIGN 6
Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

UNIT II DATA COLLECTION AND SOURCES 6
Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

UNIT III DATA ANALYSIS AND REPORTING 6
Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

UNIT IV INTELLECTUAL PROPERTY RIGHTS 6

UNIT V PATENTS 6

TOTAL: 30 PERIODS

REFERENCES
COURSE OBJECTIVES:
- To get practice in testing the Physico-mechanical properties of plastic materials.
- To provide hands on experience on various polymerization techniques.
- To make the student understand simple experimental procedures to determine molecular weight and molecular weight distribution of polymers.
- To make the student familiarize with the thermal properties of polymers.
- To make the student understand simple techniques to identify the plastic materials.

LIST OF EXPERIMENTS:
1. Identification of Plastics materials.
2. Density determination.
3. Bulk polymerization - Preparation of polymethyl methacrylate.
4. Solution Polymerization - Preparation of polyacrylamide.
5. Preparation of Phenol-Formaldehyde, UF and MF resins.
8. End group analysis.
10. Study of Molecular weight distribution (GPC).
11. Determination of cure of a phenolic moulding (percentage acetone soluble matter).
13. Determination of K-value for PVC.
14. Viscosity and Molecular Weight Determination
15. Determination of Filler content

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO1 Measure viscosity the of polymer solutions.
CO2 Synthesize various types of polymers by using suitable polymerisation techniques.
CO3 Identify plastics materials by simple methods.

EQUIPMENT REQUIRED:
Glassware for reactions and spot tests, Ostwald/Ubbelohde viscometer,

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PA4112

PLASTICS PROCESSING LABORATORY

COURSE OBJECTIVES:
- To gain practical knowledge about hand operated injection moulding, semi automatic & automatic injection moulding machine, Blow moulding process.
- To identify defects, causes & remedies of the process.
- To select the suitable process parameters for a particular process.
- To learn about microprocessor controlled injection moulding machines, Blow moulding process, rotational moulding, thermoforming with different moulds and material.
- To understand the possible defects, its causes and setting of process parameters.

LIST OF EXPERIMENTS
1. Injection Moulding (Hand Operated, Semi-Automatic)
2. Microprocessor controlled Injection moulding operation
3. Extrusion Process
4. Compression Moulding
5. Blow Moulding
6. Vacuum Forming
7. Rotational Moulding
8. Coating of Plastics
9. Welding & Sealing of Plastics
10. Screen Printing
11. FRP – Hand layup process
12. Co-extrusion process
13. Machine Maintenance
14. Mould Study

TOTAL: 60 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to
CO1 Select suitable process parameters.
CO2 Understand all the manufacturing techniques, machine components, their function and setting of process parameters.
CO3 Analyze the cycle time and process parameters to overcome the troubleshoots.

REFERENCES:
LABORATORY REQUIREMENTS
1. Injection moulding machine (conventional) - 2Nos.
2. Plastic tube extrusion machine - 1No.
4. Compression moulding machine - 1No.
5. Microprocessor controlled inj. moulding machine - 1 No.
7. Vacuum forming machine - 1 No.
8. Rotational moulding machine - 1 No.
10. Ultrasonic welding machine - 1 No.
12. Printing machine (on plastics) - 1 No.
15. Moulds for plastic products - 1 No.
16. FRP hand layup kit - 1 No.
17. Plastic co-extrusion film plant - 1 No.

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SEMESTER II

PA4201 PLASTICS TESTING

OBJECTIVES:
- Develop the knowledge of National & International standards for testing methods
- Enable the students to identify and compare the properties of different plastics materials.
- Enable the students to learn about the evaluation of thermal, electrical, optical and mechanical properties of plastics materials.
- To enable the students to learn about the property of the plastic material for several
- Create knowledge about testing of plastics products as per the standards
UNIT I STANDARDS AND SPECIFICATIONS 12

UNIT II TESTING FOR MECHANICAL PROPERTIES 12

UNIT III TESTING FOR ELECTRICAL AND OPTICAL PROPERTIES 12
Dielectric Strength—Dielectric Constant and dissipation factor—insulation resistance—volume and surface resistivity — Arc resistance – Antistatic tests. Refractive index—Luminous transmittance — Clarity and Haze — Photo —elastic properties—colour measurements and Specular Gloss.

UNIT IV TESTING FOR THERMAL PROPERTIES 12

UNIT V TESTING FOR CHEMICAL AND WEATHER RESISTANCE 12

TOTAL: 60 PERIODS

OUTCOMES:
Students will be able to
- Identify the plastic materials for some specified applications based on its property
- Assess the plastics materials for their chemical, mechanical, electrical, optical, thermal, and permanence properties as per the standard.
- Understand the basic principle of polymer testing machines.
- Identify the plastic materials by reverse engineering for some specified applications with the knowledge of testing.
- Control the quality of plastics products by testing.

REFERENCES:
4. G.C.Lves, J.A.Mead, M.M.Riley, Hand Book of Plastics Test Methods, The Plastics Institute,
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PA4202 POLYMER COMPOSITES

OBJECTIVES:
- To impart knowledge of various types of composites and its advantages and needs.
- To understand the knowledge of various resins materials used in processing of composites
- To make the student understand the various types of fiber materials and its applications for making Composites.
- To acquire knowledge about various processing methods of composites
- To enable the students understand the basic destructive and non-destructive testing of composites

UNIT I MATRIX AND REINFORCEMENT MATERIALS

UNIT II ADDITIVES FOR COMPOSITES
Additives for composites, catalysts, room temperature and elevated temperature, accelerators, coupling agents, fillers, flame retardants, toughening agents, UV, stabilizers.

UNIT III MECHANICAL PROPERTIES OF COMPOSITES
Theory of composite materials - calculation of composite properties- mechanism of load transfer, minimum and critical fibre content, critical fibre length- Rule of mixtures–Halpin -Tsai - equation.

UNIT IV PROCESSING OF COMPOSITES
Processing of composites–Important processes like hand lay-up, spray-up, resin transfer moulding, vacuum bag, pressure bag moulding, centrifugal casting, pultrusion, filament winding, moulding compounds–SMC, DMC, BMC.

UNIT V TESTING OF COMPOSITES

TOTAL: 60 PERIODS

OUTCOMES:
At the end of the course, students will be able to
Acquire knowledge of various types of composites and their advantages and needs.
Familiarize with resins used in the FRP system
Know various types of fibers and their applications in making composite products.
Acquire knowledge of various processing operations for composites
Gain knowledge of the basic destructive and non-destructive testing of composites

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PA4203 PLASTIC RECYCLING TECHNOLOGY

OBJECTIVES:
- To emphasize the fundamentals and importance of plastics recycling.
- To know various sources of plastics waste generation
- To know recycling codes of commodity and engineering plastics.
- To impart the knowledge on various sorting and separation techniques.
- To highlight recycling procedures for commodity and engineering plastics.
- To familiarize rubber recycling procedures.

UNIT I FUNDAMENTALS OF PLASTICS RECYCLING

UNIT II RECYCLING OPERATIONS
Sorting and separation techniques–Density based–Optical sorting–Electrostatic sorting –Sorting by
melting temperature—Sorting by selective dissolution—sorting of metal contaminants, size reduction—cutting—Densification—Pulverization—Chemical methods, melt filtration of contamination in recycled plastics—screen changers—filtration requirements of different recycled plastics—Pyrolysis.

UNIT III RECYCLING OF MATERIALS—I

UNIT IV RECYCLING OF MATERIALS—II

UNIT V RUBBER RECYCLING
Tyre size reduction—Application of ground Rubber crumb—Filler—Bound Rubber products—Thermoplastics binder—Civil engineering applications—Surface treated crumb rubber—applications—Rubber reclaiming and devulcanization scrap rubber and fuel source (Tyre derived fuel TDF)—Pyrolysis.

OUTCOMES:
At the end of the course, students will be able to
- Understand the impact of plastic waste on the environment.
- Sort and separate mixed plastics.
- Apply the principles of various methods of recycling and relate the methods to various polymeric materials.
- Understand the need for recycling and the classification of recycling methods.
- Recycle domestic and engineering thermoplastics.
- Acquire knowledge of various techniques for rubber recycling.

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PA4204 PLASTICS PRODUCT AND MOULD DESIGN

OBJECTIVES:
- To understand basic concepts of product design
- To learn the design concepts for various mould elements.
- To acquire knowledge about various moulds for different processing techniques
- To learn the basic design aspects related to Injection Mould, Compression Mould, Transfer Mould, Blow Mould.
- To learn the basic design aspects related to extrusion dies

UNIT I PRODUCT DESIGN

UNIT II INJECTION MOULD DESIGN

UNIT III EJECTION & COOLING SYSTEM DESIGN

UNIT IV  DESIGN OF COMPRESSION & TRANSFER MOULD


UNIT V  DESIGN OF OTHER MOULDS & DIES


OUTCOMES:
At the end of the course, students will be able to
- Understand the basics of plastics product design.
- Understand the basics of plastics mould design.
- Acquire knowledge about various moulds for different processing techniques.
- Apply the basic design aspects related to Injection Mould, Compression Mould, Transfer Mould, Blow Mould
- Apply the basic design aspects related to extrusion dies

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OBJECTIVES:

- To educate students with fundamental and advanced knowledge in the field of Additive manufacturing technology for plastics product
- To learn the fundamentals of additive manufacturing process.
- To acquire knowledge about various additive manufacturing processes
- To learn the application of additive manufacturing in mould development
- To understand the important research challenges associated with AM and its data processing Tools

UNIT I: INTRODUCTION TO ADDITIVE MANUFACTURING

- Introduction to Additive Manufacturing (AM): AM evolution, Distinction between AM & CNC machining, Advantages of AM; AM process chain: Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build, removal and clean up, post processing; Classification of AM processes: Liquid polymer system, molten material systems, discrete particle system, solid sheet system.

UNIT II: TYPES OF ADDITIVE MANUFACTURING – I

- Stereolithography Apparatus (SLA): Principle, pre-build process, part-building and post-build processes, photo polymerization of SL resins, Advantages, limitations and applications; Solid Ground Curing (SGC): Principle, process, Advantages, limitation, and applications; Fused deposition Modeling (FDM): Principle, details of processes Advantages, limitation, and applications; Laminated Object Manufacturing (LOM): Principles, details of processes, products, materials, advantages, limitations and applications;

UNIT III: TYPES OF ADDITIVE MANUFACTURING – II


UNIT IV: DESIGN FOR ADDITIVE MANUFACTURING

- Design for AM: Motivation, DFMA concepts and objectives, AM unique capabilities, exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc;

UNIT V: APPLICATIONS OF ADDITIVE MANUFACTURING

- AM Applications: Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling (Direct and Indirect method), new materials development, Bi-metallic parts, Re-manufacturing. Application examples for Aerospace, defense, automobile, Bio-medical and general engineering industries; Post processing of AM parts: Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.

OUTCOMES:

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

- Develop knowledge about the fundamentals of Additive Manufacturing
- Choose a suitable Additive Manufacturing (AM) method.
- Learn about a variety of Additive Manufacturing (AM) technologies, their potential to support design and manufacturing
- Understand the application of additive manufacturing in mold development
- Face the research challenges associated with AM and its data processing tools

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PA4211 PLASTICS TESTING LABORATORY

OBJECTIVES:
- To train the students in testing of plastics for properties. The various testing methods of plastics materials as per the ASTM standards.
- To prepare sheet specimens by Contour cutting & Punching
- To learn about the compounding of plastics materials
- To get practice in testing the Physico-mechanical properties of plastic materials.
- To understand the various testing done on different plastics products.

