INSTITUTE OF CHEMICAL TECHNOLOGY

Degree of Master of Engineering in Plastic Engineering

(M.E. Plastic Engineering)

Revised Syllabus

(2022 – 2023)

The revised syllabus comes into effect for first year students of Master of Engineering in Plastic Engineering from the academic year 2022-23

DEPARTMENT OF GENERAL ENGINEERING

M.E in Plastic Engineering

VISION STATEMENT:

The department aspires to contribute to India through excellence in technical education and research, to cater the growing needs of plastics manufacturing and processing industries and research institutions.

MISSION STATEMENT:

M1: To develop the necessary skills in students with the current scenario, through collaboration with industries and research organization, to meet the expectations of the plastics industries.

M2: To undertake multi-disciplinary research and industry projects and to encourage innovation, growth and development in the emerging areas of new materials and technology.

M3: To develop analytical skills, leadership quality and team spirit in students through balanced curriculum and a judicial mix of co-curricular, extra-curricular and professional activities.

M4: To develop a spirit for the product development through effective integration of mold design, design engineering and material study.

M5: To motivate the students to become job providers rather than job seekers.

PROGRAM EDUCATIONAL OBJECTIVES (PEO's):

PEO No.	Program Educational Objectives Statement
PEO-1	To produce graduates who will work efficiently and productively as a Plastic Engineer and Scientist in academia as well as industry in supportive or leading role.
PEO-2	Be a good learner at all stages of profession by acquiring higher education, professional degrees, or courses.
PEO-3	To produce graduates who can be employed successfully in plastic related industries or other related industries or accepted into research programs
PEO-4	Aware of the environmental and societal impact of plastic engineering and technology and work within the periphery.

PROGRAM OBJECTIVES (PO's):

POs	Statement	Courses	Action
PO1	An ability to be effective in the design of engineering technology solutions and the practical application of engineering technology principles using high safety standards.		
PO2	An ability to develop communication skills to write and present a substantial technical report/document.		
PO3	An ability to understand and apply professional, ethical, and quality standards of excellence consistent with plastics industry.		
PO4	An ability to serve their communities and the environment through innovations in plastic technology/engineering.		
PSO1	An ability to systematically break up complex problems in realizable steps related to mold design, processing of plastics, plastic product design and solve them.		

Syllabus Details for the degree of
Master of Engineering in Plastic Engineering

Course Code	Subjects	Credit	Hr/Week			Marks			
			L	T	P	CA	MS	ES	Total
SEMESTER – I									
GET 2120	Core I: Chemistry of Polymers andPlastic Materials	3	2	1	0	10	15	25	**50**
GET 2102	Core II: Processing of Plastics	3	2	1	0	10	15	25	**50**
GET 2103	Core III: Plastic Product Design andTesting	3	2	1	0	10	15	25	**50**
GET	Elective – I (Programme)	3	2	1	0	10	15	25	**50**
GET	Elective – II (Institute)	3	2	1	0	10	15	25	**50**
GEP 2121	Research Methodology	4	2	0	4	25	-	25	**50**
GEP 2122	Plastic Processing and TestingLaboratory	3	0	0	6	25	-	25	**50**
GEP 2123	Research Project – I	2	0	0	4	-	-	30 (Report) 20 (Presentation)	**50**
	TOTAL	**24**	**12**	**5**	**14**				**400**
SEMESTER – II									
GET 2124	Core IV: Design of Plastic Moulds andDies	3	2	1	0	10	15	25	**50**
GET 2108	Core V: Principles of Plastic MachineryDesign	3	2	1	0	10	15	25	**50**
GET 2117	Core VI: Plastic Waste Management	3	2	1	0	10	15	25	**50**
GET	Elective – III (Programme)	3	2	1	0	10	15	25	**50**
GET	Elective – IV (Institute)	3	2	1	0	10	15	25	**50**
GEP 2125	CAD/CAM/CAE and Design of MoldsLaboratory	3	0	0	6	25	-	25	**50**
GEP 2126	Research Project – II	6	0	0	12	-	-	60 (Report) 40 (Presentation)	**100**
	TOTAL	**24**	**10**	**5**	**18**				**400**
SEMESTER – III (GEP 2127)									
GEP 2127	Research Project – III	24	0	0	6	-	-		**450**
SEMESTER – IV (GEP 2128)									
GEP 2128	Research Project – IV	24	0	0	6	-	-		**450**

L: Lectures **CA:** Continuous Assessment **PPT**: Power point presentation
T: Tutorials **MS:** Mid Semester Examination
P: Practical **ES:** End Semester/Final Examination

SEMESTER – I

Course Code: GET 2120	Course Title: Chemistry of Polymers and Plastic Materials	Credits = 3		
		L	T	P
Semester: I	Total contact hours: 45	2	1	0

Course Outcomes (students will be able to….)		
1	Understand basics of polymer chemistry and types of polymerizations	K2
2	Apply properties of polymers/smart polymers/industry-oriented polymers for suitable applications	K3
3	Analyze Synthesis of commodity, engineering and specialty plastics	K4
4	Apply effect of polymer morphology on processing conditions	K3
5	Apply effect of various additives on polymer /polymer blend properties	K3
List of Prerequisite Courses		
1	Basic chemistry	
List of Courses where this course will be prerequisite		
1	Design of Plastic Moulds and Dies, Processing of Plastics, Research Project I & II, Plastic product design and testing	

Description of relevance of this course in the M.E. (Plastic Engineering) Program

Study of this course will provide an insight to students about chemistry of polymers/industry-oriented polymers, their properties and applications.

	Course Contents (Topics and subtopics)	Reqd. Hrs
1	General definitions used in plastics industry. Classification of polymers. Functionality, molecular weight and its determination, glass transition temperature degree of polymerisation, copolymerisation. Various methods of polymerizations	6
2	Chemistry, properties, and applications of polymers such as phenolics, amino resins, epoxies polyester, silicones, polyurethanes	6
3	Chemistry, properties, and applications of commodity plastics like poly-olefines, styrene's, acrylics, PVC etc. and their co-polymers	6
4	Chemistry, properties, and applications of Engineering polymers like polyamides, polycarbonates, polyesters, poly acetals etc. Speciality polymers and elastomers	6
5	Additives such as plasticizers, stabilizers, fillers, colourants, blowing agents used in plastics. Polymer blends and alloys	6
6	Influence of polymer morphology on processing conditions. Temperature – Pressure and density relation	6
7	Introduction to smart polymers, conducting polymers, self-healing polymers, shape memory, electro active polymers, photoactive polymers, magneto active polymers and other industry-oriented polymers.	9

List of Textbooks	
1	Plastic Materials –by Brydson J A
2	Polymer Science - by Gowarikar
3	Outline of Polymer Chemistry – by R Sinha
List of Additional Reading Material / Reference Books	
1	Encyclopaedia of polymer science and technology- Wiley publications
2	Polymer Chemistry; an Introduction –by Stevens M P
3	Polymer science and technology- Robert. Ebewele

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	2	2	-	1	3
CO2	3	3	-	2	3
CO3	3	-	3	2	2
CO4	3	2	-	2	3
CO5	2	2	2	1	2

Course Code: GET 2102	Course Title: Processing of Plastics	Credits = 3		
		L	T	P
Semester: I	Total contact hours: 45	2	1	0

Course Outcomes (students will be able to….)		
1	Evaluate the effect of various process parameters of injection molding on plastic products	**K5**
2	Analyze effect of various parameters on plastic products produced by extrusion	**K4**
3	Apply the effect of various process parameters of compression molding on product quality	**K3**
4	Apply principles of blow molding, rotational molding for plastic products.	**K3**
5	Understand basics of calendaring, thermoforming and FRP process in various applications	**K2**
List of Courses where this course will be prerequisite		
1	Design of Plastic Moulds and Dies, Principles of Plastic Machinery Design, Plastic Waste Management	

Description of relevance of this course in the M.E (Plastic Engineering) Program

Study of this course will provide an insight about understanding various process and the effect of various parameters on plastic products

