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

STUDY & EVALUATION SCHEME WITH SYLLABUS

FOR

B. TECH 4th YEAR
PLASTICS ENGINEERING

ON

CHOICE BASED CREDIT SYSTEM

(EFFECTIVE FROM THE SESSION: 2019-20)
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**DEPARTMENTAL ELECTIVE-3**

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<td>RPL070</td>
<td>Testing of Plastics Materials &amp; Product</td>
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<td>RPL071</td>
<td>Biodegradable Polymers</td>
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<td>RPL072</td>
<td>Speciality Polymers</td>
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<td>RPL073</td>
<td>Polymer blends &amp; alloys</td>
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**DEPARTMENTAL ELECTIVE-4**

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<td>Advanced Blow Moulding Process Technology</td>
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### EIGHT SEMESTER

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- Students who was not-place in any company, it is mandatory to select any one subject from DE-5 & 6.
- Students who was place in any company, it is mandatory to select MOOC subject in both DE-5 & 6.

### DEPARTMENTAL ELECTIVE-5

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<td>RPL081</td>
<td>Advanced Injection Moulding Process Technology</td>
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<td>RPL082</td>
<td>Surface Coating Technology</td>
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<td>Secondary Processing Techniques</td>
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### DEPARTMENTAL ELECTIVE-6

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<td>RPL089</td>
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UNIT-I:

UNIT-II:

UNIT-III:
**Curves:** Curves representation, Properties of curve design and representation, Interpolation vs approximation, Parametric representation of analytic curves, Parametric continuity conditions, Parametric representation of synthetic curves-Hermite cubic splines-Blending function formulation and its properties, Bezier curves-Blending function formulation and its properties, Composite Bezier curves, B-spline curves and its properties, Periodic and non-periodic B-spline curves.

UNIT-IV:
**3D Graphics:** Polygon Surfaces-Polygon mesh representations, Quadric and Super quadric surfaces and blobby objects; Solid Modeling-Solid entities, Fundamentals of Solid Modeling-Set theory, regularized set operations; Half spaces, Boundary representation, Constructive solid geometry, Sweep representation, Color models. Basic application commands for 2d drafting software like AutoCAD/Draft sight (any one) & 3d solid modeling software Solid works/Autodesk Inventor/ PTC Creo /Catia (Any one) etc.

UNIT-V:
**Finite Element Analysis:** Basic concept of the finite element method, comparison of FEM with direct analytical solutions; Steps in finite element analysis of physical systems, Finite Element analysis of 1-D problems like spring, bar, truss and beam elements formulation by direct approach; development of elemental stiffness equations and their assembly, solution and its post processing.

**Books and References:**
2. CAD/CAM, by Groover and Zimmers, Prentice Hall India Ltd.
4. CAD/CAM: Computer Aided Design and Manufacturing, by Groover, Pearson India
6. Finite Element Method By S SRao
POLYMER COMPOSITES

UNIT-I:
Introduction of composite material, comparison of different materials with composites advantages and disadvantages. Principles of composite reinforcement. Effect of fibrous reinforcement on composite strength.

UNIT-II:
Fibrous and particulate composites, Types of reinforcement such as natural, glass, carbon/graphite, aramid fibers, high strength and high modulus fibers. Surface treatment and various forms of fibers. Reinforcement of various nanofillers such as CNT's, HNT’s, MMT, Nano silica etc. in polymer matric for the fabrication of Nano composite.

UNIT-III:
Thermosetting and thermoplastic materials for the composites and their selection for a particular application. Evaluation of strength and failure criteria of composites, Optimum fiber reinforcement criteria, Kelly- Davies model.

UNIT-IV:
Processing and production techniques like hand-lay-up, spray-up, bag moldings, filament winding and pultrusion- defects.

UNIT-V:
Prepregs manufacture and characterization. Sheet molding and dough molding compounds and their processing, preform and resin transfer moldings. Hybrid and sandwich type composites. Composite Testing, joining and environmental effects.

Books and References:
4 Mechanics of Composites Materials” Script a Book Co- Jones, R.M.
Total 7 Experiments are to be carried out.