LIST OF EXPERIMENTS
2. Physio-Mechanical properties of plastics : Tensile strength – Flexural strength – Compression strength –Tear strength - Impact strength – Hardness
3. Compounding, Blending using Two Roll Mill and Specimen
4. Determinations of Carbon Black Content
5. Determination of environmental stress cracking resistance for olefins
6. Testing of HDPE/RPVC Pipes
7. Testing of Water Storage Tanks/Containers
8. Testing of Films/Sheets
9. Testing of HDPE/PP Woven Sacks/Tapes
10. Testing of Bottles/Vanaspati, Ghee, Milk Packing
LABORATORY REQUIREMENTS
1. Carbon black content tester - 1 No.
2. Environmental stress cracking resistance tester - 1 No.
3. Specimen Preparation Laboratory
4. Injection moulding machine - 1 No.
5. Compression moulding machine - 1 Nos.
6. Two roll mill - 1 No.
7. Contour cutter - 1 No.
8. Scrap grinder - 1 No.
10. Universal testing machine - 1 Nos.
11. Impact strength tester - 1 No.
15. Abrasion resistance tester - 1 No.
16. Folding endurance tester - 1 No.
17. Burst strength tester - 1 No.
18. Humidity chamber - 1 No.
19. Gas permeability tester - 1 No.
20. Sieve analysis apparatus - 1 No.
22. Dielectric strength- 1 No.
23. Arc Resistance- 1 No.
24. Haze meter- 1 No.

OUTCOMES:
At the end of the course, students will be able to
- Prepare specimen by injection moulding and contour cutting
- Gain knowledge about compounding of plastics with additives
- Learn how the plastics materials are tested for its mechanical, electrical, optical, properties.
- Practice on testing of various plastic products

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OBJECTIVES:
- To learn the use of Computer Aided Design in Plastic products and mould designing.
- To analysis the flow behavior and temperature control of plastics materials while processing using mold flow software.

LIST OF EXPERIMENTS

I. Plastics Product Design using CAD
   1. 2D and 3D modeling using CAD.
   2. Product drawing practice.

II. Mold Design using CAD/CAM
   5. Design of split type Injection Mould.
   8. Design of Extrusion Die.

III. Mold flow Analysis using CAE
   10. Optimization of Mould design and Process parameters using Mold flow Software

TOTAL: 60 PERIODS

OUTCOMES:
At the end of the course, students will be able to
- Design and develop the Plastic products and moulds using CAD/ CAM/CAE software.
- Design and develop extrusion dies
- Predict the flow behavior and temperature control of the materials in the designed mould.

REFERENCES
5. Design calculations for Compression moulds, Machinery publications, Yellow series, U.K.

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PA4311  PROJECT WORK I

OBJECTIVES
The course aims to enable the students to
- identify the problem/process relevant to their field of interest that can be carried out
- search databases and journals to collect and analyze relevant data
- plan, learn and perform experiments to find the solution
- prepare project report

TOTAL : 180 PERIODS

Individual students will identify a problem relevant to his/her field of study, collect and analyze literature, design, and carryout experiment, collect data, interpret the result and prepare the project report.

OUTCOMES:
At the end of the course the students will be able to

CO1 Identify the research/industrial problems
CO2 Collect and analyze the relevant literature
CO3 Design, conduct experiment and analyse the data
CO4 Prepare project report

PA4411  PROJECT WORK II

OBJECTIVES
The course aims to
- train students to analyze the problem/ think innovatively to develop new methods/product/process
- make them understand how to find solutions/ create products economically and in an environmentally sustainable way
- enable them to acquire technical and experimental skills to conduct experiment, analyze the results and prepare project report
- enable them to effectively think about strategies to commercialize the product

TOTAL : 360 PERIODS

Individual students will identify a problem relevant to his/her field of study, collect and analyze literature, design, and carryout experiment, collect data, interpret the result and prepare the project report.

COURSE OUTCOMES
At the end of the project the student will be able to

CO1 Formulate and analyze problems for developing new methods/solutions/processes.
CO2 Plan and conduct experiments to find solutions in a logical manner
CO3 Analyze the results, interpret and prepare project report/know the strategies for commercialization
COURSE OBJECTIVES:
- To understand the conformational property of polymer chain using different models.
- To study the chain conformation in polymer solution and melt based on thermodynamics.
- To introduce fundamental flow properties and methods used to investigate the flow behaviour under stress.
- To understand the flow behaviour in different processing methods.
- To understand the concept of melt rheology & rheometry

UNIT I MOLECULAR CONFORMATION AND CONFIGURATION 9

UNIT II ELASTICITY 9
Thermoelasticity-Thermodynamics of rubbers–Flory construction- entropic and energetic contributions to the elastic force in rubbers—unentangled rubber elasticity-Affine network model- Phantom network model-entangled rubber elasticity-Edwards tube model-Mooney-Rivlin model

UNIT III SOLUTION PROPERTIES 9
Polymer solutions-theta condition-Thermodynamic view of miscibility-upper critical solution temperature (UCST)-lower critical solution temperature (LCST)-Concentration regimes in polymer solutions Viscoelasticity-elastic deformation-irrecoverable deformation-models of viscoelasticity-Voigt-kelvin-Maxwell-Burger models-WLF equation-TTS curve-Boltzman superposition principle, stress relaxation-creep and creep recovery-

UNIT IV FLOW BEHAVIOUR 9

UNIT V MELT RHEOLOGY AND RHEOMETRY 9

COURSE OUTCOMES:
At the end of the course, students will be able to
CO1 Know the conformational change of polymer chains in solution and melt
CO2 Analyze the various thermoelasticity properties & thermodynamics process
CO3 Relate the polymer rheology to properties of polymeric materials and processing
CO4 Understand and measure the basic flow properties of polymers.
CO5 Apply the concept of rheology & rheometry for industrial application.

TOTAL: 45 PERIODS
REFERENCES:

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PA4002 PLASTICS PACKAGING LT P C
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COURSE OBJECTIVES:
- To study about the functions of packaging.
- To enable the students to understand the concepts testing of packaging material.
- To know about the different packaging materials like cans, bottles, flexible films etc.
- To study about the various methods of packaging to improve the shelf life of the products.
- To learn about the testing of packaging.

UNIT I PLASTICS MATERIALS FOR PACKAGING
Introduction to Packaging – Functions of packaging –Properties and Applications of major packaging materials viz. Polyolefins, Polystyrene, Polyvinyl Chloride, Polysterers, Polyamides (Nylons), Polycarbonate and Newer materials such as High Nitrile polymers, Polyethylene Naphthalate (PEN), Polyetherimide (PEI) and LCP.

UNIT II PROCESSING OF PACKAGING MATERIALS
Adhesives, heat sealing types, sealing method, extrusion blown film and cast film and sheet co extrusion, surface treatment testing and evaluation of films, flexible packaging, pouches, bulk and heavy duty bags, thermoforming, thin sheet thermoforming, blow moulding, extrusion and injection blow moulding, foams, cushioning and distribution packaging.
UNIT III BIO BASED PACKAGING MATERIALS


UNIT IV APPLICATIONS OF PACKAGING


UNIT V TESTING OF PACKAGING MATERIALS

Mechanical properties—Tensile properties, Impact properties, Tear strength, Burst strength, Stiffness, Crease or flex resistance, Co-efficient of friction, Blocking, Orientation and shrinkage. Optical Properties—Clarity, Haze and gloss Barrier Properties—Oxygen transmission, Water vapour transmission rate – Migration.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of the course, students will be able to

CO1 Gain knowledge on the plastic packaging process and materials.
CO2 Familiarize with the testing of plastic packaging.
CO3 Attain knowledge of Biobased packaging
CO4 Understand the concepts of plastics materials used in packaging industries
CO5 Understand the machinery used in packaging field and testing equipments used for packaging products.

REFERENCES:
4. Understanding Plastics Packaging Technology (Hanser Understanding Books) , Hanser; First edition (September 1, 1997).

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COURSE OBJECTIVES:

- To know about various additives like Lubricants, Fillers, Fibres, flame retardants, colourants, anti-oxidants, UV-stabilizers, plasticizers, anti-blocking agents, Nucleating agents, Flow promoters, Anti static agents etc.
- To understand the functions of each of these additives, technical requirements, types & mechanism, and their effective evaluation are dealt with in this subject.
- To select suitable plastics material compounding and mixing techniques like two roll milling, internal blender, single / twin screw extruder, etc.
- To understand the mechanism of degradation of polymers and stabilizing additives.
- To know the various compounding methodologies for plastics materials and learn the maintenance of compounding machinery.

UNIT I  INTRODUCTION TO ADDITIVES

UNIT II  ADDITIVES

UNIT III  COMPOUNDING EQUIPMENTS

UNIT IV  FORMULATIONS AND TECHNIQUES

UNIT V  END USE MARKET FOR PLASTICS
Case studies on material suitability (e.g., Plastic Gears, Feeding Bottle, Bowels for microwave ovens). Survey and uses of plastics with reasons for their importance in major industries like Agriculture, Packaging, Building, Transport, Electrical, Electronics and Telecommunications, Medical and Furniture.

COURSE OUTCOMES:
At the end of the course, students will be able to
CO1  Understand the fundamental of additives
CO2  Select the suitable additive as per requirement.
CO3  Identify the suitable compounding techniques to make different grades of Plastics compounds
CO4  Formulate the compound to solve the environmental related problems.
CO5  Learn about various applications of Plastics by using different additives.

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PA4004 POLYMER NANOCOMPOSITES L T P C

UNIT I INTRODUCTION TO NANOMATERIALS
Nanomaterials, Uniqueness of nanomaterials, classification of nanomaterials based on dimension (0D, 1D, 2D, 3D), different types of nanomaterials: carbon based materials (carbon nanotubes, Carbon Nanofibers, fullerenes), metal based materials (quantum dots, nanogold, nanosilver, nanoaluminium oxide, nano titanium oxide) dendrimers, inorganic nanomaterials (Montmorillonitenanoclays, POSS [polyhedral oligomeric silsesquioxane], Nanosilica) - properties. Polymer Matrices: Thermoplastic based nanocomposites, Thermoset based nanocomposites, Elastomer based nanocomposites, ceramic matrix nanocomposites

UNIT II NANOMATERIAL SYNTHESIS AND CHARACTERIZATION
Preparation, Characterization of and functionalization of various nanomaterials such as C60, Carbon nanofiber, Carbon Nanotube, Graphene and Cellulose nanofibers. Characteristics of Polymer nanostructures materials. Processing of nanoparticles, binding mechanisms in nanoparticles, dispersion of nanoparticles, and stabilization of nanoparticles.

UNIT III PREPARATION OF POLYMER NANOCOMPOSITES
Processing and fabrication of polymer nanocomposites, Melt blending, solvent casting, In-situ polymerization, solution polymerization, template synthesis, high shear mixing. Homogeneous/heterogeneous nucleation, plasma promoted nucleation. Polymer nanocomposites with structural, gas barrier and flame retardant properties, carbon fibre reinforced polymer nanocomposites, elastomer and thermoplastic elastomer nanocomposites
UNIT IV  CHARACTERIZATION OF POLYMER NANOCOMPOSITES
Mechanical properties, X-ray diffraction, Small angle X-ray Scattering, Optical Microscopy, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM), TEM and EDAX analysis, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). Electrical properties of polymer nanocomposites. Thermal properties of polymer nanocomposites by using DTA, TGA, DSC.

UNIT V  APPLICATION OF POLYMER NANOCOMPOSITES
High temperature applications: fire retardant, flame retardant nanocomposite applications, Thermoset nanocomposites for rocket ablative materials, nanomodified carbon-carbon composites, Nanocomposites for carbon fiber reinforced polymer matrix composites, Thermoplastic Elastomer nanocomposites for propulsion systems. Biomedical implants, tissue engineering scaffolds, EMI shielding application.

COURSE OUTCOMES:
At the end of the course, students will be able to
CO1  Have a clear understanding of nanocomposites.
CO2  Gain knowledge about different structures and properties of nanocomposites
CO3  Have an idea about preparation technologies and applications of nanocomposites.
CO4  Know different characterization and testing techniques and interpretation of results
CO5  Demonstrate the importance of different nano materials used to make polymer nanocomposites for specific applications.