	Course Contents (Topics and subtopics)	Reqd. Hrs
1	Introduction to polymer processing, viscoelastic behavior, injection moulding: basic principles- definition of terms-specifications-types of machines used-parts and their functions. Injection moulding cycle-process variables and their effect on product quality. Types of nozzles-cavity pressure profile. Common moulding defects, causes and remedies. Thermoset injection moulding, Machine description, process parameters. Gas injection moulding, Reaction injection moulding, Co-injection moulding, Scientific injection moulding	10
2	Extrusion: Introduction-principles-classification of extruders, single screw extruder, specifications, screw nomenclature. Various extrusion methods and post extrusion systems like sizing, cooling, take-off, cutting etc., as related to film, pipe, sheet, wire and profile extrusions. Common defects and remedies	12
3	Compression Moulding: Introduction-principles-types of machines, types of moulds. compression moulding cycle, process variables and their effect on product quality. Common moulding defects, causes and remedies, advantages, and disadvantages. Compression -injection moulding	6
4	Transfer Moulding: Introduction-principles-Pot type, Plunger type, screw transfer moulding. Common moulding defects, causes and remedies, advantages, and disadvantages.	4
5	Blow Moulding: Introduction-principles-processes-Extrusion blow moulding –Injection blow moulding-stretch blow moulding- blow moulding of large containers-parison programming	4
6	Rotational Moulding: Introduction-principles-process-machinery used-mould process parameters–merits and demerits	3
7	Calendering: Introduction-calendar roll arrangements- calendering process-process variables applications-merits and demerits. Thermoforming: Introduction- various types of thermoforming process- process variables –applications –merits and demerits. Fiber reinforced Plastics: Introduction – various processing techniques such as hand lay-up, spray lay-up, pultrusion, filament winding etc. –merits and demerits.	6

List of Textbooks	
1	Injection moulding theory and practice- By Irvin I Rubin
2.	Extrusion of Plastics – By E.G.Fischer
3.	Polymer Extrusion – By Chris Rauwendaal
4.	Plastic Technology Handbook – By Manas chanda and S.K.Roy
List of Additional Reading Material / Reference Books	
1.	Injection moulding –By A.S.Athalye
2.	Compression and Transfer Moulding theory and technology- By Bobb

3.	Calendering of Plastics – By Elden and Swan
4.	Blow Moulding – by Rosato
5.	Thermoforming – By James.L.Throne

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	3	2	-	2	3
CO2	3	2	-	2	3
CO3	3	2	3	1	2
CO4	2	-	-	1	2
CO5	2	2	-	2	2

Course Code: GET 2103	Course Title: Course Title: Plastic Product Design and Testing	Credits = 3		
		L	T	P
Semester: I	Total contact hours: 45	2	1	0

Course Outcomes (students will be able to….)		
1	Analysing basics of plastic product design	K4
2	Design engineering plastic products based on technical requirements	K6
3	Apply various test standards for plastic product testing	K3
4	Applying various test procedure to evaluate mechanical, electrical, thermal, flow, optical, and general properties for plastic product	K3
5	Analyze and interpret various test results	K4
List of Prerequisite Courses		
1		
List of Courses where this course will be prerequisite		
1	Research Project I and II, Design of Plastic Moulds and Dies	

Description of relevance of this course in the M.E(Plastic Engineering) Program

The outcome of this course is to make students aware and teach the design process for industrial products and related plastic product innovation. The design methodology and attributes help to develop enthusiasm leading to product design skill development. Beneficiary student would become capable to describe product concept, product functionality and approach.

	Course Contents (Topics and subtopics)	Reqd. Hrs
1	Design Definitions and attributes, Product configurations and component matrix, Understanding and analyzing contexts, parallel situations, Modularity and design modular systems, understanding design situations-parallel and future	5
2	Design issues and design thinking, selection of materials and technical requirements. Dimensional accuracy and functional requirements, surface finish etc. Effect of wall thickness, corner radius, drafts, shrinkage and warpage, inserts and parting lines. Design of Ribs, Bosses threads etc., Cost economics	8
3	Product design of engineering load bearing components such as gears, bearings, filament wound storage tanks, pipes etc. Effects of various basic parameters such as fabrication variables, material variables etc., on mechanical strength of plastic components. Recent developments of plastics products such as composites and their design approach.	8
4	Importance of testing, specifications and standards. Sample preparation and conditioning of samples	2
5	Various test methods for the evaluation of mechanical properties such as tensile strength, Flexural properties, impact strength, creep properties, fatigue properties etc. Testing of plastic films and sheets, Hardness test and abrasion resistance test etc.	6
6	Various test methods for the measurement of Insulation Resistance, Volume Resistivity, Surface Resistivity, Dielectric Strength, Dielectric Constant. Various test methods for the measurement of Optical Properties such as yellowness index, whiteness index, Refractive index, Percentage gloss, Clarity etc.	6
7	Various test methods for the measurement of thermal properties such as Thermal Conductivity, Coefficient of thermal expansion, Specific heat capacity, Softening point, heat distortion temperature and flammability. Thermo mechanical analysis. Differential scanning calorimeters etc. Measurement of flow Properties such as Melt flow index, rheometer test for thermo plastics, cup and spiral flow test for thermosets.	6
8	Measurement of general properties such as specific gravity, density, bulk density, environmental stress crack resistance, weathering, toxicity, chemical Resistance etc. Non-Destructive Testing for plastic parts.	4

List of Textbooks

1	Plastic Product Design – by Ronald D Beck
2	Product Design with Plastics – by Joseph D Dym
3	Plastic Product design Handbook – by Edward Miller
4	Jones, J.C: Design methods: Seeds of human futures, Wiley inter science, London, 1992

5	Filament Winding –by D.V.Rosato & C.S.Grove
6	Handbook of Plastic Testing Technology – by Vishu Shah
List of Additional Reading Material / Reference Books	
1	Engineering Design of Plastics – by Eric Bear
2	M.M Andreasen, Integrated Product Development, Ifs Publications Ltd. / springer Verlag, Berlin, 1987
3	Handbook American Society of testing and Material (ASTM)
4	Testing of Polymer (Vol. I, II, III, & IV) – by Brown

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	3	2	2	1	2
CO2	3	2	3	2	2
CO3	2	2	3	2	2
CO4	2	1	-	2	2
CO5	3	2	-	3	2

Course Code: GEP 2121	Course Title: Course Title: Research Methodology	Credits = 4		
		L	T	P
Semester: I	Total contact hours: 90	2	0	4

Course Outcomes (students will be able to….)		
1	Understand the basic concepts of research and the components.	K2
2	Understand and appreciate the significance of statistics in Plastic, Mechanical, Electrical and Civil Engineering.	K2
3	Understand and apply importance of literature survey in research design	K3
4	Understand an in-depth knowledge on the documentation in research	K2
5	Evaluate importance of various parts of a research report/paper/thesis in presentation of research results	K4
6	Prepare and deliver a model research presentation	K5
7	Understand the significance of various types of IPRs in research	K1
8	Create a model research project	K6

List of Prerequisite Courses	
1	Previous (during undergraduate) exposure to research project(s) is desirable but not necessary

List of Courses where this course will be prerequisite	
1	Research Project I & II

Description of relevance of this course in the M.E(Plastic Engineering) Program

The formal exposure to various elements of research methods such as problem formulation, literature survey, planning of various activities, documentation, writing research and review papers, report/thesis compilation, manuscript writing, patent drafting, is vital for polishing the naïve research attitude and aptitude in the PG students of the programme. The course is designed to formally introduce various concepts of research methodology in stepwise manner to the students

	Course Contents (Topics and subtopics)	Reqd. Hrs
1	RESEARCH FORMULATION AND DESIGN Motivation and Objectives, Types of Research, Criteria of good research. Defining and formulating the research problem, selecting research problem, Necessity of defining the problem, Importance of literature review in defining the problem, Literature review, Critical literature review, Identifying gap areas from literature and research database, development of working hypothesis.	L-4, P-8
2	DATA COLLECTION AND ANALYSIS Accepts of Method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically package (Sigma STAT, SPSS for student t -test, NOVA etc.), hypothesis testing.	L-6, P -12
3	SOFT COMPUTING Computer and its role in research, Use of statistical software such as SPSS, GRETL, MINITAB etc., Various optimization techniques.	L-2,P-8
4	SCIENTIFIC WRITING Layout of research and review paper, author guidelines, good writing skills, importance of discussion, Macro-level discussion. Structure of the documents. General issues of presentability. Micro-level discussion. Review and Research Papers, Important steps in writing review and research papers, critical review of research paper, how to prepare table of contents, how to write extended abstract for review papers.	L-8,P-16
5	PUBLISHING AND REVIEWING Publication process, How to publish papers, where to submit, Review process and reacting to a review report Reviewing scientific papers	L-2
6	SCIENTIFIC NORMS AND CONVENTIONS Authorship, Plagiarism, Simultaneous submissions, reviewing norms, Referring to other papers, Use of data, Collaborative Research Work	L-2

7	INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) Aspects of Research (Patents and Trademarks, 24 Designs and Copyrights): The Patent System in India – Present status of Intellectual Property Rights (IPR), Future changes expected in Indian Patents System; Advantages. What may be patented; Who may apply for patent; Preparation of patent document; Registration of patent in foreign countries and vice-versa	L-4
8	INTERPRETATION AND REPORT WRITING Meaning of interpretation, Techniques of Interpretation, Precautions in interpretation, Significance of report writing, Different steps in writing research proposal, Oral communication, Precautions for writing research proposals, conclusions.	L-2,P-16

List of Textbooks

1	Menzel, D.; Writing a Technical Paper; McGraw-Hill, United States (1961).
2	Best, J. W., Kahn, J. V., Jha, A. K.; Research in Education; 10th ed.; Pearson, New Delhi, India (2005)
3	Garg. B.L, Karadia R, Agarwal. F and Agarwal. U.K 2002. An introduction to Research Methodology., RBSA Publishers.