CAD Experiments

1. Line Drawing or Circle Drawing experiment: Writing and validation of computer program.


3. Design of machine component or other system experiment: Writing and validation of computer program.

4. Understanding and use of any 3-D Modeling Software commands.


6. Writing a small program for FEM for 2 spring system and validation of program or using a FEM Package.

7. Root findings or curve fitting experiment: Writing and validation of computer program.

8. Numerical differentiation or numerical integration experiment: Writing and validation of computer program.
NPL-752: MOULD & DIE MANUFACTURING LAB  
L-T-P  
0-0-2

Minimum 8 experiments

1. Study of different types of Cutting tools.
2. Letter writing on Pantograph milling
3. Study of EDM,
4. Study of Wire cut EDM
5. Study and Detailing of mould assembly
6. Manufacturing of Guide Pillar
7. Manufacturing of Pocket By Milling
8. Gas assisted and Water assisted Injection mould and Hot runner mould
9. Hand compression mould design – positive, semi positive, displacement type mould, and design with split cavities
10. Transfer mould design (pot type & top plunger type)
11. Automatic unscrewing mould
12. Study of Mould for Rotational Moulding
13. Study of Mould for Thermoforming Moulding
14. Study of Mould design for industrial component
UNIT-I:

UNIT-II:

UNIT-III:

UNIT-IV:

UNIT-V:
Product testing-pipe and fittings-film and sheets, Pipe and tube, blow bottle testing and FRP based products. Factors for designing tests for newer products.Factors affecting the quality of materials and products.

Books and References:
UNIT-I: 

UNIT-II: 

UNIT-III:  

UNIT-IV:  

UNIT-V:  
Test methods & standards for biodegradable plastics: Introduction, defining biodegradability, criteria used in the evaluation of biodegradable polymers, tiered systems for evaluating biodegradability, choice of environment, choosing the most appropriate methodology, description of current test methods – screening test for ready biodegradability, tests for inherent biodegradability, tests for simulation studies, other methods for assessing biodegradability – petri dish screen – environmental chamber method – soil burial tests, Test method developments for the future.

Books and References:  
3. Handbook of Biodegradable polymers- Abraham J.Donb& Others (ed.).  
UNIT-I:
High temperature and fire-resistant polymers, Applications of heat resistant polymers like polyamides, polyimides, polyquinolines, polyquinoxalines, PEEK, polysiloxane, polyphosphazenes, polybenzoxazines and polyetherimide

UNIT-II:
Conducting polymers, conduction mechanism, doping of polymeric systems. Preparation, properties and applications of polyaniline, polycetylene, polypyrrole, Photo-conducting and piezoelective polymers

UNIT-III:
Polymers as corrosion inhibitors, Polymers as antistatic agents, Polymer colloids, Polymeric surfactants, Polymers in conversion and energy storage. Liquid crystalline polymers

UNIT-IV:
Preparation, properties and applications of polymers for biomedical applications, hydrophilic polymers and ionic polymers

UNIT-V:
Recent advancements in specialist polymers

Books and References:
1. Specialty polymer by R.W Dayson.
2. Specialty polymer: Materials and Applications by Faiz Mohammad.
UNIT-I:

UNIT-II:

UNIT-III:
Rheology of polymer blends, Introduction to miscibility and immiscibility, types of blends, Flow behavior of immiscible and miscible polymer blends.

UNIT-IV:
Techniques for studying the morphological properties of blends and alloys through optical microscopy, SEM, Atomic Force Microscopy and TEM.Specimen preparation for SEM and TEM analysis.

UNIT-V:
Thermal analysis of polymer blends using DSC, TGA and DMA for their various thermal properties such as thermal stability and degradation behavior, determination of melt temperature, glass transition temperature and crystallization temperature

Books and References:
UNIT-I:
High tech-areas for applications of plastics. High temperature polymers

UNIT-II:
Polymer blends and alloys, interpenetrating polymers networks.
Introduction – basic chemistry – General properties and applications of thermoplastic elastomers.

UNIT-III:
Polymer concretes and polymer reagents. Introduction – basic chemistry – General properties and applications of Ultra-high modulus fibres.

UNIT-IV:
Introduction – basic chemistry – General properties and applications of Liquid crystalline polymers.
Introduction – basic chemistry – General properties and applications of Polymeric foams.

UNIT-V:
Introduction – basic chemistry – General properties of Polymers for low temperature and Bio-medical applications.

Books and References:
1. Temperature Engg. Thermoplastics, Elsevier pub- Collyer, A.A,High
2. Silicon Based Polymers, Noyes.-Jeigler, J.M.
3. Plastics Material- Brydson, J.A
UNIT-I:
BLOW MOLDING OF IRREGULAR PARTS
Introduction, Blow molding light weight irregular shaped parts, Moving mould sections, Integral HDPE Handle lid, Double wall internally threaded lid, Drum integral Handling HDPE Ring (L-Ring), Caps and closures, Multiple parting lines, Industrial Double wall Blow Molding, Mold preparation and other considerations.