TOTAL: 45 PERIODS

REFERENCES:
5. Properties and Applications of Polymer Nanocomposites-Clay and Carbon Based Polymer Nanocomposites- Kumar Tripathy, Deba, Prasad Sahoo, Bibhu (Eds.), Springer 2017.

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PA4005  SECONDARY PROCESSING OPERATIONS

OBJECTIVES:
- To know about the different secondary processing methods like calendaring, thermoforming, and rotomoulding.
- To gain knowledge about the processing of FRP laminates.
- Acquire knowledge about different types of foaming.
- To understand the various machining and joining methods for plastics products.
- To study about different coating processes

UNIT I  CALENDERING, THERMOFORMING AND ROTOMOULDING  9

UNIT II  FRP LAMINATES  9
Introduction, FRP processing methods – contact moulding – hand layup, spray up method– vacuum bag & pressure bag moulding, filament welding, centrifugal casting, pultrusion, matched die moulding – Laminates, definition of terms – high, pressure laminating process, types of machinery, impregnation systems – decorative and industrial laminates, continuous high pressure laminating process, application.

UNIT III  CELLULAR PLASTICS  9
Introduction—process to create foam in resins – mechanical foaming, chemical foaming, physical foaming—processes to shape and solidify foams—low pressure foam moulding, high pressure foam moulding, RIM extrusion foaming, casting foams, steam chest moulding structural foam moulding – applications.

UNIT IV  MACHINING & JOINING OF PLASTICS  9

UNIT V  CASTING PROCESSES AND ROTATIONAL MOULDING  9

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, students will be able to
- Gain knowledge of various secondary processing techniques and their importance with industrial relevance
- Select a specific processing technique as per the requirement.
- Learn different FRP processing methods and foaming methods
- Choose suitable machining and joining methods for plastic products.
- Understand different coating processes and applications

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**PA4006 RUBBER TECHNOLOGY**

**OBJECTIVES:**
- To provide the students with basic knowledge on the natural rubber and various synthetic rubbers and their processing.
- To enable the students to understand the need of various additives and compounding of rubbers and vulcanization.
- To acquire knowledge about various Thermoplastic elastomers and its applications
- To enable the students to learn the basic processing of rubber products like hose conveyor belts etc.
- To learn the basic processing of latex products like latex gloves, latex threads etc

**UNIT I NATURAL RUBBER PRODUCTION TECHNOLOGY**

Various sources of natural rubber, Latex-physical nature and chemical composition, biosynthetic pathway of natural rubber production, Tapping latex, Preservation of latex, Processing of Latex (Centrifuging, creaming, etc), Dry rubber production (Smoked sheet, air dried sheet, ISNR, etc.)

Grading of rubbers - Modified forms of natural rubber.

**UNIT II SYNTHETIC ELASTOMERS**

Manufacturing, structure, properties, compounding, curing and applications: Polyisoprene, Polybutadiene, SBR, EPDM, Butyl rubber, Neoprene, Nitrile rubber, Silicone rubber, Fluoroelastomer, Polysulphide rubber, polyurethane rubber, Acrylic rubber, EVA,
UNIT III  THERMOPLASTIC ELASTOMERS
Basic structure, Manufacture, Morphology, Commercial grades and Applications—Thermoplastic styrene block copolymers, Polyester thermoplastic elastomers, polyamide thermoplastic elastomer, Polyurethane thermoplastic elastomers.

UNIT IV  COMPOUNDING OF RUBBERS
Principles of rubber compounding. Compounding to meet processing and vulcanisate properties. Introduction to dry rubber and latex compounding ingredients, Sulphur vulcanization and non-sulphur vulcanization, vulcanization systems - accelerators, activators, promoters, antioxidants, antiozonants, processing aids, extenders, fillers and effect of fillers, Blowing agents, etc. Equipments used rubber processing, rubber Processability tests.

UNIT V  RUBBER PRODUCT MANUFACTURING
Manufacturing of Dry rubber Products: Tyres, Belting, Hoses, Footwear, Rubber metal bonded items, sports goods, cellular rubber. Manufacturing of Latex Products: Latex Gloves, Latex threads, Latex foam rubber, latex adhesives

OUTCOMES:
At the end of the course, students will be able to
- Acquire knowledge of natural rubber and other synthetic elastomers.
- Understand the basics of rubber compounding and vulcanization
- Comprehend various Thermoplastic elastomers and its applications
- Acquire knowledge about the rubber products manufacturing
- Understand the basics of latex products manufacturing

REFERENCES
3. Natural rubber agro management and crop processing [2000] George, P.J. (ed.); Rubber Research Institute, Kottayam, India

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OBJECTIVES:

- To provide theoretical basis of the process of coatings and characteristics of coatings.
- To make the students aware of the different essential components of paints and coatings.
- To introduce to the different kinds of natural and synthetic resins and their applications.
- To understand various preparation technics and characterization of surface coatings.
- To make the students familiar with the basic and recent advancements in coating technologies.

UNIT I  INTRODUCTION
Concepts & terminologies, Interfacial tension, Free energy changes, wetting, dispersion, adhesion, Chemistry & Technology of Surfactants.

UNIT II  CONCEPT OF DYES & PIGMENTS

UNIT III  CHEMISTRY AND TECHNOLOGY OF RESINS
Natural resins like rosin, shellac, Bitumen, Asphalts and Coal tar–Their modifications & uses Chemistry and Technology of Synthetic resins viz. Alkyds, Polyester, Phenolics, Amino, Acrylic & Vinyl resins: Raw materials for these resins, Chemistry of synthesis of these resins, processing techniques, properties & applications of these resins for surface coatings.

UNIT IV  MANUFACTURE OF PAINTS & POWDER COATINGS
Powder Coatings, dry distempers, cement paints, oil based distempers and paints, other stiff paints, putties. Marking and labeling of packaged products, Solvent emission, recovery and disposal, environmental, health and safety issues

UNIT V  VARIOUS SURFACE COATINGS
Preparation and characteristics of Coil Coating, UV cured coating, Waterborne PU Coatings, Non Stick coatings, Smart Coatings, super hydrophobic coatings, electro wetting, Hygienic Coatings, protective coatings, marine coatings, automotive and aerospace coatings Study of important characteristics of surface coating: Rheological properties, Optical Properties, Adhesion and Mechanical properties, Corrosion and Chemical resisting properties, Film thickness, Liquid Paint analysis according to ASTM, BIS and BS Standards, Characterization of Varnishes according to ASTM, BIS and BSS Standards.

OUTCOMES:
At the end of the course, students will be able to
- Appreciate the economical and societal importance of paints and coatings.
- Familiarize with the components used in paints and will be able to predict the properties with varying compositions of the components.
- Learn about different kinds of natural and synthetic resins and its applications.
- Gain knowledge about the manufacturing techniques for paints and coatings and the advancements in coating technologies.
- Understand different characteristics of surface coatings.

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PA4008 CAD/CAM/CAE APPLICATIONS IN MOULD / DIE DESIGNS  L T P C  3 0 0 3

OBJECTIVES:
- To enable the students to provide an overview of how computers are being used in Design of Plastic Component,
- Manufacturing of Tool and Analysis of mould flow.
- To study about different NC machines and its working principle
- To develop the knowledge of computer aided manufacturing.
- To understand various CAM software packages

UNIT I COMPUTER GRAPHICS 9
Output primitives (Points, lines, curves, etc.,) - 2-D and 3D Transformations Homogeneous Coordinates- Windowing, Viewing and clipping transformation
Hidden Line and Surface Removal Algorithms.

UNIT II COMPUTER AIDED DESIGN (CAD) 9

UNIT III COMPUTER AIDED MANUFACTURING (CAM) 9
Introduction to NC machines, CNC machines, Direct Numerical Control (DNC), Advantages & Disadvantages, Working principle of CNC machines - Introduction to CAM software packages –G Codes & M Codes – Part programming for CNC Turning Centre and CNC Machining Centre.
UNIT IV  FINITE ELEMENT ANALYSIS (FEA)  9
Introduction to Finite Element Analysis (FEA), Types of analysis - Procedure for finite element analysis
-Finite Element Analysis packages, and its application; Analysis of One Dimensional Bar elements-
Derivation of Shape function and Stiffness matrix and force vector – Assembly of matrix – Field
problems.

UNIT V  MOLD FLOW ANALYSIS  9
Introduction to Moldflow analysis- Design principles- Product design and Moldflow - Sequence of
analysis- Moldflow concepts- Meshes used in Moldflow analysis- Types, Requirement- Geometry
Creation- Importing Geometry; Shrinkages and Warpage- injection molding and shrinkage, basic
cause of warpage and shrinkages ; Moldflow design procedure- Analysis steps framework, Evaluate
an Initial design, optimized the design; Part defects.

OUTCOMES:
At the end of the course, students will be able to
- Acquire knowledge of computer-aided design and manufacturing of moulds for plastics
  processing.
- Comprehend various CNC machining processes used in Mould manufacturing.
- Gain knowledge of computer-aided manufacturing
- Attain knowledge of various CAM software packages
- Learn about various types of analysis involved in Mould flow.

REFERENCES
1. Chris McMahon and Jimmie Browne “CAD/CAM Principles”, “Practice and Manufacturing
4. Jay Shoemaker “Moldflow Design Guide: A Resource for Plastics Engineers”, Volume 10,
   Hanser, 2006.
   Publications.

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OBJECTIVES:
- To Understand basic engineering systems.
- To learn the students to apply the concepts of reverse engineering.
- To learn about the Reverse Engineering Process and data analysis.
- To learn about acceptance legality of reverse engineering.
- To Understand the terminologies related to re-engineering, forward engineering, and reverse engineering.

UNIT I INTRODUCTION

UNIT II GEOMETRICAL FORM

UNIT III MATERIAL CHARACTERISTICS AND ANALYSIS
Alloy Structure Equivalency-Phase Formation and Identification-Mechanical Strength-Hardness
Part Durability and Life Limitation
Part Failure Analysis-Fatigue-Creep and Stress Rupture-Environmentally Induced Failure.

UNIT IV MATERIAL IDENTIFICATION & DATA PROCESS ANALYSIS
Material Specification-Composition-Determination-Microstructure Analysis-Manufacturing Process Verification
Data Process and Analysis
Statistical Analysis-Data Analysis-Reliability and the Theory of Interference-Weibull Analysis-Data Conformity and Acceptance-Data Report.

UNIT V PART PERFORMANCE AND ACCEPTANCE LEGALITY
Performance Criteria-Motivation of Performance Evaluation-System Compatibility
Acceptance and Legality

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, students will be able to
- Understand the reverse engineering methodologies and apply for product development.
- Determine the functional requirements and working principles of reverse engineering.
- Understand the principles behind the design of the product, ways to redesign and improve the performance of the system.
- Understand the legality of reverse engineering.
- Gain expertise in depth analysis of the products and extraction of real time data.

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PA4010 MECHANICAL BEHAVIOR OF MATERIALS

OBJECTIVES:
- To know the mechanical behavior of both metallic and non-metallic materials under different loading and temperature conditions.
- To evaluate the failure analysis and Justify the safe use of materials for engineering applications
- To gain knowledge about selection of suitable materials for different applications & conduct cost analysis
- To understand the concepts & properties of metallic materials
- To understand the concepts & properties of non-metallic materials

UNIT I BASIC CONCEPTS OF MATERIAL BEHAVIOR

UNIT II BEHAVIOUR UNDER DYNAMIC LOADS AND DESIGN APPROACHES
Stress intensity factor and fracture toughness – Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law.- Safe life, Stress life, strain-life and fail - safe design approaches -Effect of surface and metallurgical parameters on fatigue – Fracture of non metallic materials – Failure analysis, sources of failure, procedure of failure analysis.