List of Additional Reading Material / Reference Books

1	Kothari.C.R, 1990 . Research Methodology: Methods and Techniques. New Age International .418p.
2	Day.R,A, 1992 . How to write and Publish a Scientific Paper, Cambridge University Press
3	Satarkar,S.V .2000 . Intellectual Property rights and Copyright. Ess Ess Publications
4	Leedy .P.D. and Ormrod,J.E ., 2004 Practical Research : Planning and Design, Prentice Hall
5	Fink, A,2009. Conducting Research Literature Reviews: From the internet to the Paper. Sage Publications.

CO-PO Mapping

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CO1	2	3	3	3	3
CO2	2	2	2	1	2
CO3	2	3	3	3	2
CO4	2	3	2	2	2
CO5	2	3	2	2	2
CO6	-	3	-	3	2
CO7	-	3	-	2	2
CO8	2	3	-	3	-

Course Code: GEP 2122	Course Title: Plastic Processing and Testing Laboratory	Credits = 3		
		L	T	P
Semester: I	Total contact hours: 90	-	-	6

	Course Outcomes (students will be able to….)	
1	Analyze effect of processing variables on the product quality in injection, compression molding and extrusion process.	K4
2	Select optimum processing parameters for various plastic processing methods	K4
3	Decide suitability of each process for a particular plastic product	K5
4	Apply suitability of polymer materials for a particular application by carrying out tensile, impact and flexural properties	K3
5	Analyze the effect of various fillers on flow properties of polymer composites after conducting MFI test	K4
6	Analyze the suitability of polymer material at elevated temperature for high stiffness by conducting HDT	K4

	List of Prerequisite Courses
1	Polymer Chemistry, Processing of Plastics, Plastic Product Design and Testing

	List of Courses where this course will be prerequisite
1	Research Project II and Research Project III

Description of relevance of this course in the M.E. (Plastic Engineering) Program

The formal exposure to various plastic processing methods and testing methods will impart students practical knowledge about various machines and testing methods.

	Course Contents (Topics and subtopics)	Reqd. hrs.
1	Melt compounding of polymers /fillers using twin screw extruder.	18
2	Injection molding of pellets obtained post extrusion.	12
3	Compression molding of thermosets and thermoplastic materials	15
4	Compounding of PVC using two roll mill	9
5	Testing of injection molded and compression molded samples for Mechanical properties such as tensile test, flexural strength, impact strength etc.	18
6	To find melt flow index of 2 to 3 polymers and polymers with fillers	9
7	Measurement of electrical properties such as dielectric strength, volume resistivity etc.	9

	List of Textbooks
1	Injection molding theory and practice- By Irvin I Rubin
2	Extrusion of Plastics – By E.G Fischer
3	Handbook of Plastic Testing Technology – by Vishu Shah
4	Plastic Technology Handbook – By Manas chanda and S.K.Roy

	List of Additional Reading Material / Reference Books
1	Compression and Transfer Moulding theory and technology- By Bobb
2	Handbook American Society of testing and Material (ASTM)
3	Testing of Polymer (Vol. I, II, III, & IV) – by Brown

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CO1	3	2	3	1	2
CO2	3	-	2	-	3
CO3	2	2	-	2	2
CO4	2	2	3	-	2
CO5	2	2	2	-	2
CO6	2	2	2	-	2

Course Code: GET XXX	Course Title: Elective – I (Department Elective)	Credits = 3		
		L	T	P
Semester: I	Total contact hours: 45	2	1	0
Candidate (Only M.E Plastic Engineering and Ph.D. students) will have to choose one of the elective subjects offered for that semester from the elective subjects. A consolidated list of all the elective subjects is given at the end.				

Course Code: GET XXX	Course Title: Elective – II (Institute/Open Elective)	Credits = 3		
		L	T	P
Semester: I	Total contact hours: 45	2	1	0
Candidate (Any Master's degree and Ph.D. Student) will have to choose one of the elective subjects offered for that semester from the elective subjects. A consolidated list of all the elective subjects is given at the end.				

Course Code: GEP 2123	Course Title: Research Project – I	Credits = 3		
		L	T	P
Semester: I	Total contact hours: 90	0	0	6

Course Outcomes (students will be able to….)		
1	Student would be able to collect literature related to an assigned area	K1
2	Student would be able to understand the lacunae in the literature	K2
3	Student would be able to analyze the literature and present suitable guidelines	K4
4	Student would be able to write a neat report following the guidelines	K2, K4
5	Student would be able to propose a defined plan for the research	K6

List of Prerequisite Courses	
1	All Plastic Engineering Courses

List of Courses where this course will be prerequisite	
1	Research Project II

Description of relevance of this course in the M.E Plastic Engineering Program

This course enables students to gather scientific information on a particular topic, analyze the information and present a written and oral summary on that topic. This enables the students to function in a professional environment later in their career

Course Contents

The Research project I is concerned with detailed and critical analysis of literature related to research area, supervised by a research guide. Candidate will be carrying out extensive literature survey related to the research area on which s/he will be carrying out the project in second year. Candidate is expected to submit a report as per guidelines provided below which will be evaluated by the supervisor and an external examiner from the Department/Industry based on the presentation made by the candidate. A suitable combination of the marks for report and presentation will be considered for the final evaluation.

GUIDELINES

1. Typically, the report should contain the following:
   - **(a)** Introduction: 2 pages maximum,
   - **(b)** Exhaustive review of literature (including figures): 10 – 12 pages: 50% Weightage
   - **(c)** Critical analysis of the literature and comments Critical analysis should also contain quantitative comparison of observations, results, and conclusion amongst the various papers.
2. Two typed copies of the report on thesis size bond paper (297 mm x 210 mm) are to be submitted to Coordinator on **time to be decided by the coordinator. In addition, soft copy of the report should be uploaded on the portal.** The detailed timetable for the presentation would be communicated.
3. The report should be prepared using the Times Roman font (size 12) using 1.5 spacing leaving 1-inch margin on all sides producing approximately 29 lines per page. The report should be typed on one side of the paper and need not be bound in a hard cover binding. Figures and tables should be shown as a part of the running text. Each figure should be drawn inside a rectangular box of 12 cm width and 10 cm height. The figures must be sufficiently clear, and hand drawn figures will be acceptable. Particular care must be taken if a figure is photocopied from source. Each figure must have a sequence number and caption below. Each table must have a sequence number and title at the top.
4. Name of the student, title of the problem and year of examination must be indicated on the top cover. THE NAME OF THE SUPERVISOR (ONLY INITIALS) MUST APPEAR ON THE BOTTOM RIGHT CORNER OF THE TOP COVER.
5. The report must be precise. All important aspects of the topic should be considered and reported. **The total number of pages, including tables, figures, and references should not exceed 30.** Chapters or subsections need not be started on new pages, while getting the report typed.
6. Typographical errors in the report must be corrected by the student. The student will be discredited for any omission in the report. All the symbols used in the text should be arranged in an alphabetical order and given separately after conclusions.

7. The list of references should be arranged in alphabetical order of the names of authors. In the text, the reference should be cited with author's name and year. (Author – date style) For example:

(i) The advanced applications of natural fiber hybrid composites have been reported in the published literature (Mochane et al., 2019).

OR

(ii) Mochane et al. (2019) have reported advanced applications of natural fiber hybrid composites. The title of the article should also be included. The references must be given in the following standard format.