TYPE OF AUTO FEEDING MECHANISMS
Hopper loader, Screw feeders, Hopper mounting & emptying devices, Metering devices

UNIT-II:
DIES/MOULDS
Design guideline, Introduction – Die assembly and it parts – Flow of parison, Blowing of parison, Parison thickness control, Parison swell, Calculation of Die and Mandrel dimensions, Thread closer

MOLD DESIGN BASICS
Shrinkage, Parting line, Pinch off, molded neck finishing, Venting, Clamping tonnage, Part ejection, mould cooling,

UNIT-III:
INTRODUCTION TO MOULDS
Simple blow moulds, Stretched Blow moulds, Preform moulds, Mold materials
Control system for Blow molding machines. Introduction, Temperature controlling system & elements, Hydraulic controlling system & elements, Electrical controlling system & elements, Micro process control, Types of sensors, Process control, Product Control

UNIT-IV:
MAINTENANCE
Maintenance of machines, Preventive & breakdown maintenance of different Controlling mechanism, Start and shut down process, Handling of Dies, molds and accessories, Assembly of dies &molds, Dismantling of dies &molds, Cleaning of moulds and dies,

UNIT-V:
TECHNICAL COST ANALYSIS
Elements, Fixed and variable cost elements, Blow molding cost model – (case study for product to be manufacture), Break even point – cycle time, Annual production volume – Comparative cost analysis – (case study), Injection molding, Thermoforming , and Summary of cost comparisons

Books and References:
1 Blow Moulding of Plastics – Fisher
2 Design of Blow Moulds – R. C. Batra
UNIT-I:

UNIT-II:
Jig boring, Pentograph, Profile grinding, Electrical discharge machining Characteristics, physical processes, special technological features, types of EDM, design consideration &functions and technological planning. Applications of wire cut EDM in mold making. Electroforming for mold manufacturing - discussion of the process, materials for electroforming, machining for electroformed blanks

UNIT –III:
HEAT TREATMENT PROCESSES, VARIOUS TYPES OF FURNACES.
Hobbing for mold making –
Discussion of the hobbing process & its advantages, elements of hobbing like hobbingpunch, shape of the hob, materials used for cavity, lubrication, and depth of hobbing, Hobbing presses, Hobbing operations & its economy with examples.

UNIT –IV:
Polishing technology in mold making: Definition of surface roughness, basis of polishing technology, Effect of mold materials on polishability, Types of polishing tools, Methods of polishing. Basic information on Electro sonic polishing. Principles of Electro deposition in damaged molding surfaces. Surface Texturing of molds - Process description, types of molds, types of patterns and mold shapes, metals that can be etched, mold preparation, limitations of chemical texturing.

UNIT-V:
Manual (word address format) programming- SIMPLE Examples:Canned cycles, Subroutine, and Macro. APT programming. Geometry, Motion and Additional statements, Macro- statement Open and closed loops. Control of point to point systems-Incremental open loop control, Incremental close loop, Absolute close loop; Control loop in contouring systems; Adaptive control.

Books and References:
2. ”Mold making handbook for Plastic Engineers”, KlusStokhert (Edt.),Hanser Publishers, NY,1983
11. “Plastics Mold Engineering”, DuBois; J. Harry and Pribble; W. I. (Eds.),SPE Polymer Technology
UNIT-I:

UNIT-II:

UNIT-III:

UNIT-IV:
Case studies on preference of one plastic to other and co-relation of properties of conventional materials and blends and alloys – case studies on application of blends and alloys.

UNIT-V:
End Use Market for Plastics Principles of Material selection including consideration of conventional materials competitive with plastics – Case studies on material suitability (e.g. Plastics Gears, Feeding Bottle, Bowels for micro wave 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.

Books and References:
7. Polymer additive – by Muller.
DEPARTMENT ELECTIVES – 5

PLASTIC WASTE MANAGEMENT

UNIT-I:

UNIT-II:

UNIT-III:
Mechanical recycling of commonly used plastics, such as PP, PE, PET, etc. mixed waste recycling – co-extruded films waste, commingled waste Extrusion flow moulding for production of plastics lumbers, chemical recycling/feedStoch recycling processes for recovery of oil, monomer and energy – thermolytic processes. Solvolysis – process outline for PMMA, PET, etc.