UNIT III SELECTION OF MATERIALS
Motivation for selection, cost basis and service requirements–Selection for mechanical properties, strength, toughness, fatigue and creep – Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing – Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications – Computer aided materials selection.
UNIT IV     MODERN METALLIC MATERIALS


UNIT V     NON METALLIC MATERIALS

Polymeric materials – Formation of polymer structure – Production techniques of fibers, foams, adhesives and coating – structure, properties and applications of engineering polymers – Advanced structural ceramics, WC, TiC, TaC, Al2O3, SiC, Si3N4 CBN and diamond – properties, processing and applications.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, students will be able to
Familiarize the students in the area of material behavior under different loading and selection of materials for the design of engineering structures
- Understand the mechanism involved in the elastic and plastic behavior of metals
- Apply their knowledge in mechanisms of metallic and nonmetallic systems
- Understand the fundamental of fracture mechanics
- Apply their knowledge of cost analysis & selection of materials

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OBJECTIVES:
- To understand the specialized injection moulding process viz., Co-injection moulding, Two colour injection moulding process, Gas assisted Injection Moulding, Reaction Injection Moulding, Liquid injection moulding, structural foam moulding and to understand the effect of shrinkage, merit & demerits of the process.
- To understand advanced blow moulding process.
- To expertise the student with sufficient background for selection of processing techniques.
- To understand advanced Extrusion process.
- To gain knowledge on the applications of advanced injection moulding & Extrusion processes.

UNIT I  SPECIALIZED INJECTION MOULDING PROCESS – I  9

UNIT II  SPECIALIZED INJECTION MOULDING PROCESS – II  9

UNIT III  ADVANCED BLOW MOULDING – I  9

UNIT IV  ADVANCED BLOW MOULDING – II  9

UNIT V  ADVANCED EXTRUSION PROCESSES  9

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, students will be able to
- Select the advanced processing technique as per the requirement.
- Acquire knowledge of processing plastic materials by advanced injection moulding processes.
- Apply the knowledge of processing plastic materials by advanced extrusion moulding processes.
- Acquire knowledge of advanced processing techniques, end product application & it’s importance with industrial relevance.
- Evaluate the applications of various processing techniques.

REFERENCES
13. Schar, J., Press blowing option for tough to blow parts, SPE ANTEC April’87.

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**PA4012 FRACTURE MECHANISM & ANALYSIS IN POLYMERS**

OBJECTIVES:
- To impart knowledge on mechanics of cracked components of different modes by which these components fail under static load conditions.
- To identify the role of deformation of materials in fracture.
- To understand about crack growth curve
- To evaluate various crack arrest mechanisms.
- To evaluate various applications of fracture mechanics

UNIT I ELEMENTS OF SOLID MECHANICS
The geometry of stress and strain, elastic deformation, plastic and elasto-plastic deformation – limit analysis–Airy’s function – field equation for stress intensity factor.

UNIT II STATIONARY CRACK UNDER STATIC LOADING

UNIT III ENERGY BALANCE AND CRACK GROWTH
UNIT IV  FATIGUE CRACK GROWTH CURVE

Empirical relation describing crack growth law--life calculations for a given load amplitude – effects of changing the load spectrum--rain flow method– external factors affecting the K1c values.- leak before break analysis.

UNIT V  APPLICATIONS OF FRACTURE MECHANICS

Crack Initiation under large scale yielding – thickness as a design parameter – mixed mode fractures - crack instability in thermal and residual stress fields - numerical methods.

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, students will be able to
- Familiarize with the design of components that contain cracks under static load conditions
- Understand cracking under various loading conditions.
- Acquire knowledge about energy balance in crack growth.
- Conduct various analysis on crack growth
- Acquire knowledge of applications of fracture mechanics

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PA4013  BIOMEDICAL PLASTICS  L T P C

OBJECTIVES:
- To learn about various types of biopolymers produced from starch and microbes.
- To understand various natural and synthetic polymers used for biomedical applications.
- To learn about the plastics that are used as implants in cardiovascular, dental, ophthalmology, and other artificial organs.
- To be familiarized with evaluation methods of biomedical polymers and their interaction with human system in in-vivo and in-vitro environments.
- To understand various natural and synthetic polymers used for biomedical applications and their compatibility with biological system

TOTAL: 45 PERIODS
UNIT I  MATERIALS USED IN MEDICINE
Introduction, Polymers, Silicone Biomaterials: History and Chemistry, Medical Fibers and Biotextiles, Hydrogels, Biodegradable and Bioerodible Materials, Natural Materials, Metals, Ceramics, Glasses, and Glass-Ceramics, Composites, Textured and Porous Materials, Surface-Immobilized Biomolecules

UNIT II  BIOLOGICAL TESTING OF BIOMATERIALS
Introduction to Testing Biomaterials, In Vitro Assessment of Tissue Compatibility, In Vivo Assessment of Tissue Compatibility, Evaluation of Blood-Materials Interactions, Microscopy for Biomaterials Science

UNIT III  DEGRADATION OF MATERIALS IN BIOLOGICAL ENVIRONMENT
Introduction: Degradation of Materials in the Biological Environment, Chemical and Biochemical Degradation of Polymers, Degradative Effects of the Biological Environment on Metals and Ceramics, Pathological Calcification of Biomaterials,

UNIT IV  APPLICATION OF MATERIALS IN MEDICINE, BIOLOGY, AND ARTIFICIAL ORGANS
Introduction, Nonthrombogenic Treatments and Strategies, Cardiovascular Medical Devices, Implantable Cardiac Assist Devices, Extracorporeal Artificial Organs, Orthopedic Applications, Dental Implantation, Adhesives and Sealants, Ophthalmological Applications, Intraocular Lens Implants, Burn Dressings and Skin Substitutes, Sutures, Drug Delivery Systems, Cochlear Prostheses, Biomedical Sensors and Biosensors, Overview of Tissue Engineering, Synthetic Bioresorbable Polymer Scaffolds.

UNIT V  PRACTICAL ASPECTS OF BIOMATERIALS
Introduction, Sterilization of Implants and Devices, Implant and Device Failure, Correlation, Surfaces and Biomaterials Science, Development and Regulation of Medical Products Using Biomaterials, Ethical Issues in the Development of New Biomaterials, Legal Aspects of Biomaterials

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, students will be able to
- Understand the production of bio-plastics from bio-based feed stocks.
- Know about various plastics that are used for biomedical applications such as cardiovascular, dental, ophthalmology, and other artificial organs.
- Understand the methods and standards used for the evaluation of biomedical polymers.
- Describe the criteria for the selection of biomedical polymers.
- Explain the biomedical applications of polymers.

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OBJECTIVES:
- To gain all the information about current status of the materials.
- To know all the advance direction for the materials.
- To understand about processing of advanced materials.
- To acquire knowledge about super alloys
- To learn about plasma synthesis techniques & their applications

UNIT I  SMART MATERIALS 9

UNIT II  SUPER ALLOYS 9
Classification of Nanomaterials, fabrication of nanomaterials, Applications of Nanomaterials. Classification of super alloys, Development of different phases in super alloys, Ni-based super alloys, commercially available pure nickel alloys, Co-based super alloys, Fe-based super alloys, Ti alloys, Al-Li alloys.

UNIT III  BIOMATERIALS 9

UNIT IV  ULTRA-LIGHT MATERIALS 9
Bulk metallic glasses (BMG): Various methods for BMG production, Classification of BMG, Properties and behaviors of BMG, Thermodynamic aspects of stability, Potential applications of BMG. Aerogels, Aerographite, Metallic Foams, Polymeric Foams, Metallic Microlattices, their synthesis, properties and applications.

UNIT V  PLASMA SURFACE ENGINEERING 9
Plasma, plasma synthesis techniques, Energy associated with plasma, Kinetics in plasma, different types of plasma spraying, cold plasma, applications of plasma. Energy generation and energy storage: battery cell, Self-charging battery, Battery both generates and stores energy, Flow battery.

OUTCOMES:
At the end of the course, students will be able to
- Know the current-development/advances-in-materials in the metallurgical field.
- Be aware of the advances in materials related to interdisciplinary areas.
- Understand the different types of crystal structures in biomaterials
- Gain knowledge about different ultralight engineering materials and their applications
- Apply the concept of plasma surface engineering and their applications

REFERENCES

**MAPPING OF CO’S WITH PO’S**

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**PA4015 CONDUCTING POLYMERS**

**OBJECTIVES:**
- To enable the students to understand the basic concepts on conducting polymers
- To impart knowledge about synthesis mechanism and applications of conducting polymers
- To learn about various types of characterization methods
- To gain knowledge about doping concepts
- To elucidate various applications of conducting polymers

**UNIT I ELECTROCHEMISTRY OF CONDUCTING POLYMERS**

Introduction to conducting polymers - discovery of polyacetylene-concept of doing and n-type -polarons and bipolarons-conduction mechanism-redox type polymers (electro - active polymers). Important properties of conjugated polymers-electrical conductivity, photoconductivity, charge storage capacity, photoluminescence, and electroluminescence.

**UNIT II GENERAL SYNTHESIS OF CONDUCTING POLYMERS**

Electrically conducting polymers-Chain growth polymerisation, step growth polymerization, electrochemical polymerization, Metathesis polymerization (Ring opening metathesis polymer (ROMP). Advantages and disadvantages of conducting polymers, methods to enhance the processability of conducting polymers

**UNIT III SYNTHESIS OF DIFFERENT CONDUCTING POLYMERS**

Synthesis and properties of conducting polymers-Polyacetylene, Poly p-phenylene, Polyheterocyclic and polyaromatic conducting polymers like polythiophene, polyvinyl carbazole, polypyrrene, polyaniline, Polypyrrole, Poly phenylene vinylene, Polypyridine.

**UNIT IV CHARACTERIZATION AND PROCESSABILITY OF CONDUCTING POLYMERS**

Characterization methods - elemental analysis for dopants - IR - UV (electro chemical) scanning electron microscopy (SEM)-electrochemical characterization-cyclic voltammetry- electrochemical quartz crystal microbalance (EQCM) - probe beam deflection (PBD) -Langmuir - blodgett technique. Concept of doping- Charge carriers: polarons, bipolarons and solitons. Types of dopants, oxidative
dopants and reductive dopants, mechanism of doping, p-type doping and n-type doping, inorganic and organic dopants, effect of doping on the dielectric properties of conducting polymers

UNIT V APPLICATIONS OF CONDUCTING POLYMERS

Applications of conducting polymers - electro active applications - Polymer rechargeable batteries, sensors, electrochemical actuators, electro luminescent applications. Conductivity applications - antistatic coatings, conducting adhesives, artificial nerves. Electronic applications - EMI shielding, Frequency selective surfaces, satellite communication links, Dielectric properties of conducting polymers in the high and very high frequency fields (a.c field), ultra high frequency field (Microwave field). Recent trends in conducting polymer and conducting polymer nanocomposites

TOTAL: 45 PERIODS

OUTCOMES:
At the end of the course, students will be able to
- Understand the basic concepts and the mechanism of conduction in polymers
- Synthesise conducting polymers by various methods.
- Characterize the conduction in polymers
- Understand the application of conductive polymers in various devices.
- Familiarize with the recent and future trend of conducting polymers.

REFERENCES

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48
OBJECTIVES:
- To make the student to acquire knowledge in liquid crystalline polymers for special application.
- To provide exposure to the students about advanced polymeric materials.
- To acquire knowledge about various theories of LCP
- To learn about processing & identification of LCP
- To elucidate various applications of LCP

UNIT I  INTRODUCTION  9
Definition of LCP, Types of liquid crystalline polymer, Local order and classification, Chemistry and physics of liquid crystalline polymer, Synthesis of liquid crystalline polymer, Properties of liquid crystalline polymer.

UNIT II  STABILITY OF LIQUID CRYSTALLINE POLYMERS  9
Thermotropic liquid crystals-Rigid-rods to main-chain polymers, development of side chain liquid crystalline polymers, Stability of liquid crystalline polymers, Factors limiting liquid crystallinity in rigid rod-like molecules, Control of mesophase stability in main chain thermotropic liquid, crystalline polymers, Lyotropic rigid-rod polymers, Polymers with mesogenic side-chains, Liquid crystalline polymers with more complex molecular architectures.