(a) Format for listing references of articles from periodicals:
Mochane.M., Mokhena.T. Mokhothu.T., Recent progress on natural fiber hybrid composites for advanced applications: a Review", Polymer Letters, 13, 159-198 (2019), doi: 10.3144/expresspolymlett.2019.15.

(b) Format for listing references of Books:
B. T. Åström, Manufacturing of Polymer Composites, 1st Edition. London: Routledge, 2017.

(c) Format for listing Thesis:
D. Lithner, "Environmental and health hazards of chemicals in plastic polymers and products," Ph.D. (Tech.) Thesis, University of California, Berkeley, 2011.

(d) Format for listing references of Patents:
H. A. G. Ansell L. Reid, "Method of reducing circulation fluid loss using water absorbing polymer. US Patent (US 5,086,841)," 1992.

(e) Format for listing Handbooks, Tables, Symposia etc.:
Gorman, M. Japanese standards association publishes ASTM handbook for Japanese audience. Standardization News 29, 35 (2001).

(f) Format for listing Private Communications and other categories:
Sharma, M.M., Private Communication (1984).

8. Consistency of units should be maintained in the written report. SI systems should be used. [For SI system – Ref: Ind. Chem. Engr., 24, 32, 3 (1983)]. Units used in the literature (if not SI) should be correctly converted.

9. The time allotted for the oral presentation is 20 minutes: additional 10 minutes are provided for questions and answers.

10. INCOMPLETE AND CARELESSLY WRITTEN REPORT IS LIABLE TO BE REJECTED.

11. The last date for submission will NOT be extended on any grounds whatsoever.

12. There must not be any acknowledgment about the guidance by the faculty in the report.

13. The report will be evaluated based on (i) rational approach to the problem, ii) correctness and completeness of the written text and iii) performance in the oral presentation.

14. Word-to-word copying from the published article is not permitted. Flowery language is not to be used.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	2	3	2	2	2
CO2	2	3	3	2	2
CO3	2	3	-	2	2
CO4	2	3	2	2	2
CO5	2	3	2	2	2

SEMESTER – II

Course Code: GET 2124	Course Title: Design of Plastic Molds and dies	Credits = 3		
		L	T	P
Semester: II	Total contact hours: 45	2	1	0

Course Outcomes (students will be able to…..)	
1	Understand the basic factors to be considered in plastic mold design. K2
2	Understand and apply importance of mold design factors in mold design calculations. K3
3	Understand basic principles of extrusion die design K2
4	Design and draw injection, transfer and compression molds. K6
5	Understand various injection mold design simulation softwares K2
6	Understand various materials used for molds and extrusion dies construction. K2
7	Understand concept of 3 D printing K2
List of Prerequisite Courses	
1	Chemistry of polymers, Processing of plastics, Plastic product design
List of Courses where this course will be prerequisite	
1	Research Project I

Description of relevance of this course in the M.E(Plastic Engineering) Program

The formal exposure to various elements of mold design will help students to design and draw injection molds, compression molds and transfer molds for plastic materials. Most of the plastic industries use simulation software's which requires basic knowledge of mold design. The course is designed to formally introduce various concepts chemical etching, laser graining and 3D printing in stepwise manner to the students

	Course Contents (Topics and subtopics)	Reqd. Hrs
1	Introduction of Course Importance of design of molds and extrusion dies. General considerations in mold design	3
2	Injection mold design Factors considered in injection mold design, two plate and three plate cold runner mold, Design of injection mold parts such as locating ring, sprue bush, runners, gates, ejection system and cooling channels. Runner balancing in multi cavity injection molds.	9
3	Hot runner molds Construction, various parts, runners, gates used.	3
4	Compression mold design Factors to be considered while designing compression mold, Types of compression molds such as positive type, Flash molds and semi-positive mold. Design of two plate and three plate molds and spilt molds. Design of molds for articles with threads and inserts.	6
5	Transfer mold design Essential mould details for pot type transfer moulds such as loading chambers, land areas, ejection methods and bolsters. Factors affecting choice of mould design, proportions of moulds, undercuts, bulk factors, section thickness. Mould heating methods for compression and transfer moulds.	3
6	Extrusion die design Types of Extrusion dies, Various details of an extrusion die. Design of Extrusion dies for pipes, tubes, films, sheets and insulation covering.	6
7	Molds and dies construction materials Selection of materials for molds and dies, different types of materials with their specific properties used in mold and dies fabrication	3
8	Mold fabrication and polishing methods Machining methods such as CNC Milling, Electrical discharge machining, wire cutting etc. Techniques such as photo chemical etching, laser graining etc for producing regular mold patterns	3
9	Injection molding simulation softwares Introduction to softwares such as Moldflow, Moldex3D	6

10	Introduction to 3D Printing	3
List of Textbooks		
1	Injection Mould Design – by Pye R.G.W.	
2	Dies for Plastics Extrusion; – by Joshi M. V.	
3	Compression and Transfer Moulding of plastics – by Butler J	
List of Additional Reading Material / Reference Books		
1	Injection Moulding Theory & Practices – by Rubin	
2	Plastic Engineering Handbook by Frados	

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	3	2	2	-	2
CO2	3	1	-	2	2
CO3	3	-	2	-	2
CO4	3	-	2	-	3
CO5	3	2	2	2	3
CO6	3	-	2	-	2
CO7	2	2	3	2	1

Course Code: GET 2108	Course Title: Principles of Plastic Machinery Design	Credits = 3		
		L	T	P
Semester: II	Total contact hours: 45	2	1	0

	Course Outcomes (students will be able to….)	
1	Evaluate effect of various design parameters on plastic processing	K5
2	Analyze effect of various hydraulic devices in plastic processing machinery	K4
3	Understand basics of mixers in plastic processing, Understand effect of thermal heating and temperature control in plastic processing.	K2
4	Analyze effect of various design parameters for screw extruder.	K4
5	Understand classifications and applications of clamping system for injection molding.	K2

	List of Courses where this course will be prerequisite
	Research Project I &II

Description of relevance of this course in the M. E. (Plastic Engineering) Program

Study of this course will provide an insight about working principle and design aspect of Plastic machinery and applications of hydraulics in plastic machinery.

	Course Contents (Topics and subtopics)	Reqd. Hrs
1	Clamping Systems: Mechanical and hydraulic clamping systems. Single toggle and double toggle clamping units, clamping systems for large injection molding machines. Advantages and disadvantages of hydraulic and mechanical clamping systems.	6
2	Hydraulic Design: General principles of operations of hydraulic. Standard symbols used in hydraulic circuits. Features of hydraulic systems. Various types of hydraulic Pumps. Hydraulic valves such as directional control valve, pressure control valve, flow control valve, sequence valve, pilot operated check valve. Hydraulic circuits for injection molding machines such as deceleration circuit, prefill circuit. Auxiliary unit such as filters, cylinders, pressure intensifier, accumulator etc.	12
3	Single screw design, nomenclature, types of flow, effects of various parameters of screw on plastic processing, bridging, design variations of extruder screw based on polymer materials, barrels, screw drive, advantages of single screw	8
4	Twin screw design, co-rotating and counter rotating, intermeshing, comparison with single screw, advantages of twin screw extruder, mixer screw	7
5	Mixing devices, batch mixer, dry mixer, continuous mixer, two roll mill, calendaring unit	8
6	Electrical heating, types of heaters, temperature measurement and control	4

	List of Textbooks
1.	Injection moulding theory and practice- By Irvin I Rubin.
2.	Hydraulic Circuits and Control System by Fawcett J.R. by Vickers Sprrey.
3.	Injection Moulding by Rees
4.	Hydraulics by Vickers

	List of Additional Reading Material / Reference Books
1.	Understanding Compounding by Robert.H. Wildi and Christianmaier
2.	Injection Moulding Machines by A. Whelan
3.	Practical injection moulding of plastics By Mink

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	3	2	-	2	3
CO2	2	-	-	2	2
CO3	2	-	-	2	3
CO4	3	2	-	2	3
CO5	2	-	-	1	2

Course Code: GET 2117	Course Title: Plastic Waste Management	Credits = 3		
		L	T	P
Semester: II	Total contact hours: 45	2	1	0

Course Outcomes (students will be able to…..)		
1	Understand Plastic Waste Management Practices.	K2
2	Apply knowledge for plastic resource recovery and circular economy.	K3
3	Decide suitability of process for mechanical recycling of plastics.	K5
4	Select better option from recycling, incineration and landfilling	K4
5	Understand Plastic waste Management rules in India, Global rules and regulations	K2
List of Prerequisite Courses		
1	Processing of Plastics, Chemistry of Polymers and Plastic Materials.	
List of Courses where this course will be prerequisite		
1	Research Project I &II	

Description of relevance of this course in the M.E(Plastic Engineering) Program

The formal exposure to various methods of plastic waste management will help students to work towards plastic resource recovery and circular economy and to apply their knowledge to solve this global problem.