UNIT-IV:

UNIT-V:

Books and References:
UNIT-I:
Introduction to light weighted formed / hollow injection Molded articles: Gas-assisted injection molding – Introduction, Field of application, Materials – Gas injection systems & mechanisms, Processing technology & steps, Discontinuous pressure generation Continuous pressure generation, Gas pressure control, Gas Injection units (through nozzle & into mould), Mould technology, Product properties, Design guidelines & quality, Troubleshooting.
Injection molding with fusible core technology: Introduction, application and advantages.

UNIT-II:
Injection molding machine for thermosets: Feeding system, Oil heated barrel, Oil temperature controller, Screw / barrel / nozzle design.
Controlled low pressure injection molding: Concept of low- pressure moulding, Alternative injection moulding strategies, Operating conditions, Foaming agents, Equipments, Process Control, Thermoplastic solid molding, Structural foam molding.

UNIT-III:
Hydraulic application: Hydraulic system, Multi pump, Variable pump, Accumulator, High capacity valves, Intensifier, Hydraulic safety gate.

UNIT-IV:
Type of molds: Introduction to mold design only, Hot runner moulds, Gas – assisted injection moulds, Low– pressure injection moulds, Moulds for two - colour/ two component molding, Moulds for rotating core process, Moulds for retractable core process, Reaction injection moulds.
Introduction to packaging products its process & printing Techniques: Equipment’s, Auto labelling, Surface treatment, Printing techniques &it's process.

UNIT-V:
Technical cost analysis: Introduction to Technical cost modeling, Cost analysis method, Direct & indirect cost elements, Fixed and variable cost elements, Injection molding cost model – ( case study for product to be manufacture), Breakeven point – cycle time, Annual production volume, Comparative cost analysis – (case study), Summary of cost comparisons.

Books and References:
UNIT-I:
Origin and development of surface coatings. Constituents of paint, varnishes and lacquers.

UNIT-II:

UNIT-III:

UNIT-IV:

UNIT-V:
Specialty coatings like water based, powder and high solid, etc. Industrial and architectural finishes.

Books and References:
1. Organic Coatings: Science and Technology, Zeno W. Wicks, John Wiley and Sons Ltd
2. Surfactants in Polymers, Coatings, Inks and Adhesives, Edited by D.R. Karsa
3. Coatings Materials and Surface Coating ; Arthur A. Tracton
5. Coatings Technology: Fundamentals, Testing, and Processing Techniques Arthur A Tracton,
UNIT-I:
FRP Laminates: Introduction, FRP processing methods contact molding hand lay-up, spray up method vacuum bag & pressure bag moulding, filament welding, centrifugal casting, pultrusion, matched die molding laminates, definition of terms high, pressure laminating process, types of machinery, impregnation systems – decorative and industrial laminates, continuous high-pressure laminating process, application.

UNIT-II:
Cellular Plastics: 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-III:

UNIT-IV:
Casting Processes: Dip casting, slush casting, continuous casting, cell casting, processes and applications. Calendaring – Types of Calendaring systems.

UNIT-V:

Books and References:
TECHNOLOGY OF ELASTOMERS

UNIT-I:

UNIT-II:
Production of different grades of natural rubber from latex, modified and natural rubber derivatives, Reactions of rubber, application of latex, technically specified rubber, chemistry and technology of vulcanization.

UNIT-III:
Manufacturing processes, properties and application of synthetic elastomers viz. styrene butadiene rubbers, Acrylonitrile-butadiene rubber, butyl rubber, polychloroprene rubber.

UNIT-IV:
Manufacturing processes, properties and applications of ethylene-propylene rubber, polyurethane elastomers, chlorosulphonated polyethylene, polysulphide and silicon, thermoplastic elastomers.

UNIT-V:
Industrial fabrication of rubber article such as transmission belts, hoses, tyres, purged goods, compounding and processing techniques, direct manufacture of articles from latex.

Books and References:
1. Rubber toughened Plastics, American Society- C. Keith Riew.
UNIT-I:
EXTRUSION LINES (with calibration system and takeoff / haul off units) Dies, Pipes, Corrugated pipes, Nylon braided PVC hose pipe, PVC reinforced PVC suction hose pipe, Post extrusion process
BLOWN FILM EXTRUSION
Dies, Tubular film extrusion, Blown film Co– extrusion, Polymers, combinations and properties, Advantages.

UNIT-II:
MANUFACTURE OF ORIENTED FILMS
Advantages, Process, Temperature control of film System, Stretching units
EXTRUSION COATING & LAMINATION
Dies, Introduction & Advantages, Paper film & foil lamination, Material combination, Adhesion, Pretreatment, Co - extrusion as adhesion promoter

UNIT-III:
EXTRUSION OF FOAMED INTERMEDIATE PRODUCTS.
Dies, Manufacturing process, Raw material, Post extrusion, Single stage & multi stage process, Dies & calibrating devices.
ROD EXTRUSION OF PTFE AND UHMWPE, Description of the process, Processing machine, Extrusion dies.

UNIT-IV:
PACKAGING
Maintenance (Electrical & Mechanical)
PROCESS CONTROL SYSTEM – Introduction, Temperature controlling system & elements, Hydraulic Controlling system & elements, Electrical controlling system & elements, Micro process control, Type of sensors, Process control, Product control.

UNIT V
TECHNICAL COST ANALYSIS,
Introduction to Technical cost modeling, Cost analysis method, Direct & indirect cost elements, Fixed and variable cost elements, Extrusion molding cost model – (case study for product to be manufacture), Break even point – cycle time, Annual production volume – Comparative cost analysis – (case study), Summary of cost comparisons.

Books and References:
1. Plastic Extrusion Technology – Fisher
2. Plastics Engineering Hand Book (Spi) – Berrins
3. Plastic Extrusion Technology Hand Book- Levy
4. Hand Book Of Polymeric Foams & Foam Technology-Klempner
APPLICATIONS OF NANOTECHNOLOGY IN POLYMERS

UNIT-I:
Importance and emergence of nanotechnology, Size dependence of properties, crystal structure, energy bands, insulators, semiconductors and conductors, gaps of semiconductors, Fermi surfaces, localized particles.

UNIT-II:
Improvements in solar energy conversion and storage; better energy efficient lighting; stronger and newer materials to improve energy transportation efficiency; use of low-energy chemical pathways to break down toxic substances for remediation and restoration; Device applications, Use in hydrogen Storage and Production, Fuel Cells, Battery, Carbon Nanotubes for energy storage.

UNIT-III:

UNIT-IV:
Nano polymers in Medicines, Nanomedicine, Molecular design using biological selection, DNA and protein based nanocircuitry, Neurons for network formation, DNA based nanomechanical devices, Drug Delivery.

UNIT-V:
Therapeutic action of nanoparticles and nanodevices, Targeted, Nontargeted delivery, Controlled drug release; exploiting novel delivery routes using nanoparticles; gene therapy using nanoparticles.

Books and References:
UNIT-I:
Introduction to polyurethane- chemistry and materials of polyurethane manufacture: basic reaction, cross linking in polyurethane, important building blocks for polyurethane (isocynates, polyols, amines and additives) - The manufacturer of polyurethanes (the process, parameters and controls).

UNIT-II:
Polyurethane processing-basic design principles of polyurethane processing equipment -steps in the polyurethane processing. Flexible foams-(production, properties and application slabstock foam, carpet backing, flexible molded foams &semirigidmolded foams. Reinforced RIM – trends in the use of RIM and RRIM.

UNIT-III:
Rigid polyurethane foams-chemistry of raw materials, manufacturing of rigid polyurethane (manufacturing of buns, panels, foaming of applications, molded rigid foams), properties, relationship between production methods and properties- application of rigid polyurethane. Polyurethane skin integral foam-production, properties and applications.

UNIT-IV:
Solid polyurethane materials- polyurethane casting systems (cast elastomers and casting resins)-thermoplastic polyurethane elastomers: productions / processing, properties and applications, polyurethane, pains, technique and coatings, adhesives builders, elastomers fibers, manufacture / processing and applications.

UNIT-V:
Determination of composition and testing of polyurethane-chemical compositions, detection methods, identification of functional groups, determinations of properties materials and products (Characterisation, physics/mechanical, temp dependence, chemical performance, combustibility) polyurethane and environment health and safety: making and using polyurethane safety.

Books and References:
1 Polyurethane Hand Book, Hanser Publication Munich- Dr.GumterOertal (ed.)
2 The ICI Polyurethane book -published journals by ICI, John Wiley and sons NYGeorge woods.