UNIT III  THEORIES OF LIQUID CRYSSTALLINITY IN POLYMERS  9

UNIT IV  PROCESSING OF STRUCTURAL LIQUID CRYSTALLINE POLYMERS  9
Processing of structural liquid crystalline polymers: Rheology, Processing and the consequences of flow alignment, Liquid crystalline polymers as structural materials, Liquid crystalline polymers in blends and composites, Identification of LCP by DSC, Microscopy and XRD.

UNIT V  APPLICATIONS OF FUNCTIONAL LIQUID CRYSTALLINE POLYMERS  9

OUTCOMES:
At the end of the course, students will be able to
- Know about preparation and properties of liquid crystalline polymers.
- Methodically discuss application of liquid crystalline polymers.
- Appreciate the uses of polymers for specialty applications
- Evaluate various applications of liquid crystalline polymers
- Identify different LCP

REFERENCES
New York: Plenum Press.

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AUDIT COURSES

AX4091 ENGLISH FOR RESEARCH PAPER WRITING L T P C 2 0 0 0 0

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6
Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

UNIT III TITLE WRITING SKILLS 6
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6
Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first-time submission

TOTAL: 30 PERIODS
REFERENCES:

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COURSE OBJECTIVES:
- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6
Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

UNIT III DISASTER PRONE AREAS IN INDIA 6
Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6
Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6
Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People’s Participation in Risk Assessment. Strategies for Survival

COURSE OUTCOMES:
At the end of the course, students will be able to
- CO1 Ability to summarize basics of disaster
CO2 Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3 Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4 Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5 Ability to develop the strengths and weaknesses of disaster management approaches.

REFERENCES:

AX4093 CONSTITUTION OF INDIA

COURSE OBJECTIVES:
Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional role and entitlement to civil and economic rights as well as the emergence nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES

UNIT IV ORGANS OF GOVERNANCE
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION
Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI  ELECTION COMMISSION
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

COURSE OUTCOMES:
Students will be able to:
- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING
1. The Constitution of India, 1950 (Bare Act), Government Publication.
UNIT III

1. இரட்டடக்காப்பியங்கள்
   - சிலப்பதிகொரவழக்குகரகொகத
2. மூகப்பாறுகொள்கனகொய்க
   - அசுரமாறிகரிக்கிகுறிகொத்தத

UNIT IV

1. அகணைத்திருத்தியம்
   - பார்க்கத்தைக்குற்றிகொத்தத, மூன்றுமாறுமியப்பார்க்கொத்தத
   - அசுரமாறிகரிக்குறிகொத்தத, அருகில் பல்பகத
2. வாயிலச்
   - அசுரமாறிகரிகு புலைகொரகொக
3. சிறுமிகொனை (617, 618)
   - இமயில்கொத்தது
4. தொழில் கொள்கனகொத்தம்
5. புறாகொனை
   - இமயில்கொரகொண்டியாற்றத
6. வாயிலச் (4) - வடவன
   - கொனை (11) - மூன்று
   - கொண்டிகொள்கன (11) - பார்க்க, புலை
   - கொண்டிகொள்கன 50 (27) - பார்க்க
   - அசுரமாறிகரிகு கொன்றியத

UNIT V

1. நேர்முனை விளக்கம்
   - கருப்பைப்பளப்பைகுறிகொத்தம், கருப்பைப்பளப்பைகுறிகொத்தம்
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   - தொழில்
2. தெருைக் கொள்கனகொத்தம்
3. சுளைப்பைக் கொள்கனகொத்தம்
4. புறாகொகக் கொள்கனகொத்தம்
5. அறிவியல் கொன்றியத
6. குழுச்சிகொன்றியத
7. தொழில் கொள்கனகொத்தம்

TOTAL: 30 PERIODS

தமிழ்கல்வியடிப்புத்ரங்கங்கள் / புத்தகங்கள்

1. தமிழ்விக்கிப்பீடியொ (Tamil Wikipedia) - https://ta.wikipedia.org
2. தமிழ்விக்கிப்பீடியொ (Tamil Virtual University) - www.tamilvu.org
3. வொழியல்களஞ்சியம் - தமிழ்ப்பள்ளிக்கழகம், தஞ்சாவூர்
4. நேர்முனை விளக்கம் - தமிழ்ப்பள்ளிக்கழகம், தஞ்சாவூர்
5. தமிழ்கல்வியடிப்புத்ரங்கள் - தமிழ்ப்பள்ளிக்கழகம் (thamilvalarchithurai.com)
6. அறிவியல் கொள்கனகொத்தம் - தமிழ்ப்பள்ளிக்கழகம், தஞ்சாவூர்
OBJECTIVE

- Students will be introduced to the concepts and principles of IWRM, which is inclusive of the economics, public-private partnership, water & health, water & food security and legal & regulatory settings.

UNIT I CONTEXT FOR IWRM

- Water as a global issue: key challenges – Definition of IWRM within the broader context of development – Key elements of IWRM - Principles – Paradigm shift in water management - Complexity of the IWRM process – UN World Water Assessment - SDGs.

UNIT II WATER ECONOMICS

- Economic view of water issues: economic characteristics of water good and services – Non-market monetary valuation methods – Water economic instruments – Private sector involvement in water resources management: PPP objectives, PPP models, PPP processes, PPP experiences through case studies.

UNIT III LEGAL AND REGULATORY SETTINGS

- Basic notion of law and governance: principles of international and national law in the area of water management - Understanding UN law on non-navigable uses of international water courses – International law for groundwater management – World Water Forums – Global Water Partnerships - Development of IWRM in line with legal and regulatory framework.

UNIT IV WATER AND HEALTH WITHIN THE IWRM CONTEXT

- Links between water and health: options to include water management interventions for health – Health protection and promotion in the context of IWRM – Global burden of Diseases - Health impact assessment of water resources development projects – Case studies.

UNIT V AGRICULTURE IN THE CONCEPT OF IWRM

- Water for food production: ‘blue’ versus ‘green’ water debate – Water foot print - Virtual water trade for achieving global water and food security — Irrigation efficiencies, irrigation methods - current water pricing policy- scope to relook pricing.

TOTAL: 45 PERIODS

OUTCOMES

- On completion of the course, the student is expected to be able to

| CO1 | Describe the context and principles of IWRM; Compare the conventional and integrated ways of water management. |
| CO2 | Select the best economic option among the alternatives; illustrate the pros and cons of PPP through case studies. |
| CO3 | Apply law and governance in the context of IWRM. |
| CO4 | Discuss the linkages between water-health; develop a HIA framework. |
| CO5 | Analyse how the virtual water concept pave way to alternate policy options. |

REFERENCES:

4. Technical Advisory Committee, Dublin principles for water as reflected in comparative assessment of institutional and legal arrangements for Integrated Water Resources
OBJECTIVES:
- Understand the accelerating health impacts due to the present managerial aspects and initiatives in water and sanitation and health sectors in the developing scenario.

UNIT I  FUNDAMENTALS WASH  
Meanings and Definition: Safe Water- Health, Nexus: Water- Sanitation - Health and Hygiene – Equity issues-Water security - Food Security. Sanitation And Hygiene (WASH) and Integrated Water Resources Management (IWRM) - Need and Importance of WASH.

UNIT II  MANAGERIAL IMPLICATIONS AND IMPACT  

UNIT III  CHALLENGES IN MANAGEMENT AND DEVELOPMENT  

UNIT IV  GOVERNANCE  
Public health -Community Health Assessment and Improvement Planning (CHA/CHIP)-Infrastructure and Investments on Water, (WASH) - Cost Benefit Analysis – Institutional Intervention-Public Private Partnership - Policy Directives - Social Insurance -Political Will vs Participatory Governance -

UNIT V  INITIATIVES  
Management vs Development -Accelerating Development- Development Indicators -Inclusive Development-Global and Local- Millennium Development Goal (MDG) and Targets - Five Year Plans - Implementation - Capacity Building - Case studies on WASH.

OUTCOMES:

| CO1 | Capture to fundamental concepts and terms which are to be applied and understood all through the study. |
| CO2 | Comprehend the various factors affecting water sanitation and health through the lens of third world scenario. |
| CO3 | Critically analyse and articulate the underlying common challenges in water, sanitation and health. |
| CO4 | Acquire knowledge on the attributes of governance and its say on water sanitation and health. |
| CO5 | Gain an overarching insight in to the aspects of sustainable resource management in the absence of a clear level playing field in the developmental aspects. |
REFERENCES

OCE433 PRINCIPLES OF SUSTAINABLE DEVELOPMENT

OBJECTIVES:
- To impart knowledge on environmental, social and economic dimensions of sustainability and the principles evolved through landmark events so as to develop an action mindset for sustainable development.

UNIT I SUSTAINABILITY AND DEVELOPMENT CHALLENGES

UNIT II PRINCIPLES AND FRAMEWORK

UNIT III SUSTAINABLE DEVELOPMENT AND WELLBEING

UNIT IV SUSTAINABLE SOCIO-ECONOMIC SYSTEMS
UNIT V ASSESSING PROGRESS AND WAY FORWARD


TOTAL: 45 PERIODS

OUTCOMES:
- On completion of the course, the student is expected to be able to

| CO1 | Explain and evaluate current challenges to sustainability, including modern world social, environmental, and economic structures and crises. |
| CO2 | Identify and critically analyze the social environmental, and economic dimensions of sustainability in terms of UN Sustainable development goals |
| CO3 | Develop a fair understanding of the social, economic and ecological linkage of Human well being, production and consumption |
| CO4 | Evaluate sustainability issues and solutions using a holistic approach that focuses on connections between complex human and natural systems. |
| CO5 | Integrate knowledge from multiple sources and perspectives to understand environmental limits governing human societies and economies and social justice dimensions of sustainability. |

REFERENCES:

OCE434 ENVIRONMENTAL IMPACT ASSESSMENT

OBJECTIVES:
- To make the students to understand environmental clearance, its legal requirements and to provide knowledge on overall methodology of EIA, prediction tools and models, environmental management plan and case studies.

UNIT I INTRODUCTION
UNIT II  IMPACT IDENTIFICATION AND PREDICTION

UNIT III  SOCIO-ECONOMIC IMPACT ASSESSMENT
Socio-economic impact assessment - relationship between social impacts and change in community and institutional arrangements. factors and methodologies- individual and family level impacts. communities in transition-rehabilitation

UNIT IV  EIA DOCUMENTATION AND ENVIRONMENTAL MANAGEMENT PLAN
Environmental management plan - preparation, implementation and review – mitigation and rehabilitation plans – policy and guidelines for planning and monitoring programmes – post project audit – documentation of EIA findings – ethical and quality aspects of environmental impact assessment

UNIT V  CASE STUDIES
Mining, power plants, cement plants, highways, petroleum refining industry, storage & handling of hazardous chemicals, common hazardous waste facilities, CETPs, CMSWMF, building and construction projects

OUTCOMES:
- On completion of the course, the student is expected to be able to

| CO1 | Understand need for environmental clearance, its legal procedure, need of EIA, its types, stakeholders and their roles |
| CO2 | Understand various impact identification methodologies, prediction techniques and model of impacts on various environments |
| CO3 | Understand relationship between social impacts and change in community due to development activities and rehabilitation methods |
| CO4 | Document the EIA findings and prepare environmental management and monitoring plan |
| CO5 | Identify, predict and assess impacts of similar projects based on case studies |

REFERENCES:
1. EIA Notification 2006 including recent amendments, by Ministry of Environment, Forest and Climate Change, Government of India
2. Sectoral Guidelines under EIA Notification by Ministry of Environment, Forest and Climate Change, Government of India
COURSE OBJECTIVES:
- This course is intended to study the basics of Blockchain technology.
- During this course the learner will explore various aspects of Blockchain technology like application in various domains.
- By implementing, learners will have idea about private and public Blockchain, and smart contract.

UNIT I INTRODUCTION OF CRYPTOGRAPHY AND BLOCKCHAIN
Introduction to Blockchain, Blockchain Technology Mechanisms & Networks, Blockchain Origins, Objective of Blockchain, Blockchain Challenges, Transactions and Blocks, P2P Systems, Keys as Identity, Digital Signatures, Hashing, and public key cryptosystems, private vs. public Blockchain.