	Course Contents (Topics and subtopics)	Reqd. Hrs
1	Introduction – Sources of plastics waste – Separation technologies, viz. Sorting – Manual, automated, Density separation, Flotation, Solvent separation, Melt filtration, Separation of resin from fiber in waste FRP	9
2	Plastics waste management – 4 R & I approach viz. Source reduction, Reuse, Repair, Recycling, and Incineration with exaMTPLes. Plastics recycling – Classification – Code of practice –Primary, secondary, territory and quaternary recycling with exaMTPLes Co-extrusion and Co injection moulding – Waste plastics as fillers	9
3	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/feedstock recycling processes for recovery of oil, monomer and energy– thermolytic processes. Solvolysis – process outline for PMMA, PET, etc. Fluidized bed incinerator with energy recovery.	9
4	Recycling of plastics by surface refurbishing – Application of a coating, polishing with exaMTPLes– Plastics ageing – Environmental ageing – Thermal ageing – Chemical degradation – Wear and erosion. Biodegradable plastics – an overview. Environmental issues, policies and legislation in India, Review, Tutorial section. Plastics – Energy saving, Eco-friendly – Case studies. Life cycle analysis – a model.	9
5	Biodegradable plastics –an overview, Environmental issues, policies and legislations in India .Plastics-Energy Saving, Eco-friendly- Case studies . Life cycle analysis –a model.	6

List of Textbooks

1	Plastic Waste Management by Murali Srinivasan and Natamai Subramaniam

List of Additional Reading Material / Reference Books

1	Recycling and recovery of plastics, Hanser Publishers, New York, 1996-R. Johanner Brandrup
2	Plastics Waste Management, Disposal Recycling and reuse, Marcel Dekker, Inc.New York,1993-Nabil Mustafa
3	Plastics and the Environment, Wiley Inter Science, New York (2003) – Anthony L.Andrady (Ed)
4	Plastics Recycling, Products and Processes, Hanser Publishers, New York,1992 –R.J. Ehrig.
5	Technologies in Plastics Recycling, American Chemical Society, Washington, DC 1992.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	2	2	3	3	2
CO2	2	2	2	3	2
CO3	2	-	2	3	2
CO4	2	1	2	3	2
CO5	2	1	3	2	2

Course Code: GEP 2125	Course Title: CAD/CAM/CAE and Design of Mold Laboratory	Credits = 3		
		L	T	P
Semester: II	Total contact hours: 90	-	-	6

Course Outcomes (students will be able to….)		
1	Construct solid models of plastic and mechanical components and learn 3D modelling of machine and plastic components.	K3
2	Design various molds and dies using computer aided design and understand assembly of various types of plastic molds.	K6
3	Applying basics of computer aided manufacturing programme and analyze of injection of molds using soft wares.	K3
4	Analyze variation in pressure, temperature and time graph using computer aided programme.	K4
5	Analyze, design, and draw Injection molds for plastic products.	K4
6	Design and draw compression molds for plastic products.	K6
7	Applying basic principles of design of transfer molds.	K3
8	Design of extrusion dies.	K6
List of Prerequisite Courses		
1	Basics of AutoCAD 2D and 3D drafting, Reading of Engineering Drawing and Machine Drawings	
2	Design of Plastic Moulds and Dies	
List of Courses where this course will be prerequisite		
1	Research Project I and Research Project II	

Description of relevance of this course in the M. E. Plastic Engg. Program

The formal exposure to various elements of mold design will help students to design and draw injection molds, compression molds and transfer molds for plastic materials. Most of the plastic industries use simulation software's which requires basic knowledge of mold design. The course is designed to formally introduce various concepts chemical etching, laser graining and 3D printing in stepwise manner to the students

	Course Contents (Topics and subtopics)	Reqd. hrs
1	Basics of computer aided manufacturing programmes. Study of various computer aided engineering packages to analyze molds and dies for flow, cool, shrink, wrap stress etc., to optimize the design.	16
2	Design and drafting of various mold and die using computer aided design packages.	12
3	3-D modeling of machine parts ad machine components. Assembly of simple machine parts	12
4	3-D modelling and assembly of various types of plastic molds and dies.	8
5	Injection and compression mold analysis.	6
6	Designing of Injection Mold.	6
7	Compression Mold design	6
8	Transfer Mold design.	6
9	Extrusion dies	6
10	Study of pressure, time, and temperature graphs. Selection of polymer materials.	6
11	Interpretation of various plots for thermoplastic, thermoset, and gas injection molding processes. Cost saving analysis.	6

List of Textbooks	
1	Manual of Solid works, Mold X and Unigraphics software
2	Injection molding theory and practice- By Irvin I Rubin
List of Additional Reading Material / Reference Books	
1	Plastic Technology Handbook – By Manas Chanda and S.K. Roy.

CO-PO Mapping					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PSO**
CO1	3	-	-	3	3
CO2	3	3	-	2	2
CO3	2	-	-	2	2
CO4	2	3	-	2	3
CO5	2	3	-	2	3
CO6	2	3	-	2	3
CO7	2	2	-	2	2
CO8	3	-	-	2	2

Course Code: GET XXX	**Course Title: Elective – III (Department Elective)**	**Credits = 3**		
		L	**T**	**P**
Semester: II	**Total contact hours: 45**	**2**	**1**	**0**
Candidate will have to choose one of the elective subjects offered for that semester from the elective subjects. A consolidated list of all the elective subjects is given at the end.				

Course Code: GET XXX	**Course Title: Elective – IV (Institute/Open Elective)**	**Credits = 3**		
		L	**T**	**P**
Semester: II	**Total contact hours: 45**	**2**	**1**	**0**
Candidate will have to choose one of the elective subjects offered for that semester from the elective subjects. A consolidated list of all the elective subjects is given at the end.				

Course Code: GEP 2126	**Course Title: Research Project – II**	**Credits = 6**		
		L	**T**	**P**
Semester: II	**Total contact hours: 90**	**-**	**-**	**12**

Course Outcomes (students will be able to….)		
1	Student would be able to collect literature related to an assigned area	K1
2	Student would be able to understand the lacunae in the literature	K2
3	Student would be able to analyze the literature and present suitable guidelines	K4
4	Student would be able to write a neat report following the guidelines	K2, K4
5	Student would be able to propose a defined plan for the research	K6

Description of relevance of this course in the M.E. (Plastic Engineering) Program

This would be concerned with the continuation of the research project-I executed in the first semester and the exact work plan will be decided in consultation with the research guide. The candidate will be continuing his/her project work and will complete the procurement of the materials/chemicals for the project work. At the end of the project, the candidate is expected to submit a report as per similar guidelines provided for GEP 2123 above which will be evaluated by the research guide and an external examiner from the Department/Industry based on the presentation made by the candidate. A suitable combination of the marks for report and presentation will be considered for the final evaluation.

SEMESTER – III and IV

Course Code: GEP 2127	Course Title: Research Project – III	Credits = 6		
		L	T	P
Semester: III	Total contact hours: 360	-	-	24

Course Outcomes (students will be able to….)		
1	An ability to write and present a substantial technical report/document.	K3
2	An ability to apply knowledge of plastic engineering for the development of new materials/ability to solve practical problems.	K6
3	An ability to implement application of modern tools, software's to analyze and develop plastic products.	K4

Description of relevance of this course in the M. E. Plastic Engg. Program

This would be concerned with the continuation of the research project executed in the first semester and the exact work plan will be decided in consultation with the research guide. At the end of the project, the candidate is expected to submit a report as per similar guidelines provided for GEP 2123 above which will be evaluated by the research guide and an external examiner from the Department/Industry based on the presentation made by the candidate. A suitable combination of the marks for report and presentation will be considered for the final evaluation.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	3	3	-	2	3
CO2	3	3	2	2	2
CO3	3	2	2	2	3

Course Code: GEP 2128	Course Title: Research Project – IV	Credits = 6		
		L	T	P
Semester: IV	Total contact hours: 360	-	-	24

Course Outcomes (students will be able to….)		
1	An ability to write and present a substantial technical report/document.	K3
2	An ability to apply knowledge of plastic engineering for the development of new materials/ability to solve practical problems.	K6
3	An ability to implement application of modern tools, software's to analyze and develop plastic products.	K4