UNIT II BITCOIN AND CRYPTOCURRENCY

UNIT III INTRODUCTION TO ETHEREUM
Introduction to Ethereum, Consensus Mechanisms, Metamask Setup, Ethereum Accounts, Transactions, Receiving Ethers, Smart Contracts.

UNIT-IV INTRODUCTION TO HYPERLEDGER AND SOLIDITY PROGRAMMING

UNIT V BLOCKCHAIN APPLICATIONS
Internet of Things, Medical Record Management System, Domain Name Service and Future of Blockchain, Alt Coins.

TOTAL: 45 PERIODS

COURSE OUTCOMES:
After the completion of this course, student will be able to
CO1: Understand and explore the working of Blockchain technology
CO2: Analyze the working of Smart Contracts
CO3: Understand and analyze the working of Hyperledger
CO4: Apply the learning of solidity to build de-centralized apps on Ethereum
CO5: Develop applications on Blockchain

REFERENCES:
COURSE OBJECTIVES:
- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS 6

UNIT II NEURAL NETWORKS 9

UNIT III CONVOLUTIONAL NEURAL NETWORK 10

UNIT IV NATURAL LANGUAGE PROCESSING USING RNN 10

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING 10

COURSE OUTCOMES:
CO1: Feature Extraction from Image and Video Data
CO2: Implement Image Segmentation and Instance Segmentation in Images
CO3: Implement image recognition and image classification using a pretrained network (Transfer Learning)
CO4: Traffic Information analysis using Twitter Data
CO5: Autoencoder for Classification & Feature Extraction

TOTAL: 45 PERIODS
REFERENCES
1. Deep Learning A Practitioner’s Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017

OME431 VIBRATION AND NOISE CONTROL STRATEGIES L T P C 3 0 0 3

OBJECTIVES
● To appreciate the basic concepts of vibration in damped and undamped systems
● To appreciate the basic concepts of noise, its effect on hearing and related terminology
● To use the instruments for measuring and analyzing the vibration levels in a body
● To use the instruments for measuring and analyzing the noise levels in a system
● To learn the standards of vibration and noise levels and their control techniques

UNIT- I BASICS OF VIBRATION 9

UNIT- II BASICS OF NOISE 9
Introduction - Anatomy of human ear - Mechanism of hearing - Amplitude, frequency, wavelength and sound pressure level - Relationship between sound power, sound intensity and sound pressure level - Addition, subtraction and averaging decibel levels - sound spectra -Types of sound fields - Octave band analysis - Loudness.

UNIT- III INSTRUMENTATION FOR VIBRATION MEASUREMENT 9

UNIT- IV INSTRUMENTATION FOR NOISE MEASUREMENT AND ANALYSIS 9
Microphones - Weighting networks - Sound Level meters, its classes and calibration - Noise measurements using sound level meters - Data Loggers - Sound exposure meters - Recording of noise - Spectrum analyser - Intensity meters - Energy density sensors - Sound source localization.

UNIT- V METHODS OF VIBRATION CONTROL, SOURCES OF NOISE AND ITS CONTROL 9

TOTAL: 45 PERIODS
OUTCOMES:
On Completion of the course the student will be able to
1. apply the basic concepts of vibration in damped and undamped systems
2. apply the basic concepts of noise and to understand its effects on systems
3. select the instruments required for vibration measurement and its analysis
4. select the instruments required for noise measurement and its analysis.
5. recognize the noise sources and to control the vibration levels in a body and to control noise under different strategies.

REFERENCES:

OME432   ENERGY CONSERVATION AND MANAGEMENT IN DOMESTIC SECTORS

COURSE OBJECTIVES:
1. To learn the present energy scenario and the need for energy conservation.
2. To understand the different measures for energy conservation in utilities.
3. Acquaint students with principle theories, materials, and construction techniques to create energy efficient buildings.
4. To identify the energy demand and bridge the gap with suitable technology for sustainable habitat
5. To get familiar with the energy technology, current status of research and find the ways to optimize a system as per the user requirement

UNIT I   ENERGY SCENARIO

UNIT II   HEATING, VENTILLATION & AIR CONDITIONING

UNIT III   LIGHTING, COMPUTER, TV

UNIT IV   ENERGY EFFICIENT BUILDINGS
UNIT V  ENERGY STORAGE TECHNOLOGIES  
Necessity & types of energy storage – Thermal energy storage – Battery energy storage, charging and discharging– Hydrogen energy storage & Super capacitors – energy density and safety issues – Applications.

TOTAL: 45 PERIODS

COURSE OUTCOMES: 
Upon completion of this course, the students will be able to:
1. Understand technical aspects of energy conservation scenario.
2. Energy audit in any type for domestic buildings and suggest the conservation measures.
3. Perform building load estimates and design the energy efficient landscape system.
4. Gain knowledge to utilize an appliance/device sustainably.
5. Understand the status and current technological advancement in energy storage field.

REFERENCES:

OME433  ADDITIVE MANUFACTURING  
L  T  P  C
3  0  0  3

UNIT I  INTRODUCTION  

UNIT II  DESIGN FOR ADDITIVE MANUFACTURING  

UNIT III  VAT POLYMERIZATION  

UNIT IV  MATERIAL EXTRUSION AND SHEET LAMINATION  

POWDER BASED PROCESS

UNIT V CASE STUDIES AND OPPORTUNITIES ADDITIVE MANUFACTURING PROCESSES 9

TOTAL: 45 PERIODS

REFERENCES:

OME434 ELECTRIC VEHICLE TECHNOLOGY L T P C 3 0 0 3
UNIT I NEED FOR ELECTRIC VEHICLES 9
History and need for electric and hybrid vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies, comparison of diesel, petrol, electric and hybrid vehicles, limitations, technical challenges

UNIT II ELECTRIC VEHICLE ARCHITECHTURE 9
Electric vehicle types, layout and power delivery, performance – traction motor characteristics, tractive effort, transmission requirements, vehicle performance, energy consumption, Concepts of hybrid electric drive train, architecture of series and parallel hybrid electric drive train, merits and demerits, mild and full hybrids, plug-in hybrid electric vehicles and range extended hybrid electric vehicles, Fuel cell vehicles.

UNIT III ENERGY STORAGE 9
Batteries – types – lead acid batteries, nickel based batteries, and lithium based batteries, electrochemical reactions, thermodynamic voltage, specific energy, specific power, energy efficiency, Battery modeling and equivalent circuit, battery charging and types, battery cooling, Ultra-capacitors, Flywheel technology, Hydrogen fuel cell, Thermal Management of the PEM fuel cell
UNIT IV ELECTRIC DRIVES AND CONTROL
Types of electric motors – working principle of AC and DC motors, advantages and limitations, DC motor drives and control, Induction motor drives and control, PMSM and brushless DC motor -drives and control, AC and Switch reluctance motor drives and control – Drive system efficiency – Inverters – DC and AC motor speed controllers

UNIT V DESIGN OF ELECTRIC VEHICLES

REFERENCES:

TOTAL: 45 PERIODS

COURSE OBJECTIVES:
The main learning objective of this course is to prepare the students for:
1. Applying the principles of generic development process; and understanding the organization structure for new product design and development.
2. Identifying opportunity and planning for new product design and development.
3. Conducting customer need analysis; and setting product specification for new product design and development.
4. Generating, selecting, and testing the concepts for new product design and development.
5. Applying the principles of Industrial design and prototype for new product design and development.

UNIT I INTRODUCTION TO PRODUCT DESIGN & DEVELOPMENT

UNIT II OPPORTUNITY IDENTIFICATION & PRODUCT PLANNING

UNIT III IDENTIFYING CUSTOMER NEEDS & PRODUCT SPECIFICATIONS
UNIT IV  CONCEPT GENERATION, SELECTION & TESTING  9

UNIT V  INDUSTRIAL DESIGN & PROTOTYPING  9

COURSE OUTCOMES:
Upon completion of this course, the students will be able to:
1. Apply the principles of generic development process; and understand the organization structure for new product design and development.
2. Identify opportunity and plan for new product design and development.
3. Conduct customer need analysis; and set product specification for new product design and development.
4. Generate, select, and test the concepts for new product design and development.
5. Apply the principles of Industrial design and prototype for design and develop new products.

TEXT BOOK:

REFERENCES:

OBA431  SUSTAINABLE MANAGEMENT  L T P C 3 0 0 3

COURSE OBJECTIVES:
- To provide students with fundamental knowledge of the notion of corporate sustainability.
- To determine how organizations impacts on the environment and socio-technical systems, the relationship between social and environmental performance and competitiveness, the approaches and methods.

UNIT I  MANAGEMENT OF SUSTAINABILITY  9
Management of sustainability -rationale and political trends: An introduction to sustainability management, International and European policies on sustainable development, theoretical pillars in sustainability management studies.

UNIT II  CORPORATE SUSTAINABILITY AND RESPONSIBILITY  9
Corporate sustainability parameter, corporate sustainability institutional framework, integration of sustainability into strategic planning and regular business practices, fundamentals of stakeholder engagement.

UNIT III  SUSTAINABILITY MANAGEMENT: STRATEGIES AND APPROACHES  9
Corporate sustainability management and competitiveness: Sustainability-oriented corporate strategies, markets and competitiveness, Green Management between theory and practice, Sustainable Consumption and Green Marketing strategies, Environmental regulation and strategic
postures; Green Management approaches and tools; Green engineering: clean technologies and innovation processes; Sustainable Supply Chain Management and Procurement.

UNIT IV SUSTAINABILITY AND INNOVATION 9
Socio-technical transitions and sustainability, Sustainable entrepreneurship, Sustainable pioneers in green market niches, Smart communities and smart specializations.

UNIT V SUSTAINABLE MANAGEMENT OF RESOURCES, COMMODITIES AND COMMONS 9

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: An understanding of sustainability management as an approach to aid in evaluating and minimizing environmental impacts while achieving the expected social impact.
CO2: An understanding of corporate sustainability and responsible Business Practices
CO3: Knowledge and skills to understand, to measure and interpret sustainability performances.
CO4: Knowledge of innovative practices in sustainable business and community management
CO5: Deep understanding of sustainable management of resources and commodities

REFERENCES:
4. Margaret Robertson, Sustainability Principles and Practice, 2014
5. Peter Rogers, An Introduction to Sustainable Development, 2006

OBA432 MICRO AND SMALL BUSINESS MANAGEMENT L T P C
3 0 0 3

COURSE OBJECTIVES
• To familiarize students with the theory and practice of small business management.
• To learn the legal issues faced by small business and how they impact operations.

UNIT I INTRODUCTION TO SMALL BUSINESS 9

UNIT II SCREENING THE BUSINESS OPPORTUNITY AND FORMULATING THE BUSINESS PLAN 9
Concepts of opportunity recognition; Key factors leading to new venture failure; New venture screening process; Applying new venture screening process to the early stage small firm Role planning in small business – importance of strategy formulation – management skills for small business creation and development.
UNIT III BUILDING THE RIGHT TEAM AND MARKETING STRATEGY
Management and Leadership – employee assessments – Tuckman’s stages of group development - The entrepreneurial process model - Delegation and team building - Comparison of HR management in small and large firms - Importance of coaching and how to apply a coaching model. Marketing within the small business - success strategies for small business marketing - customer delight and business generating systems, - market research, - assessing market performance- sales management and strategy - the marketing mix and marketing strategy.

UNIT IV FINANCING SMALL BUSINESS
Main sources of entrepreneurial capital; Nature of ‘bootstrap’ financing - Difference between cash and profit - Nature of bank financing and equity financing - Funding-equity gap for small firms. Importance of working capital cycle - Calculation of break-even point - Power of gross profit margin- Pricing for profit - Credit policy issues and relating these to cash flow management and profitability.

UNIT V VALUING SMALL BUSINESS AND CRISIS MANAGEMENT
Causes of small business failure - Danger signals of impending trouble - Characteristics of poorly performing firms - Turnaround strategies - Concept of business valuation - Different valuation measurements - Nature of goodwill and how to measure it - Advantages and disadvantages of buying an established small firm - Process of preparing a business for sale.

COURSE OUTCOMES
CO1. Familiarise the students with the concept of small business
CO2. In depth knowledge on small business opportunities and challenges
CO3. Ability to devise plans for small business by building the right skills and marketing strategies
CO4. Identify the funding source for small start ups
CO5. Business evaluation for buying and selling of small firms

REFERENCES
3. Journal articles on SME’s.

INTELLECTUAL PROPERTY RIGHTS

UNIT I INTRODUCTION
Intellectual property rights - Introduction, Basic concepts, Patents, Copyrights, Trademarks, Trade Secrets, Geographic Indicators; Nature of Intellectual Property, Technological Research, Inventions and Innovations, History - the way from WTO to WIPO, TRIPS.

UNIT II PROCESS
New Developments in IPR, Procedure for grant of Patents, TM, GIs, Patenting under Patent Cooperation Treaty, Administration of Patent system in India, Patenting in foreign countries.
UNIT III  
STATUTES  9

UNIT IV  
STRATEGIES IN INTELLECTUAL PROPERTY  9
Strategies for investing in R&D, Patent Information and databases, IPR strength in India, Traditional Knowledge, Case studies.

UNIT V  
MODELS  9
The technologies Know-how, concept of ownership, Significance of IP in Value Creation, IP Valuation and IP Valuation Models, Application of Real Option Model in Strategic Decision Making, Transfer and Licensing.

TOTAL: 45 PERIODS

COURSE OUTCOMES
CO1: Understanding of intellectual property and appreciation of the need to protect it
CO2: Awareness about the process of patenting
CO3: Understanding of the statutes related to IPR
CO4: Ability to apply strategies to protect intellectual property
CO5: Ability to apply models for making strategic decisions related to IPR

REFERENCES
2. Intellectual Property rights and copyrights, EssEss Publications.

OBA434  
ETHICAL MANAGEMENT  L T P C  3 0 0 3

COURSE OBJECTIVE
➢ To help students develop knowledge and competence in ethical management and decision making in organizational contexts.

UNIT I  
ETHICS AND SOCIETY  9
Ethical Management- Definition, Motivation, Advantages-Practical implications of ethical management. Managerial ethics, professional ethics, and social Responsibility-Role of culture and society’s expectations- Individual and organizational responsibility to society and the community.

UNIT II  
ETHICAL DECISION MAKING AND MANAGEMENT IN A CRISIS  9
Managing in an ethical crisis, the nature of a crisis, ethics in crisis management, discuss case studies, analyze real-world scenarios, develop ethical management skills, knowledge, and competencies. Proactive crisis management.
UNIT III STAKEHOLDERS IN ETHICAL MANAGEMENT
Stakeholders in ethical management, identifying internal and external stakeholders, nature of stakeholders, ethical management of various kinds of stakeholders: customers (product and service issues), employees (leadership, fairness, justice, diversity) suppliers, collaborators, business, community, the natural environment (the sustainability imperative, green management, Contemporary issues).

UNIT IV INDIVIDUAL VARIABLES IN ETHICAL MANAGEMENT
Understanding individual variables in ethics, managerial ethics, concepts in ethical psychology- ethical awareness, ethical courage, ethical judgment, ethical foundations, ethical emotions/intuitions/intensity. Utilization of these concepts and competencies for ethical decision-making and management.

UNIT V PRACTICAL FIELD-GUIDE, TECHNIQUES AND SKILLS
Ethical management in practice, development of techniques and skills, navigating challenges and dilemmas, resolving issues and preventing unethical management proactively. Role modelling and creating a culture of ethical management and human flourishing.

TOTAL: 45 PERIODS

COURSE OUTCOMES
CO1: Role modelling and influencing the ethical and cultural context.
CO2: Respond to ethical crises and proactively address potential crises situations.
CO3: Understand and implement stakeholder management decisions.
CO4: Develop the ability, knowledge, and skills for ethical management.
CO5: Develop practical skills to navigate, resolve and thrive in management situations

REFERENCES

ET4251 IoT FOR SMART SYSTEMS LT P C

COURSE OBJECTIVES:
1. To study about Internet of Things technologies and its role in real time applications.
2. To introduce the infrastructure required for IoT.
3. To familiarize the accessories and communication techniques for IoT.
4. To provide insight about the embedded processor and sensors required for IoT.
5. To familiarize the different platforms and Attributes for IoT.

UNIT I INTRODUCTION TO INTERNET OF THINGS
Overview, Hardware and software requirements for IOT, Sensor and actuators, Technology drivers, Business drivers, Typical IoT applications, Trends and implications.

UNIT II IOT ARCHITECTURE
UNIT III  PROTOCOLS AND WIRELESS TECHNOLOGIES FOR IOT

PROTOCOLS:
NFC, SCADA and RFID, Zigbee MIPI, M-PHY, UniPro, SPMI, SPI, M-PCIe GSM, CDMA, LTE, GPRS, small cell.

Wireless technologies for IoT: WiFi (IEEE 802.11), Bluetooth/Bluetooth Smart, ZigBee/ZigBee Smart, UWB (IEEE 802.15.4), 6LoWPAN, Proprietary systems-Recent trends.

UNIT IV  IOT PROCESSORS

Services/Attributes: Big-Data Analytics for IOT, Dependability, Interoperability, Security, Maintainability.

Embedded processors for IOT: Introduction to Python programming -Building IOT with RASPERRY PI and Arduino.

UNIT V  CASE STUDIES

Industrial IoT, Home Automation, smart cities, Smart Grid, connected vehicles, electric vehicle charging, Environment, Agriculture, Productivity Applications, IOT Defense

TOTAL: 45 PERIODS

COURSE OUTCOMES:
At the end of this course, the students will have the ability to
CO1: Analyze the concepts of IoT and its present developments.
CO2: Compare and contrast different platforms and infrastructures available for IoT
CO3: Explain different protocols and communication technologies used in IoT
CO4: Analyze the big data analytic and programming of IoT
CO5: Implement IoT solutions for smart applications

REFERENCES:
COURSE OBJECTIVES:
The course is aimed at
1. Understanding about the learning problem and algorithms
2. Providing insight about neural networks
3. Introducing the machine learning fundamentals and significance
4. Enabling the students to acquire knowledge about pattern recognition.
5. Motivating the students to apply deep learning algorithms for solving real life problems.

UNIT I LEARNING PROBLEMS AND ALGORITHMS
Various paradigms of learning problems, Supervised, Semi-supervised and Unsupervised algorithms

UNIT II NEURAL NETWORKS

UNIT III MACHINE LEARNING – FUNDAMENTALS & FEATURE SELECTIONS & CLASSIFICATIONS
Classifying Samples: The confusion matrix, Accuracy, Precision, Recall, F1- Score, the curse of dimensionality, training, testing, validation, cross validation, overfitting, under-fitting the data, early stopping, regularization, bias and variance. Feature Selection, normalization, dimensionality reduction, Classifiers: KNN, SVM, Decision trees, Naïve Bayes, Binary classification, multi class classification, clustering.

UNIT IV DEEP LEARNING: CONVOLUTIONAL NEURAL NETWORKS
Feed forward networks, Activation functions, back propagation in CNN, optimizers, batch normalization, convolution layers, pooling layers, fully connected layers, dropout, Examples of CNNs.

UNIT V DEEP LEARNING: RNNS, AUTOENCODERS AND GANS
State, Structure of RNN Cell, LSTM and GRU, Time distributed layers, Generating Text, Autoencoders: Convolutional Autoencoders, Denoising autoencoders, Variational autoencoders, GANs: The discriminator, generator, DCGANs

COURSE OUTCOMES (CO):
At the end of the course the student will be able to
CO1 : Illustrate the categorization of machine learning algorithms.
CO2: Compare and contrast the types of neural network architectures, activation functions
CO3: Acquaint with the pattern association using neural networks
CO4: Elaborate various terminologies related with pattern recognition and architectures of convolutional neural networks
CO5: Construct different feature selection and classification techniques and advanced neural network architectures such as RNN, Autoencoders, and GANs.

REFERENCES:

PX4012 RENEWABLE ENERGY TECHNOLOGY L T P C 3 0 0 3

OBJECTIVES:
To impart knowledge on
- Different types of renewable energy technologies
- Standalone operation, grid connected operation of renewable energy systems

UNIT I INTRODUCTION 9
Classification of energy sources – Co2 Emission - Features of Renewable energy - Renewable energy scenario in India - Environmental aspects of electric energy conversion: impacts of renewable energy generation on environment Per Capital Consumption - CO₂ Emission - importance of renewable energy sources, Potentials – Achievements – Applications.

UNIT II SOLAR PHOTOVOLTAICS 9

UNIT III PHOTOVOLTAIC SYSTEM DESIGN 9
Block diagram of solar photo voltaic system : Line commutated converters (inversion mode) - Boost and buck-boost converters - selection of inverter, battery sizing, array sizing - PV systems classification- standalone PV systems - Grid tied and grid interactive inverters- grid connection issues.

UNIT IV WIND ENERGY CONVERSION SYSTEMS 9

UNIT V OTHER RENEWABLE ENERGY SOURCES 9
Qualitative study of different renewable energy resources: ocean, Biomass, Hydrogen energy systems, Fuel cells, Ocean Thermal Energy Conversion (OTEC), Tidal and wave energy, Geothermal Energy Resources.

TOTAL : 45 PERIODS

OUTCOMES:
After completion of this course, the student will be able to:
CO1: Demonstrate the need for renewable energy sources.
CO2: Develop a stand-alone photo voltaic system and implement a maximum power point
tracking in the PV system.

CO3: Design a stand-alone and Grid connected PV system.
CO4: Analyze the different configurations of the wind energy conversion systems.
CO5: Realize the basic of various available renewable energy sources

REFERENCES:

PS4093 SMART GRID L T P C
3 0 0 3

COURSE OBJECTIVES
• To Study about Smart Grid technologies, different smart meters and advanced metering infrastructure.
• To know about the function of smart grid.
• To familiarize the power quality management issues in Smart Grid.
• To familiarize the high performance computing for Smart Grid applications
• To get familiarized with the communication networks for Smart Grid applications

UNIT I INTRODUCTION TO SMART GRID
9 Evolution of Electric Grid, Concept, Definitions and Need for Smart Grid, Smart grid drivers, functions, opportunities, challenges and benefits, Difference between conventional & Smart Grid, Comparison of Microgrid and Smart grid, Present development & International policies in Smart Grid, Smart Grid Initiative for Power Distribution Utility in India – Case Study.

UNIT II SMART GRID TECHNOLOGIES
9 Technology Drivers, Smart Integration of energy resources, Smart substations, Substation Automation, Feeder Automation, Transmission systems: EMS, FACTS and HVDC, Wide area monitoring, Protection and control, Distribution systems: DMS, Volt/Var control, Fault Detection, Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers, Plug in Hybrid Electric Vehicles (PHEV) – Grid to Vehicle and Vehicle to Grid charging concepts.

UNIT III SMART METERS AND ADVANCED METERING INFRASTRUCTURE
9 Introduction to Smart Meters, Advanced Metering infrastructure (AMI) drivers and benefits, AMI protocols, standards and initiatives, AMI needs in the smart grid, Phasor Measurement Unit(PMU) & their application for monitoring & protection. Demand side management and demand response programs, Demand pricing and Time of Use, Real Time Pricing, Peak Time Pricing.
UNIT IV POWER QUALITY MANAGEMENT IN SMART GRID


UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS

Architecture and Standards - Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), PLC, Zigbee, GSM, IP based Protocols, Basics of Web Service and CLOUD Computing, Cyber Security for Smart Grid.