Description of relevance of this course in the M. E. Plastic Engg. Program

This would be concerned with the continuation of the research project executed in the first semester and the exact work plan will be decided in consultation with the research guide. At the end of the project, the candidate is expected to submit a report as per similar guidelines provided for GEP 2123 above which will be evaluated by the research guide and an external examiner from the Department/Industry based on the presentation made by the candidate. A suitable combination of the marks for report and presentation will be considered for the final evaluation.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	3	3	-	2	3
CO2	3	3	2	2	2
CO3	3	2	2	2	3

SEMESTER – Electives

Course Code: GET 2118		Course Title: Mould Manufacturing Technologies	Credits = 3		
			L	T	P
Semester: I	Elective – I	Total contact hours: 45	2	1	0

Course Outcomes (students will be able to…..)		
1	Select suitable material for moulds used in plastic industry	K4
2	Apply knowledge for improving surface finish of moulds .	K3
3	Decide suitability of Machining methods for a particular mould.	K5
4	Apply knowledge for cost estimation of moulds.	K3
5	Understand repair and maintenance of moulds	K2

List of Prerequisite Courses		
1	Production Processes, Metallurgy	

List of Courses where this course will be prerequisite		
1	Design of Moulds, Research Project I & II	

Description of relevance of this course in the M.E(Plastic Engineering) Program

This course will provide insight to the students regarding mold materials, their surface treatment, fabrication of molds and cost estimation. This will help students in mold designing and their relevant Project work.

	Course Contents (Topics and subtopics)	Reqd. Hrs
1	**Materials:** Selection of steels– Properties of steels– common steels used for moulds **Mould** –strength of materials, calculation of wall thickness for cavity– Insert size–Life of mould. Non-ferrous metals for mould construction: Application–Zinc base alloys Aluminium alloys –Beryllium copper Non-metallic materials for mould construction: Advantages and its applications –epoxies-polyester– silicon	12
2	**Surface treatment of mould materials: Introduction**–Heat treatment process– casehardening, nitriding, through hardening –tips on successful heat treatment–vacuum hardening–cryogenic heat treatment Hard chrome-plating–Nickel plating–chemical etching–Mould Polishing techniques.	12
3	**Mould making techniques: Pantograph** engraving–Hydro copying–Jig boring–CNC machines–CNC Lathe CNC Milling–CNC EDM–Advantages and its Applications– Assembly of moulds– Rapid prototyping	12
4	**Mould estimation, repair and protection: Procedure** for estimating mould cost – General outline – Cost calculation – Basic moulds–Cavity–Basic functional components Special functions etc. Introduction Mould Repair and maintenance–scheduling mould maintenance– advantages – storage –Corrosion protection – wear and lubrication – special consideration	9

List of Textbooks	
1	Injection Mould Design by RGW Pye
2	Workshop Technology by Hajra and Chaudhary
3	Irwin Rubin, Injection Moulded Theory and Practice, Wisely Interscience Publication,

List of Additional Reading Material / Reference Books	
1	Cyril Donaldson George H. Lecain V C Goold, Tool Design, TATA McGraw-Hill, 1998
2	Richard R. Kibbe John E. Neele, Roland O Meyer, Warran T. White, Machine Tool Practices, Prentice Hall of India Pvt. Ltd., 1999.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	3	2	2	1	2
CO2	3	1	2	1	2
CO3	3	-	2	-	2
CO4	3	-	2	-	2
CO5	3	-	1	-	1

Course Code: GET 2129		Course Title: Processing and Mechanics of Composites	Credits = 3		
			L	T	P
Semester: I	Elective – I	Total contact hours: 45	2	1	0

Course Outcomes (students will be able to….)		
1	Analyze polymer composites and factors affecting its performance	K4
2	Analyze mechanical properties of polymer composites	K4
3	Analyze deformation behaviour of single ply or lamina	K4
4	Understand processing and fracture modes of polymer composites	K2

List of Courses where this course will be prerequisite	
	Plastic Product Design and Testing, Research Project I &II

Description of relevance of this course in the M. E. (Plastic Engineering) Program

Study of this course will provide an insight about understanding polymer composites and various factors affecting its performance.

	Course Contents (Topics and subtopics)	Reqd. Hrs
1	Polymer composites, Study of various types of matrix materials, thermoplastic and thermosetting. Study of various reinforcements – long, shot fibers, particulate fillers, flakes. Factors affecting performance of particulate filler composites Important processing parameters in the design of fibre reinforced plastics.	12
2	Mechanical properties of polymer composites, density, analysis of continuous fiber, modulus of elasticity in longitudinal and transvers direction, analysis of short fibers, critical length of fiber, stress strain behaviour of matrix and fiber, minimum volume fraction, critical volume fraction.	15
3	Deformation behaviour of single ply or lamina, compliance matrix, analysis of unidirectional composites, stiffness of symmetric laminates. Engineering constant for orthotropic materials, stress strain relations for anisotropic materials	13
4	Review of various processing techniques such as hand lay-up, spray lay-up, pultrusion, filament winding etc. –merits and demerits. Fracture modes of composites, single and multiple fractures, debonding, fiber pull-out and delamination fracture.	5

List of Textbooks	
1.	Polymer Engineering Composites by Richardson
2.	Handbook of Reinforced Plastics by Oleesky and Mohr
3.	Plastic Engineering by R.J.Crawford
4.	Plastic Technology Handbook – By Manas chanda and S.K.Roy
5.	Overview of composite materials by B.W.Rosen and N.F.Dow

List of Additional Reading Material / Reference Books	
1.	Plastic additives handbook by Hans Zweifel
2.	Composites material by Krishan K Chawla
3.	Outline of polymer technology by R. Sinha
4.	Plastic materials and processing by A. Brent Strong

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	3	2	-	3	2
CO2	2	2	-	2	2
CO3	3	2	-	2	2
CO4	3	2	-	2	2

Course Code: GET 2130		Course Title: Modeling and simulation of polymer rheology	Credits = 3		
			L	T	P
Semester: I	Elective – I	Total contact hours: 45	2	1	0

Course Outcomes (students will be able to…..)		
1	Understand the basics of polymer rheology	K2
2	Apply knowledge for analyzing polymer flows	K3
3	Development of models of polymer flow suitable for plastic processing	K4, K5
4	Capture the processing technique and compare different models	K4
5	Modeling of melt flow behavior and development of related machinery	K5

List of Prerequisite Courses	
1	Processing of Plastics, Chemistry of Polymers and Plastic Materials.

List of Courses where this course will be prerequisite	
1	Research Project I &II

Description of relevance of this course in the M.E(Plastic Engineering) Program

The hands-on experience of development of rheological models of polymer melt flow would help students understand polymer processing in a great way and the students would be able to design processing machineries, molds and dies in precise manner.

	Course Contents (Topics and subtopics)	Reqd. Hrs
1	Basics of fluid continuum concept, Viscosity and visco-elasticity, Different rheological models for viscous flows, rheological models for viscoelastic liquids, Multiphase system of Polymers	9
2	Measurement of rheological properties-Concept of rheometry, Classification of rheometric methods, capillary rheometers, Cone-plate rheometers, Extension rheometers	9
3	Mathematical approach of polymer processing, Extrusion, Injection Molding, Blow molding, Thermoforming, Compression molding, Process modeling-Pressure flows, drag flows and pressure-drag flow between parallel surfaces, Numerical methods for resolving the differential equations	9
4	Modeling of Screw Extrusion-Solid conveying, melt conveying, characteristics of extrusion operations, Modeling of Extrusion dies-general method of modeling, Circular die, Annular die, Profile die	9
5	Modeling of injection molding process, Filling, packing, warpage analysis, gate location and runner modeling, injection Screw modifications based on related melt flow.	6

List of Textbooks	
1	Rheology in polymer processing-Modeling and simulation by Krzystof Wilczynski Hancer publishers Munich(2022)

List of Additional Reading Material / Reference Books	
1	Polymer rheology-Fundamentals and applications by Tim Osswald and Natelie Rudolph, Hancer publishers
2	Introduction to polymer rheology by Montgomery T. Shaw Wiley Publishers (2011)

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	3	2	2	2	3
CO2	2	1	-	1	2
CO3	2	1	-	1	2
CO4	3	-	-	1	3
CO5	3	2	-	2	2

Course Code: GET 2113		Course Title: Finite Element Analysis	Credits = 3		
			L	T	P
Semester: I	Elective – II	Total contact hours: 45	2	1	0

Course Outcomes (students will be able to…..)		
1	Understand the concepts behind formulation methods in FEM.	K2
2	Develop element characteristic equation and generation of global equation.	K6
3	Relate the application and characteristics of FEA elements such as bars, beams, plane and iso-parametric elements.	K3
4	apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow, axi symmetric and dynamic problems and solve them displacements, stress and strains induced	K3

List of Prerequisite Courses	
1	Structural Mechanics, Heat Transfer, Mathematics

List of Courses where this course will be prerequisite	
1	Research Project I & II and Final Project.

Description of relevance of this course in the M.E(Plastic Engineering) Program

This course will provide insight to the students in solving any engineering problem using finite element methods and help them in understanding ANSYS software and meshing of CAD models for plastics simulation softwares.

	Course Contents (Topics and subtopics)	Reqd. Hrs
1	Introduction: Basic concepts, general applicability of the method, general description of FEM, one dimensional problems with linear & cubic interpolation model, derivation of finite element equations using direct approach. Discretization of domain: introduction, basic element shapes, discretization process, node numbering scheme, automatic mesh generation. Different elements used in one,two and three dimensional analysis.	9
2	Interpolation Models: Introduction, polynomial form of interpolation functions, simplex, interpolation polynomial in terms of nodal degree of freedom, selection of order of interpolation polynomial, linear interpolation polynomial in terms of global coordinates, linear interpolation polynomial in terms of local coordinates, integration of functions of natural coordinates	12
3	Higher order and Iso-parametric elements: Introduction, higher order one dimensional elements, higher order elements in terms of natural coordinates, Iso-parametric elements. Derivation of element matrices and vectors by using direct and weighted residual approach, assembly of element matrices and vector and derivation of system equations, Numerical solution of finite element equations by using Gaussian elimination method.	12
4	Applications in heat transfer: Finite element solution of one-dimensional, two-dimensional and three-dimensional steady state heat conduction problems by using Galerkin approach. Applications in fluid mechanics, Applications in structural Mechanics problems	12

List of Textbooks

1. Logan, D. L., A first course in the finite element method,6th Edition, Cengage Learning, 2016.
2. Rao, S. S., Finite element method in engineering, 5th Edition, Pergamon Int. Library of Science, 2010.
3. Chandrupatla T. R., Finite Elements in engineering, 2nd Edition, PHI, 2013.

List of Additional Reading Material / Reference Books

1. J.N.Reddy, “Finite Element Method”- McGraw -Hill International Edition.Bathe K. J. Finite Elements Procedures, PHI.
2. Cook R. D., et al. “Conceptsand Application of Finite Elements Analysis”- 4th Edition, Wiley & Sons, 2003.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	3	2	2	2	2

CO2	2	-	-	-	2
CO3	2	-	-	-	2
CO4	2	-	-	-	2

Course Code: GET 2131		Course Title: Six Sigma and Statistics for industrial process improvement	Credits = 3		
			L	T	P
Semester: I	Elective – II	Total contact hours: 45	2	1	0

Course Outcomes (students will be able to…..)		
1	Understand the basics of statistics	K2
2	Apply knowledge of statistics for plastic industry process improvement	K3
3	Study and model the production processes using statistical concepts	K4, K5
4	Understanding the role of six sigma for continuous improvement in industrial processes	K4
List of Prerequisite Courses		
1		
List of Courses where this course will be prerequisite		
1	Research Project I &II	

Description of relevance of this course in the M.E. (Plastic Engineering) Program

Understanding and hands on experience of different statistical techniques and six sigma concepts would help students to solve industrial problems and process improvement in plastic industry.

	Course Contents (Topics and subtopics)	Reqd. Hrs
1	Introduction to six sigma-What is six sigma, its history and applications, Lean concepts, Basic concepts of six sigma	9
2	Projects and processes-Concept of process and quality, selection of right projects, six sigma team management,	9
3	DMAIC and DMADV approaches-DMAIC-Define, measure and analyse	6
4	Beginner statistics-Intermediate graphic control, normal distributions, correlations, and regression	6
5	Intermediate statistics-non normal probability distributions, hypothesis testing, sample size advanced control charts	6
6	Applications of six sigma concept to different industries-Six sigma in plastic industry and engineering, Six sigma in human resource, Six sigma in healthcare, six sigma in finance and IT	9

List of Textbooks	
1	Six sigma-complete step by step guide by Council for Six sigma Certifications U.S.
List of Additional Reading Material / Reference Books	
1	Six Sigma Demystified- by Paul Keller, McGraw Hill Publishers
2	Statistics for Six sigma made easy by Warren Brussee, McGraw Hill Publishers

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	2	-	2	-	2
CO2	3	2	3	2	2
CO3	3	2	3	2	2
CO4	2	1	3	3	2

Course Code: GET 2132		Course Title: Advanced Processing Technologies	Credits = 3		
			L	T	P
Semester: II	Elective – III	Total contact hours: 45	2	1	0

Course Outcomes (students will be able to…..)		
1	Decide suitability of advanced injection molding processes for special applications.	K5
2	Apply knowledge for Multilayer molding process	K3
3	Decide suitability of Blow molding process for a particular application	K5
4	Understand various blow molding processes	K2
List of Prerequisite Courses		
1	Processing of Plastics	
List of Courses where this course will be prerequisite		
1	Research Project III & IV	

Description of relevance of this course in the M.E. (Plastic Engineering) Program

This course will provide insight to the students regarding advancement in widely used industrial processes such as Injection molding and blow molding.

	Course Contents (Topics and subtopics)	Reqd. Hrs
1	Advanced injection moulding techniques Microprocessor controlled Injection moulding – Multi colour Injection moulding, Sandwich moulding –Gas assisted injection moulding – RIM (Reaction injection moulding) Basic processes and procedures –Moulding aspects – shrinkage and summary – Quality control in Injection moulding, statistical process control techniques. 2K Injection moulding.	12
2	Multi-layer Moulding, Counter flow moulding, Liquid Injection Moulding processes. Structural foam moulding – Low pressure and high pressure processes – Merits & demerits.	12
3	Introduction – Classification of advanced Blow moulding processes – Deep draw Double Wall Blow Moulding Technology – Split moulds – Versatility – Applications. Press Blow Moulding Technology Process – Applications, Three dimensional Blow Moulding Process – Applications	12
4	Advanced Blow Moulding Stretch blow moulding – Injection stretch blow moulding – Extrusion stretch blow moulding Process – Merits & demerits – Applications. Multi–layer Blow Moulding – Process -Applications	9

List of Textbooks	
1	Injection molding theory and practice- By Irvin I Rubin
2	Blow Molding Handbook by Dominick .V.Rosato
3	Irwin Rubin, Injection Molded Theory and Practice, Wisely Inter science Publication,
List of Additional Reading Material / Reference Books	
1	Plastic Blow Molding Handbook by Norman Lee
2	Stretch Blow Molding by Ottmar Brandau

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	3	2	-	2	2
CO2	3	1	-	1	2
CO3	2	-	-	1	1
CO4	2	-	-	1	1

Course Code: GET 2133		Course Title: Advanced Polymer based Materials in Engineering applications	Credits = 3		
			L	T	P
Semester: II	Elective – III	Total contact hours: 45	2	1	0

Course Outcomes (students will be able to…..)		
1	Design and analysis of fiber reinforced polymer composites.	K6
2	Applications of performance enhancing and special purpose construction chemicals, polymer modified cement mortars for repairs	K3
3	Applications of different types of polymers in manufacturing of pipes for water supply/ wastewater, effluent transport, drainage system.	K3
4	Applications of polymers in electrical applications	K3
5	Applications of polymer composites in automobile and medical applications	K3
List of Prerequisite Courses		
1	Processing of Plastics	
List of Courses where this course will be prerequisite		
1	Research Project III & IV	

Description of relevance of this course in the M.E(Plastic Engineering) Program

This course will provide insight to the students regarding advancement in widely used industrial processes such as Injection molding and blow molding.

	Course Contents (Topics and subtopics)	Reqd. Hrs
1	Classification of polymer composites, factors affecting the performance of fiber reinforced polymer composites, particulate fillers, stress strain graph for fiber and matrix, minimum and critical volume fraction, fiber matrix interface, effect of coupling agents, natural fiber composites, nano composites, and its applications	12
2	Polymers /polymer blends used in automotive applications. Desired polymer properties for automotive applications for various automobile parts. Special Plastics for electrical vehicles. Glass and carbon fibre polymer composites for improving performance of vehicles.	6
3	Medical applications of plastics: Cardiovascular implants, Dental Implants, Role of plastics in ophthalmology, Hydro gels, Drug Delivery systems, Sutures, Burn Dressings and Artificial skin, Hernia Mesh, Adhesives and Sealants, Artificial organs and devices, Blood bags etc. Medical grade plastics	6
4	Materials used for internal and external coatings, anti-corrosive coatings, special purpose floorings, water proofing compounds, various polymers and epoxies used for industrial applications, Composite materials –various types of fibers, fabrics used in polymer composites, glass and carbon fiber polymer composites, uses in various industrial applications in repairs of structures.	6
5	Concrete- different types of performance enhancing and special purpose construction chemicals. Plasticizers and super plasticizers, air entraining agents, accelerators and retarders, viscosity modifying agents, corrosion inhibitors, polymer modified cement mortars for repairs. Different types of polymers in manufacturing of pipes for water supply/ waste water, effluent transport, drainage system	6
6	Plastics and their desired properties for electrical applications. Cable insulating materials, insulators for transmission lines. Improvement of dielectric strength of capacitors	9

List of Textbooks	
1	Injection molding theory and practice- By Irvin I Rubin
2	Blow Molding Handbook by Dominick .V.Rosato
3	Irwin Rubin, Injection Molded Theory and Practice, Wisely Inter science Publication,
List of Additional Reading Material / Reference Books	
1	Plastic Blow Molding Handbook by Norman Lee
2	Stretch Blow Molding by Ottmar Brandau

CO-PO Mapping					
CO\PO	**PO1**	**PO2**	**PO3**	**PO4**	**PSO**
CO1	2	3	-	2	2
CO2	1	2	-	2	2
CO3	1	2	-	2	2
CO4	2	2	2	2	2
CO5	3	2	3	2	3

Course Code: GET 2134		Course Title: Total Quality Management	Credits = 3		
			L	T	P
Semester: II	Elective – IV	Total contact hours: 45	2	1	0

Course Outcomes (students will be able to….)		
1	To learn the basic concepts of quality from organizational point of view.	K1
2	To understand the TQM principles and various tools available to achieve TQM	K2, K4
3	To create awareness about the ISO and QS certification process and its needs for the industries.	K6
4	To get the awareness about the national and international quality awards.	K5
5	To learn concept of TQM from Japanese approach.	K3
List of Prerequisite Courses		
1	Basic project management knowledge, Basic computer and software maneuvering knowledge, Production process, Manufacturing technology.	
List of Courses where this course will be prerequisite		
1	Product manufacturing process.	

Description of relevance of this course in the M. E. Plastic Engg. Program

The exposure of the subject Total Quality Management has an important and beneficial effect on developing a learner in overall organizational development. By implementing this subject, the students will focus on quality management and continuous improvement, which is needed in processing industries and can establish and uphold cultural values that create long-term success to both customers and the organization itself.

	Course Contents (Topics and subtopics)	Reqd. hrs
1	Introduction, historical perspective, evolution of quality, basic concepts of quality, Mission/vision/objectives	1
2	Definition of quality, dimensions of product and service quality	2
3	Basic concepts of TQM and TQM frameworks	3
4	TQM Principles: Customer focus; Customer satisfaction- Customer perception of quality; customer complaints; service quality; customer retention	8
5	TQM Principles: Employee Involvement- Motivation, Empowerment, Teams building, recognition and rewards, performance appraisal, benefits.	7
6	TQM Principles: Continuous process involvement- Juran triology, PDSA cycle, 5S Kaizen	8
7	TQM Principles: Supplier Partnership- Partnering, source, supplier selection, supper rating, relationship development.	5
8	TQM Principles: Performance measures- Basic concepts, strategy, performance measures	5
9	ISO standards and Quality systems: What are ISO standards, Need for an ISO standards, ISO-9000, ISO-9001-2008.	5
10	Quality systems and audits: Elements of quality systems, document preparation and management, quality auditing using QS-9000, Concepts of ISO 14000	3
11	Requirements of quality systems and its benefits- TQM and implementation in manufacturing and service sectors.	3

List of Textbooks	
1	Dale H.Besterfield et al, Total Quality Management, Third edition, Pearson Education (First Indian Reprints 2004)
2	Shridhara Bhat K, Total Quality Management – Text and Cases, Himalaya Publishing House, First Edition 2002.
3	Total Quality Management by N.V.R Naidu, G. Rajendra New Age international, First Edition, Jan 2006
4	Total Quality Management by R.S Naagarazan, New Age international,3e, 2015
List of Additional Reading Material / Reference Books	
1	James R. Evans and William M. Lindsay, "The Management and Control of Quality", 8th Edition, First Indian Edition, Cengage Learning, 2012.
2	Total Quality Management by N.V.R Naidu, G. Rajendra New Age international, First Edition, Jan 2006

3	Janakiraman. B and Gopal .R.K., "Total Quality Management – Text and Cases", Prentice Hall (India) Pvt. Ltd., 2006.
4	Suganthi. L and Anand Samuel, "Total Quality Management", Prentice Hall (India) Pvt. Ltd., 2006.
5	ISO9001-2015 standards
6	Total Quality Management by V.S Bagad Technical Publications, First Edition, Jan 2008
7	Total Quality Management by S. Rajaram Dreamtech Press, First Edition, Jan 2008

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	2	-	3	1	2
CO2	2	2	3	-	2
CO3	1	-	3	-	2
CO4	-	-	3	-	3
CO5	-	-	3	-	1

Course Code: GET 2135		Course Title: Project Management Methodology and Planning	Credits = 3		
			L	T	P
Semester: II	Elective – IV	Total contact hours: 45	2	1	0

Course Outcomes (students will be able to….)		
1	To develop a critical understanding of project management to enable students to recognize the importance of discipline in a variety of organizational and functioning contexts.	K2
2	Students will learn critical understanding of the concepts employed in project management at strategic, system and operational level.	K3, K4
3	Students will able to develop knowledge and skills required for implementation in an organization.	K5, K6
List of Prerequisite Courses		
1	Research Methodology	
List of Courses where this course will be prerequisite		
1	Project Planning, Project scheduling.	

Description of relevance of this course in the M. E. Plastic Engg. Program

The exposure of the subject Project Management Methodology and Planning is beneficial in developing a learner in overall organizational development. By implementing this subject, the students will focus on learning the methods used in project planning and in managing any projects for successful project management in an organization.

	Course Contents (Topics and subtopics)	Reqd. hrs
1	Basics of Project management (PM): Definition of a project, What is PM, various stages in PM, importance of PM, role of a PM manager, PM certifications	6
2	Project Management Methodologies: Traditional and sequential methodologies, agile family management, change management methodologies, process-based methodologies, other methodologies, PMBOK method.	12
3	Project Lifecycle (PLC): What is PLC, initiation phase of a PLC, planning phase (CPM, PDM, PERT, GERT, Q-GERT, SLAM, DPM, resource loading), execution phase, controlling phase (Controlled analysis, project crashing, critical chain, project termination), monitoring phase (monitoring analysis, risk management, quality assurance, conflict management), closure of a project	20
4	Project Organization: organizational structure, PDTs and distributed PDTs, design structural matrix	6
5	Project learnings: System dynamics, project reviews, project audits, project closure	6

List of Textbooks	
1	Fundamentals of Project Management, Third Edition by James P. Lewis
2	Project Management Methodology, A Practical Guide for the Next Millenium by Ralph L. Kliem, Irwin S. Ludin, Ken L. Robertson
3	A Guide to the Project Management Body of Knowledge (PMBOK® Guide)–Sixth Edition 6th Edition, PMI
4	Moder, Joseph J. and Cecil R. Phillips, Project Management with CPM and PERT, Van Nostrand-Reinhold Company, New York, 1970 (2nd. ed.)
List of Additional Reading Material / Reference Books	
1	Project Management: A Systems Approach to Planning, Scheduling, and Controlling 11th Edition, Author: Harold Kerzner, Publisher: Wiley
2	Wiest, J. D. and F. K. Levy, A Management Guide to PERT/ CPM, Prentice Hall, Inc., New York, 1969.

CO-PO Mapping

CO\PO	PO1	PO2	PO3	PO4	PSO
CO1	2	2	2	1	2
CO2	2	2	-	2	2
CO3	2	2	3	1	2

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