TOTAL : 45 PERIODS

COURSE OUTCOME:

Students able to
CO1: Relate with the smart resources, smart meters and other smart devices.
CO2: Explain the function of Smart Grid.
CO3: Experiment the issues of Power Quality in Smart Grid.
CO4: Analyze the performance of Smart Grid.
CO5: Recommend suitable communication networks for smart grid applications

REFERENCES


CP4391 SECURITY PRACTICES

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COURSE OBJECTIVES:

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT I SYSTEM SECURITY


UNIT II NETWORK SECURITY


UNIT III SECURITY MANAGEMENT

UNIT IV  CYBER SECURITY AND CLOUD SECURITY  

UNIT V  PRIVACY AND STORAGE SECURITY  

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Understand the core fundamentals of system security
CO2: Apply the security concepts to wired and wireless networks
CO3: Implement and Manage the security essentials in IT Sector
CO4: Explain the concepts of Cyber Security and Cyber forensics
CO5: Be aware of Privacy and Storage security Issues.

REFERENCES

MP4251  CLOUD COMPUTING TECHNOLOGIES  
L T P C  3 0 0 3

COURSE OBJECTIVES:
• To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
• To understand the architecture, infrastructure and delivery models of cloud computing.
• To explore the roster of AWS services and illustrate the way to make applications in AWS
• To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
• To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I  VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE  
Virtualization for data center automation

UNIT II  CLOUD PLATFORM ARCHITECTURE  12

UNIT III  AWS CLOUD PLATFORM - IAAS  9

UNIT IV  PAAS CLOUD PLATFORM  9

UNIT V  PROGRAMMING MODEL  9
Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job –Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Employ the concepts of virtualization in the cloud computing
CO2: Identify the architecture, infrastructure and delivery models of cloud computing
CO3: Develop the Cloud Application in AWS platform
CO4: Apply the concepts of Windows Azure to design Cloud Application
CO5: Develop services using various Cloud computing programming models.

REFERENCES
COURSE OBJECTIVES:
- To provide a sound knowledge in UI & UX
- To understand the need for UI and UX
- Research Methods used in Design
- Tools used in UI & UX
- Creating a wireframe and prototype

UNIT I  UX LIFECYCLE TEMPLATE

UNIT II  CONTEXTUAL INQUIRY

UNIT III  DESIGN THINKING, IDEATION, AND SKETCHING

UNIT IV  UX GOALS, METRICS, AND TARGETS

UNIT V  ANALYSING USER EXPERIENCE

SUGGESTED ACTIVITIES:
1: Hands on Design Thinking process for a product
2: Defining the Look and Feel of any new Project
3: Create a Sample Pattern Library for that product (Mood board, Fonts, Colors based on UI principles)
4: Identify a customer problem to solve.
5: Conduct end-to-end user research - User research, creating personas, Ideation process (User stories, Scenarios), Flow diagrams, Flow Mapping
COURSE OUTCOMES:
CO1: Build UI for user Applications
CO2: Use the UI Interaction behaviors and principles
CO3: Evaluate UX design of any product or application
CO4: Demonstrate UX Skills in product development
CO5: Implement Sketching principles

REFERENCES
5. Designing UX: Prototyping: Because Modern Design is Never Static, Ben Coleman, and Dan Goodwin. SitePoint, 2017

MU4153 PRINCIPLES OF MULTIMEDIA

COURSE OBJECTIVES:
- To get familiarity with gamut of multimedia and its significance
- To acquire knowledge in multimedia components.
- To acquire knowledge about multimedia tools and authoring.
- To acquire knowledge in the development of multimedia applications.
- To explore the latest trends and technologies in multimedia

UNIT I INTRODUCTION

Suggested Activities:
1. Flipped classroom on media Components.
2. External learning – Interactive presentation.

Suggested Evaluation Methods:
1. Tutorial – Handling media components
2. Quizzes on different types of data presentation.

UNIT II ELEMENTS OF MULTIMEDIA
Text-Types, Font, Unicode Standard, File Formats, Graphics and Image data representations – data types, file formats, color models; video – color models in video, analog video, digital video, file formats, video display interfaces, 3D video and TV: Audio – Digitization, SNR, SQNR, quantization, audio quality, file formats, MIDI; Animation- Key Frames and Tweening, other Techniques, 2D and 3D Animation.
Suggested Activities:
1. Flipped classroom on different file formats of various media elements.

Suggested Evaluation Methods:
1. Demonstration on after effects animations.
2. Quizzes on file formats and color models.

UNIT III  MULTIMEDIA TOOLS  9

Suggested Activities:
1. Flipped classroom on multimedia tools.
2. External learning – Comparison of various authoring tools.

Suggested Evaluation Methods:
1. Tutorial – Audio editing tool.
2. Quizzes on animation tools.

UNIT IV  MULTIMEDIA SYSTEMS  9

Suggested Activities:
1. Flipped classroom on concepts of multimedia hardware architectures.
2. External learning – Digital repositories and hypermedia design.

Suggested Evaluation Methods:
1. Quizzes on multimedia hardware and compression techniques.
2. Tutorial – Hypermedia design.

UNIT V  MULTIMEDIA APPLICATIONS FOR THE WEB AND MOBILE PLATFORMS  9

Suggested Activities:
1. External learning – Game consoles.
2. External learning – VRML scripting languages.

Suggested Evaluation Methods:
1. Demonstration of simple interactive games.
2. Tutorial – Simple VRML program.

COURSE OUTCOMES:
CO1: Handle the multimedia elements effectively.
CO2: Articulate the concepts and techniques used in multimedia applications.
CO3: Develop effective strategies to deliver Quality of Experience in multimedia applications.
CO4: Design and implement algorithms and techniques applied to multimedia objects.
CO5: Design and develop multimedia applications following software engineering models.

REFERENCES:

DS4015 BIG DATA ANALYTICS L T P C
3 0 0 3

COURSE OBJECTIVES:
• To understand the basics of big data analytics
• To understand the search methods and visualization
• To learn mining data streams
• To learn frameworks
• To gain knowledge on R language

UNIT I INTRODUCTION TO BIG DATA

UNIT II SEARCH METHODS AND VISUALIZATION

UNIT III MINING DATA STREAMS

UNIT IV FRAMEWORKS
MapReduce – Hadoop, Hive, MapR – Sharding – NoSQL Databases - S3 - Hadoop Distributed File Systems – Case Study- Preventing Private Information Inference Attacks on Social Networks- Grand Challenge: Applying Regulatory Science and Big Data to Improve Medical Device Innovation

UNIT V R LANGUAGE
COURSE OUTCOMES:
CO1: understand the basics of big data analytics
CO2: Ability to use Hadoop, Map Reduce Framework.
CO3: Ability to identify the areas for applying big data analytics for increasing the business outcome.
CO4: gain knowledge on R language
CO5: Contextually integrate and correlate large amounts of information to gain faster insights.

TOTAL: 45 PERIODS

REFERENCE:

NC4201 INTERNET OF THINGS AND CLOUD

COURSE OBJECTIVES:
- To understand Smart Objects and IoT Architectures
- To learn about various IOT-related protocols
- To build simple IoT Systems using Arduino and Raspberry Pi.
- To understand data analytics and cloud in the context of IoT
- To develop IoT infrastructure for popular applications

UNIT I FUNDAMENTALS OF IoT

UNIT II PROTOCOLS FOR IoT

UNIT III CASE STUDIES/INDUSTRIAL APPLICATIONS
Case studies with architectural analysis: IoT applications – Smart City – Smart Water – Smart Agriculture – Smart Energy – Smart Healthcare – Smart Transportation – Smart Retail – Smart waste management.

UNIT IV CLOUD COMPUTING INTRODUCTION

UNIT V IoT AND CLOUD

TOTAL: 45 PERIODS
COURSE OUTCOMES:
At the end of the course, the student will be able to:
CO1: Understand the various concept of the IoT and their technologies.
CO2: Develop IoT application using different hardware platforms
CO3: Implement the various IoT Protocols
CO4: Understand the basic principles of cloud computing.
CO5: Develop and deploy the IoT application into cloud environment

REFERENCES
UNIT IV  REHABILITATION AND ASSISTIVE ROBOTS
Pediatric Rehabilitation, Robotic Therapy for the Upper Extremity and Walking, Clinical-Based
Gait Rehabilitation Robots, Motion Correlation and Tracking, Motion Prediction, Motion
Replication. Portable Robot for Tele rehabilitation, Robotic Exoskeletons – Design considerations,
Hybrid assistive limb. Case Study

UNIT V  WEARABLE ROBOTS
Augmented Reality, Kinematics and Dynamics for Wearable Robots, Wearable Robot technology,
Sensors, Actuators, Portable Energy Storage, Human–robot cognitive interaction (cHRI), Human–
robot physical interaction (pHRI), Wearable Robotic Communication - case study

TOTAL: 45 PERIODS

COURSE OUTCOMES:
CO1: Describe the configuration, applications of robots and the concept of grippers and actuators
CO2: Explain the functions of manipulators and basic kinematics
CO3: Describe the application of robots in various surgeries
CO4: Design and analyze the robotic systems for rehabilitation
CO5: Design the wearable robots

REFERENCES
2. Spong and Vidhyasagar, “Robot Dynamics and Control”, John Wiley and Sons, First
   edition, 2008
   2008
5. Shane (S.Q.) Xie, Advanced Robotics for Medical Rehabilitation - Current State of the Art
   and Recent Advances, Springer, 2016
7. Jose L. Pons, Wearable Robots: Biomechatronic Exoskeletons, John Wiley & Sons Ltd,
   England, 2008
8. Howie Choset, Kevin Lynch, Seth Hutchinson, “Principles of Robot Motion: Theory,
   Algorithms, and Implementations”; Prentice Hall of India, First edition, 2005
    Applications & Visions”, Springer 2011

VE4202  EMBEDDED AUTOMATION  L T P C
3 0 0 3

COURSE OBJECTIVES:
• To learn about the process involved in the design and development of real-time embedded
  system
• To develop the embedded C programming skills on 8-bit microcontroller
• To study about the interfacing mechanism of peripheral devices with 8-bit microcontrollers
• To learn about the tools, firmware related to microcontroller programming
• To build a home automation system
UNIT - I  INTRODUCTION TO EMBEDDED C PROGRAMMING
C Overview and Program Structure - C Types, Operators and Expressions - C Control Flow - C Functions and Program Structures - C Pointers And Arrays - FIFO and LIFO - C Structures - Development Tools

UNIT - II  AVR MICROCONTROLLER
ATMEGA 16 Architecture - Nonvolatile and Data Memories - Port System - Peripheral Features : Time Base, Timing Subsystem, Pulse Width Modulation, USART, SPI, Two Wire Serial Interface, ADC, Interrupts - Physical and Operating Parameters

UNIT – III  HARDWARE AND SOFTWARE INTERFACING WITH 8-BIT SERIES CONTROLLERS
Lights and Switches - Stack Operation - Implementing Combinational Logic - Expanding I/O - Interfacing Analog To Digital Convertors - Interfacing Digital To Analog Convertors - LED Displays : Seven Segment Displays, Dot Matrix Displays - LCD Displays - Driving Relays - Stepper Motor Interface - Serial EEPROM - Real Time Clock - Accessing Constants Table - Arbitrary Waveform Generation - Communication Links - System Development Tools

UNIT – IV  VISION SYSTEM

UNIT – V  HOME AUTOMATION
Home Automation - Requirements - Water Level Notifier - Electric Guard Dog - Tweeting Bird Feeder - Package Delivery Detector - Web Enabled Light Switch - Curtain Automation - Android Door Lock - Voice Controlled Home Automation - Smart Lighting - Smart Mailbox - Electricity Usage Monitor - Proximity Garage Door Opener - Vision Based Authentic Entry System

TOTAL: 45 PERIODS

COURSE OUTCOMES:
On successful completion of this course, students will be able to
CO1: analyze the 8-bit series microcontroller architecture, features and pin details
CO2: write embedded C programs for embedded system application
CO3: design and develop real time systems using AVR microcontrollers
CO4: design and develop the systems based on vision mechanism
CO5: design and develop a real time home automation system

REFERENCES: