INSTITUTE OF CHEMICAL TECHNOLOGY
Ordinances, Regulations and Syllabi relating to the
Degree of Master of Plastic Engineering (M.E. Plastic Engineering)

1. Introduction

The Institute is revamping its academic structure especially for the masters courses by way of introducing the compulsory industrial training for a period of six months (to be taken in the third semester of the program). The number of credits in the first two semesters has also been increased and a research component has been included. The total credits in the first two semesters now stand at 27 each instead of earlier 21. All the courses will continue to be credit based and the evaluation will be grade based.

The Departmental administrative committee and academic program committee periodically proposed the program outcomes having consistency with the graduate attributes available with NBA. The committee critically analysed information obtained from graduated students, employers and immediately passed out students. The program outcomes are as follows:

SR NO	**PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)**
1	To provide an interdisciplinary specialization in masters degree with an emphasis on materials, polymer processing, product design and mold design.
2	To produce employable graduates with knowledge and competence in scientific and engineering aspects of polymers, complemented by the appropriate skills and attributes.
3	To impart the fundamental concepts of synthetic resins, composites, engineering plastics, speciality plastics and their applications in industries.
4	To gain knowledge on computer-aided design and drafting and analysis softwares in engineering applications.
SR.NO.	**PROGRAMME OUTCOMES (POs)**
1	An ability to independently carry out research or investigation and development work to solve practical problems (K5)
2	An ability to write and present a substantial technical report or document (K6)
3	An ability to demonstrate a degree of mastery over the area of plastic engineering and technology (K5)
4	An ability to use modern tools, software, equipment etc. to analyze and obtain solution to the problems (K5)
5	An ability to systematically break up complex problems in realizable steps related to mould design, processing of plastic, plastic product design and solve them.(K4)

SR. NO.	PROGRAM SPECIFIC OUTCOMES (PSOs)
1	An ability to study the impact of Plastic process industry on the global, economic, and societal context
2	Graduates will be acquainted with the latest development in different fields related to Plastic Engineering so as to enable them to take up higher studies, research & developmental work.
3	Graduates will be introduced to various softwares pertaining to plastic mold design and analysis so as to enable them to take up further studies in Design engineering

Credit system is a systematic way of describing an educational programme by attaching credits to its components. The definition of credits may be based on different parameters, such as student workload, learning outcomes and contact hours. It is a student-centric system based on the **student workload** required to achieve

the objectives of a programme. It should facilitate academic recognition of the courses and mobility of the students. Credits assignment is based on the principle that Credits can only be obtained after successful completion of the work required and appropriate assessment of the learning outcomes achieved. As per the AICTE norms 2L/week of lectures are 2 credits, while 2h/week of practical/ /seminar/literature review/research work are 1 credit. This has been taken as the basis during the working of the proposed syllabus.

Student workload consists of the time required to complete all prescribed learning activities such as attendance at lectures/practical, seminars, projects, etc. Credits are allocated to all the educational components of a study programme and indicate the quantity of work each component requires to achieve its specific objectives.

Evaluation is an important component of any teaching-learning process. The Institute gives emphasis on continuous evaluation with considerable freedom to the teacher in deciding the mode of evaluation of the students. The performance of the student is documented by a **grade** at the end of the semester. The grading scale ranks the students on a statistical basis. Therefore, statistical data on student performance is a prerequisite for applying the grading system.

2. Course Credits

In general a certain quantum of work measured in terms of **credits** is laid down as the requirement for a particular degree. The student acquires credits by passing courses every semester, the amount of credit associated with a course being dependent upon the number of hours of instruction per week in that course.

There are mainly two types of courses in the Institute - lecture courses and laboratory courses. Lecture courses consist of lecture (L) and tutorial (T) hours. Laboratory courses consist of practical (P) hours. The credit (C) for a course is dependent on the number of hours of instruction per week in that course, as given below:

(1) 1h/week of lecture (L) or tutorial (T) = 1 credit
(2) 2h/week of Practicals (P) = 1 credit
(3) Credit (C) for a theory course = No. of hours of lectures per week

(4) Credits (C) for a Laboratory course/Seminar/research work =
½ x No. of hours per week

Credits will be assigned to In-plant, Seminar, Projects and other mandatory course requirements also and these will be mentioned in the respective syllabi. There may be some non-credit requirements. A student is required to earn credits as mentioned in the syllabus.

3. Evaluation

3.1 The weightages of different modes of assessments shall be as under.

	In-Semester evaluation		End-Semester-Exam	Components of continuous mode
	Continuous mode	Mid Semester-Exam		
Theory	20%	30%	50%	Quizzes, class tests (open or closed book), home assignments, group assignments, *viva-voce* assignments, discussions
Practical	50%	-	50%	Attendance, *viva -voce*, journal, assignments, project, experiments, tests
Seminar/ Research work			100%	Continuous evaluation not applicable, End semester evaluation will be based on written report evaluation and presentation in front of the external examiner within the Department

3.2. In-Semester Evaluation:

(a) It is expected that the teacher would conduct at least two assessments (in any form as quizzes, tests, home work, group work etc) under the continuous mode in a Semester.
(b) The teacher will announce at the beginning of the respective course the method of conducting the tests under the continuous mode and the assignment of marks
(c) In-semester performance of all students should be displayed and sent to the academic office by the teacher at least 15 days before the end-semester examination.
(d) For the theory courses, there will be one mid-semester test for each course to be held as per the schedule fixed in the Academic Calendar.

(e) For mid –semester examinations in theory papers, duration of examination will be 1 hour for 3 credit courses and 2 hours for 4 credit courses

3.3. End-Semester examination:

a) The semester end examination will cover the full syllabus of the course and will be conducted as per the Institutional time table at the end of each semester.

b) For end –semester examinations in theory papers, duration of examination will be 1 hour for 3 credit courses and 2 hours for 4 credit courses

c) For the end semester evaluation of seminar/research work, student will be expected to submit a written report and also make a presentation. The evaluation will be based on the quality of the written report and presentation.

3.4 Passes and Fail

(a) The candidates who obtain 40% and more marks of the total marks of a course head shall be deemed to have **passed** the respective course head.

(b) The candidates who obtain marks less than 40% of the total marks of a course head shall be deemed to have **failed** in the respective course head **(Grade FF).**

3.5 Grades:

(a) The performance of a student shall be documented by a **Letter grade.** Each letter grade has a **Grade point** associated with it. The Grades and Grade points shall be assigned to each head of passing and both will be indicated in the mark-list of the semester examination.

(c) The total marks (in-semester + end-semester) of a candidate in a subject head are converted into a letter grade, based on the relative (and some times the absolute) performance of the student.

Letter Grade	Grade Point
AA	10
AB	9
BB	8
BC	7
CC	6.5
CD	6
DD	5.5
EE	5

(d) For granting class, a grade point of 6.0 and above will be considered equivalent to First class.

(c) The grades to be allotted in the case of students who fail or do not appear at the end-semester examination shall be as under.

Letter Grade	Grade Point	Explanation
FF	0	The candidate fails in course head. The candidate will be allowed to take end-semester repeat or subsequent examinations as per rule.
XX		The candidate has not kept term for the course head due to attendance less than requisite. Further see 3.5(g) below. In the above cases, the candidate has to repeat the respective course by paying the fees.
I	0	The candidate has kept term for the course head, has taken all the internal examinations with satisfactory performance, but has failed to take the end-semester examination or repeat examination due to genuine reasons. The candidate will be allowed to take end-semester repeat or subsequent examinations as per rule.
FR	0	The candidate has exhausted all the permissible chances to clear the end-semester examinations. The candidate has to register for the respective semester again for all the subject heads or will be out of the respective degree course as per the rules.
DR	0	(i) The candidate hasn't participated in academic programme. (ii) The candidate has taken a drop for the subject head; - provided he/she intimates the same (i or ii) at least 7 days in advance of the

		commencement of the end-semester examination for the respective year.

(d) Grades **FF** and **I** are place-holders only and do not enter into CPI/SPI calculations directly. These grades get converted to one of the regular grades after the end-semester examination.

(e) A candidate with an **FR** grade is not eligible for any repeat examination in that course and has to re-register for that semester by paying the appropriate fees.

(f) **I** grade will not be continued beyond the permissible number of end-semester/repeat examinations.

(g) **'XX' Grade:** The grade **XX** in a course is awarded if – (i) candidate does not maintain the minimum 75% attendance in the Lecture/Tutorial/Practical classes, (ii) candidate receives less than 20% of the combined marks assigned for continuous assessment and mid-semester examination, and (iii) candidate indulges in a misconduct/uses unfair means in the examination, assignments, etc., of a nature serious enough to invite disciplinary action in the opinion of the teacher.
(**Note:** Award of the **XX** grade in the case of g(iii) above shall be done by Disciplinary Action Committee (DAC)).

(h) The names/roll numbers of students to be awarded the **XX** grade should be communicated by the teacher to the Academic office as per academic calendar before the last date of submission of the application for end-semester examination.

3.6. Awarding the grades

The grading scale ranks the students on a statistical basis on the basis of the overall performance of the students of a given class in the given course head. Therefore, statistical data on students' performance is a prerequisite for applying the grading system. While assigning grades in a given course head, it is essential to know the **average marks (AM)** obtained by the students *who have passed the subject head* and the **highest marks (HM)** obtained in the *same subject head*.

3.6.1. If the **average marks (AM)** obtained by the students *who have passed the subject head* is <60%, the interval AM shall be awarded grade CC and the other grades shall be decided as follows:
(i) AA, AB, BB, and BC grades shall be decided between the AM and HM by dividing the range in equal intervals.
(ii) CD, DD and EE grades shall be decided between the AM and minimum marks required for passing the head (i.e. 40%) by dividing the range in equal intervals.

3.6.2. If the **average marks (AM)** obtained by the students *who have passed the subject head* is such that **60% ≤ AM < 70%,** the interval AM shall be awarded grade BC and the other grades shall be decided as follows:
(i) AA, AB, BB grades shall be decided between the AM and HM by dividing the range in equal intervals.
(ii) CC, CD, DD and EE grades shall be decided between the AM and minimum marks required for passing the head (i.e. 40%) by dividing the range in equal intervals.

3.6.3. If the **average marks (AM)** obtained by the students *who have passed the subject head* is **≥ 70%,** the interval AM shall be awarded grade BB and the other grades shall be decided as follows:
(i) AA and AB grades shall be decided between the AM and HM by dividing the range in equal intervals.
(ii) BC CC, CD, DD and EE grades shall be decided between the AM and minimum marks required for passing the head (i.e. 40%) by dividing the range in equal intervals.

4. SPI and CPI

(a) **Semester Performance Index (SPI):** The performance of a student in a semester is indicated by **Semester Performance Index (SPI),** which is a weighted average of the grade points obtained in all the courses taken by the student in the semester and scaled to a maximum of 10. (SPI is to be calculated upto two decimal places.)
A Semester Grade Point Average (SGPA) will be computed for each semester as follows:

$$SGPA = \frac{\left(\sum_{i=1}^{n} c_i g_i \right)}{\left(\sum_{i=1}^{n} c_i \right)}$$

Where
'n' is the number of courses for the semester,
'c_i' is the number of credits allotted to a particular course, and
'g_i' is the grade-points awarded to the student for the course based on his performance as per the above table.
SGPA will be rounded off to the second place of decimal and recorded as such.

(b) **Cumulative Performance Index (CPI):** An up to date assessment of the overall performance of a student from the time he entered the Institute is obtained by calculating **Cumulative Performance Index (CPI)** of a student. The CPI is weighted average of the grade points obtained in all the courses registered by the student since he entered the Institute. CPI is also calculated at the end of every semester (upto two decimal places).

Starting from the first semester at the end of each semester (S), a Cumulative Grade Point Average (CGPA) will be computed as follows:

$$CGPA = \frac{\left(\sum_{i=1}^{m} c_i g_i \right)}{\left(\sum_{i=1}^{m} c_i \right)}$$

Where
'm' is the total number of courses from the first semester onwards up to and including the semester S, 'c_i' is the number of credits allotted to a particular course, and
'g_i' is the grade-points awarded to the student for the course based on his performance as per the above table.
CGPA will be rounded off to the second place of decimal and recorded as such.

(c) The CGPA, SGPA and the grades obtained in all the subjects in a semester will be communicated to every student at the end of every semester / beginning of the next semester.

(d) **When** a student gets the grade 'FF', or I' in any subject head during a semester, the SGPA and CGPA from that semester onwards will be tentatively calculated, taking only 'zero' grade point for each such 'FF' or 'I' grade. When the 'FF' grade(s) has / have been substituted by better grades after the repeat examination or subsequent semester examination, the SGPA and CGPA will be recomputed and recorded.

5. Repeat End-Semester Examination

5.1. For those candidates who fail in a subject head or are eligible for appearing at the repeat examination, **Repeat End-Semester Examination** will be conducted within one month from the declaration of the results of regular end-semester examination, as per **Regulation R.14**.

5.2. The marks obtained by candidates in the in-semester examinations (continuous assessment and Mid-Semester Examination) will be carried forward in such cases.

5.3. Grading the performance in the Repeat Examination: The grades will be assigned as per 3.5 and 3.6 above. However, for a candidate taking any repeat examination or subsequent regular semester examination or performance improvement examination shall be awarded **one grade lower** than that decided on the basis of the actual marks obtained; provided 'EE' grade obtained in such an examination shall remain 'EE'. For reference see the table below.

Grade obtained in repeat or subsequent end-semester examination	**Grade to be assigned**	**Grade point**
AA	AB	9.0
AB	BB	8.0

BB	BC	7.0
BC	CC	6.5
CC	CD	6.0
CD	DD	5.5
DD	EE	5.0
EE	EE	5.0

5.4. Revaluation of end-semester and repeat examination: Candidate's performance in these examinations will be displayed on proper notice board and after 3 days of such display the marks will be sent to the Academic Office. No revaluation of these examinations will be allowed.

6. Passing of a Semester examination

A candidate shall be declared as **'PASSED'** any semester examination if he/she has
(a) Cleared all heads of passing by securing grades EE or higher in all the heads;
(b) Passed all the heads of passing such as project, seminar, training, etc as per the rules;
(c) Satisfactorily completed all the mandatory requirements of the course;
(d) paid all the Institute dues;
(e) No case of indiscipline pending against him/her.

7. Eligibility for the Award of a Degree

A candidate shall be declared eligible for the award of a degree, if he/she has cleared all the semester examinations as given in (6) above.

8. Allowed to keep terms (ATKT)

8.1 A candidate who has I grade in one or more heads of passing of an odd semester of an academic year shall be allowed to keep terms for the respective even semester.

8.2. A candidate shall be allowed to keep terms for the subsequent academic year if he/she has FF or I grades in not more than two heads of passing from all the heads of passing of the two terms of the previous academic year taken together. Such a candidate shall be declared as **FAILED, ATKT**.

9. Repeating a course

9.1 A student is required to repeat the course under the following situations:
(a) A student who gets an **XX, FR, or DR** grade in a course; or
(b) A student has exhausted all permissible chances to clear the course.

9.2 A candidate from first year who remains absent for the regular end-semester examination of a semester and the corresponding repeat examination for **ALL SUBJECTS** shall have to take fresh admission for the corresponding year; unless the candidate has dropped out / terminated from the course.

9.3 If a candidate at the Second, fails to pass any semester examination in not more than 4 consecutive examinations, including the repeat examinations, from the date of registering for the respective year, the candidate shall have to take readmission for the corresponding year again in which the failure has occurred, provided the course is not changed.

10. Improvement of performance

A candidate will be allowed to appear at the **entire examination** after the regular end-semester examination as per the respective rules to improve the performance. In such a case if the result of the examination repeated –
1. Is better than the previous one, the previous result shall be declared null and void; and
2. Is worse than the previous one, the result of the subsequent examination shall not be declared.
3. However, awarding of final grade will be made under the provision of sub clause 5.3 above.

11. Exit rules for poorly performing students

A candidate shall be excluded from a course under the following conditions:

(a) If he/she fails to pass any semester examination of the any year of the course in not more than four consecutive attempts (Examination conducted by Institute) from the date of joining the course.
(b) If he/she does not keep two consecutive terms without giving any reasonable justification (as prescribed by the institute) for doing so.
(c) If a candidate fails to fulfill all the requirements of his/her respective degree within the prescribed period from the date of taking admission to the course, the candidate shall be excluded from the course.

12. Miscellaneous

(a) Although CPI will be given in the Semester grade report, the final degree certificate will not mention any **Class** whatsoever.
(b) Not withstanding anything said above if a course is revised /restructured then transient provisions applicable at the time of revision /restructuring shall be applicable.

Syllabus Details for the Degree of
Master of Plastic Engineering Course

No.	Subject	Credit	Hr/Week			Marks			
			L	T	P	Continuous Assessment	Mid-semester Examination	Final Examination	Total
SEMESTER I									
GET 2101	Core I: Technology and Chemistry of Polymers.	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 and Testing.	3	2	1	0	10	15	25	50
	Elective I	3	2	1	0	10	15	25	50
	Elective II	3	2	1	0	10	15	25	50
GEP 2104	Plastic Processing and Testing lab	3			6	25		25	50
GEP 2105	Seminar and Critical Review	3	---	---	6			30 (Report) 20 (Presentation)	50
GEP 2106	Research Project I	6	---	---	12			60 (Report) 40 (Presentation)	100
	TOTAL:	27	10	5	24				450
SEMESTER II									
GET 2107	Core IV: Design of Moulds.	3	2	1	0	10	15	25	50
GET 2108	Core V: Principles of Plastic Machinery Design.	3	2	1	0	10	15	25	50
GET 2109	Core VI: CAD/CAM/CAE	3	2	1	0	10	15	25	50
	Elective III	3	2	1	0	10	15	25	50
	Elective IV	3	2	1	0	10	15	25	50
GEP 2110	CAD/CAM/CAE and Design of Moulds lab.	3			6	25		25	50
GEP 2111	Research Project II	9	---	---	18			90 (Report) 60 (Presentation)	150
	TOTAL:	27	10	5	24				450
SEMESTERS III									
Industrial Training of duration of minimum of 15 weeks to maximum of 6 months as per approval of research supervisor and Head of the Department with total assigned credit as 30 and marks as 450									
SEMESTER IV									
Research Project, Thesis with total assigned credit as 30 and marks as 450									

Semester III and Semester IV Evaluation will be conducted at the end of IV semester.

SEMESTER I

1. GET 2101 – Technology and Chemistry of Polymers.

Course Outcomes: At the end of course students will be able to

1. Analysis of polymeric materials on the basis of polymer chemistry and types of polymerization**. (K4)**
2. Classify and compare between various polymers**. (K5)**
3. Applications of various polymers ,their synthesis and properties **(K3**)
4. Explain various additives used in plastics and importance of polymer blends and alloys **(K2)**

Syllabus

- General definitions used in plastics industry. Classification of polymers. Functionality, molecular weights and its determination, glass transition temperature degree of polymerisation, copolymerisation . — 3
- Analysis of polymeric materials. Various methods of polymerizations. — 3
- Chemistry, properties and applications of polymers such as phenolics, amino resins, epoxies polyester, silicones, polyurethanes. — 6
- Chemistry, properties and applications of commodity plastics like poly-olefines, styrinics, acrylics, PVC etc. and their co-polymers. — 6
- Chemistry, properties and applications of Engineering polymers like polyamides, polycarbonates, polyesters, poly acetals etc. Speciality polymers and elastomers. Additives such as plasticizers, stabilizers, fillers, colourants, blowing agents used in plastics. Polymer blends and alloys. — 7
- Additives such as plasticizers, stabilizers, fillers, colourants, blowing agents used in plastics. Polymer blends and alloys. — 5

Reference books:

1. Outline of Polymer Chemistry – by R Sinha
2. Plastic Materials –by Brydson J A
3. Polymer Science - by Gowarikar
4. Encyclopedia of polymer science and technology- wiley publications
5. Polymer Chemistry; an Introduction –by Stevens M P
6. Polymer science and technology- Robert.Ebewele

2. GET 2102 – Processing of Plastics .

Course Outcomes: At the end of course students will be able to

1. Apply basic principles of injection moulding to identify moulding defects and rectifying it. **(K3)**
2. Application of extrusion process for various plastic parts such as profiles, pipes, tubings, films, sheets and insulation coating on cables. **(K3)**
3. Compare between compression and transfer moulding process on the basis of process variables**. (K5)**
4. Application of blow moulding, rotational moulding for hollow articles**. (K3)**
5. Applications of calendaring, thermoforming and FRP processes**. (K3)**

Syllabus:

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 productquality. Types of nozzles-cavity pressure profile. Common moulding defects ,causes and remedies.Thermoset injection moulding –Machine description ,parts –process parameters. — 6

	• **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. Trouble shooting I extrusion line.Twin screw extruder-principle-types-process-merits and demerits. Vented extruders. • **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. **Transfer Moulding** :Introduction-principles-Pot type, Plunger type, screw transfer moulding. Common moulding defects ,causes and remedies, advantages and disadvantages. • **Blow Moulding** :Introduction-principles-processes-Extrusion blow moulding –Injection blow moulding-stretch blow moulding- blow moulding of large containers-parison programming. **Rotational Moulding** :Introduction-principles-process-machinary used-mold process parameters –merits and demerits • **Calendering** :Introduction-calender roll arrangements-calendering process-process variables-applications-merits and demerits. **Thermoforming**:Introduction- various types of thermoforming process- process variables – applications –merits and demerits. **Fibre reinforced Plastics** :Introduction – various processing techniques such as hand lay up, spray lay up, pultrusion, filament winding etc –merits and demerits. **Reference books:** 1. Injection moulding theory and practice- By Irvin I Rubin. 2. Injection moulding –By A.S.Athalye 3. Practical injection moulding of plastics – By Mink 4. Extrusion of Plastics – By E.G.Fischer 5. Polymer Extrusion – By Chris Rauwendaal 6. Compression and Transfer Moulding theory and technology- By Bobb 7. Blow Moulding – by Rosato. 8. Calendering of Plastics – By Elden and Swan 9. Thermoforming – By James.L.Throne. 10. Plastic Technology Handbook – By Manas chanda and S.K.Roy	8 5 5 6
3.	**GET 2103 – Plastic Product Design and Testing.** **Course Outcomes: The 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 products**.(K3)** **5.** Analyse and interpret various test results**. (K4)** **Syllabus:** • 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. • Product design of engineering load bearing components such as gears, bearings, filament wound chemical 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. • Importance of testing, specifications and standards. Sample preparation and conditioning of	5 5 2

	samples. • 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. • 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. • 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. • 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. **Reference books:** Plastic Product Design – by Ronald D Beck Product Design with Plastics – by Joseph D Dym Plastic Product design Handbook – by Edward Miller Engineering Design of Plastics – by Eric Bear Filament Winding –by D.V.Rosato & C.S.Grove Handbook of Plastic Testing Technology – by Vishu Shah Testing of Polymer (Vol. I, II, III, & IV) – by Brown Handbook American Society of testing and Material (ASTM)	5 4 5 4
4.	**Elective-I (from the list appended)** • 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.	
5.	**Elective-II (from the list appended)** • 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.	
6	**GEP 2104: Plastic Processing and Testing Laboratory** **Course Outcomes: At the end of the course students will be able to** 1. set processing parameters and operate various plastic processing machines. 2. analyse cycle time, trouble shooting for various plastic processing methods. 3. understand sample preparation for various tests to be carried out on plastic products. 4. Carry out various tests for the plastic products as per test standards. **Syllabus:** • Injection Moulding. • Extrusion process • Compression Moulding • Blow Moulding • Rotational moulding • To determine the tensile strength at break & yield & % elongation ofdumbbell shaped specimens of various polymers	12 12 12 6 6 12

	• To determine the izod and charpy impact strength for various polymer. • To determine the melt flow index , heat deflection temperature and vicat softening temperature for various polymers. • To determine dielectric strength, volume resistivity and surface resistivity for polymers.	9 12 9
7.	**GEP 2105 – Seminar and Critical Review** **Course Outcomes: Students will be able to** **1.** Survey literature related to the given topic **(K3)** 2. Analyze the reported outcomes and classify the work under key categories **(K3)** 3. Write a technically correct report as per the suggested guidelines and present the seminar work **(K4)** **Syllabus:** The Seminar work is concerned with a detailed and critical review of an area of interest to Plastic Engineering. Typically, the report should contain and will be evaluated based on the following points: **(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 on the analysis 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.** The detailed timetable for the presentation would be communicated. **3.** The report should be prepared using the Times Roman font (size 12) using 1 1/2 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 effect of particle size and concentration of fly ash on properties of polyester thermoplastic elastomer composites has been reported in the published literature (M.S.Sreekanth et al., 2009). **OR** (ii) M.S.Sreekanth et al. (2009) have studied effect of particle size and concentration of fly ash on properties of polyester thermoplastic elastomer 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: Murooka S., Uchida K. And Kato Y.,	

	Recirculation Turbulent Flow of Liquid in Gas-Liquid-Solid Fluidised Bed", J. Chem. Engg. Japan, 15, 29-34 (1982). **(b)** Format for listing references of Books: Constant R.F.,"Crystallization, Academic Press, New York, pp. 89-90, 1968. **(c)** Format for listing Thesis: Niranjan K., "Hydrodynamic and Mass Transfer Characteristics of Packed Columns", Ph.D. (Tech.) Thesis, University of Mumbai, 1983. **(d)** Format for listing references of Patents in Chemical Abstracts: Cananaush R.M., U.S.Patent 2,647,141, Cf. C.A. 48, 82636 (1954). **(e)** Format for listing Handbooks, Tables, Symposia etc.: Kumar R and Kuloor N.R., "Formation of Drops and Bubbles", in Advances in Chemical Engineering, Vol.8, T.B. Drew et.al. (Eds.) New York, Academic Press, pp.256-364 (1970). **(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 of seminar 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 Seminar. **13.** The Seminar will be evaluated on the basis of (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. The submitted report 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.	
8	**GEP 2106 – Research Project I** **Course Outcomes: Students will be able to** 1. Analyze existing literature for research topic and develop detailed plan of experiments/simulations **(K3)** 2. Systematically perform experiments/modeling activity to accomplish the set objectives **(K4)** 3. Critically analyse the results and write a technically correct report as per the suggested guidelines and present the work **(K4)** **Details:** The Research project I is concerned with detailed literature review of the assigned research area in consultation with the guide, developing an experimental/simulation protocol and initiate the actual research work. Based on the outcomes of the candidate is expected to submit a report as per similar guidelines provided for GEP 2105 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 II

9.	**GET 2107 -Design of Moulds** **Course Outcomes: Students will be able to** 1. Design and draw compression moulds for plastic products**. (K6)** 2. Applying basic principles of design of transfer moulds. **(K3**) 3. Analyze, design and draw Injection moulds for plastic products**. (K4)** 4. Design of extrusion dies**. (K6)**	

	Syllabus: • **Compression Moulds** :Factors to be considered while designing compression mould, Types of compression moulds such as positive type, Flash moulds and semi-positive mould. Design of two plate and three plate moulds and spilt moulds. Design of moulds for articles with threads and inserts. • **Transfer Moulds**: 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. • **Injection Moulds**: Factors to be considered while designing an Injection mould. Design of two plates and three plate moulds. Types of sprues, runners, gates, cooling channels etc. Design of Moulds for articles with threads and inserts, undercuts, ribs and bosses. Determination of shot capacity, clamping force number of mould cavities. Runner balancing and hot runner moulds for multi-cavity moulds. Mould temperature controller type mould. • **Extrusion Dies**: Types of Extrusion die. Various details of an extrusion die. Extrusion dies for pipes, tubing's, films, sheets and insulation covering. Materials of construction for various mould /die parts. **Reference books:** 1.Plastic Engineering Handbook by Frados 2.Compression and Transfer Moulding of plastics – by Butler J 3.Injection Mould Design – by Pye R.G.W. 4.Injection Moulding Theory & Practices – by Rubin 5.Dies for Plastics Extrusion; – by Joshi M. V.	7 5 12 6
10.	**GET 2109- CAD/CAM/CAE :** **Course Outcomes: Students will be able to** 1. Construct solid models of plastic and mechanical components**. (K3)** 2. Design various moulds and dies using computer aided design**. (K6)** 3. Applying basics of computer aided manufacturing programme. **(K3**) 4. Analyze variation in pressure, temperature and time graph using computer aided programme**. (K4)** **Syllabus:** • Basics of computer aided manufacturing programmes. Study of various computer aided engineering packages to analyze moulds and dies for flow, cool, shrink, wrap stress etc., to optimize the design. • Design and drafting of various mould and dies using computer aided design packages. • Study of pressure, time, and temperature graphs. Selection of polymer materials. • Interpretation of various plots for thermoplastic, thermoset and gas injection moulding processes. Cost saving analysis. **Reference books:** 1. Manual of Solid works, Mold X and Unigraphics software	12 6 6 6

11.	**GET 2108- Principles of Plastic Machinery Design** **Course Outcomes: Students will be able to** 1. Applying basic principles of hydraulics to working of hydraulic machinery**. (K3)** 2. Applications of various pumps, valves etc in hydraulic circuit**. (K3)** 3. Applications of hydraulic circuits in plastic processing machines**. (K3)** 4. Analysis of various design parameters for screw extruder**. (K4)** 5. Classifications and applications of clamping system for injection moulding. **(K4**) 6. Applications of thermal heating and temperature control in plastic processing**. (K3)** **Syllabus:** • Clamping Systems: Mechanical and hydraulic clamping systems. Single toggle and double toggle clamping units, clamping systems for large injection moulding machines. Advantages and disadvantages of hydraulic and mechanical clamping systems. • Hydraulic Design: General principles of operations of hydraulic and pneumatic systems. 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 moulding machines such as deceleration circuit, prefill circuit, meter-in, meter –out circuit .Auxiliary unit such as filters, cylinders, pressure intensifier, accumulator etc. • Design of single screw and twin screw extruders. Steam, hot water and gas heating. Electric resistance heating types of heater and applications. Infrared heating, Induction heating and high frequency heating and their applications in plastic industry. Temperature measurement and control. **Reference books:** 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.Understanding Compounding By Robert.H.Wildi and Christianmaier 5.Injection Moulding Machines by A. Whelan 6.Practical injection moulding of plastics By Mink	4 18 8
12.	**Elective-III (from the list appended)** • 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.	
13.	**Elective-IV (from the list appended)** • 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.	

14.	**GEP 2110 -CAD/CAM/CAE and Design of Moulds lab.** **Course Outcomes: Students will be able to** **1.** learn 3-D modelling of machine and plastic components. **2.** understand assembly of various types of plastic moulds. **3.** analyze of injection of Moulds using soft wares. **4.** draw injection moulds, compression moulds, transfer moulds and extruder dies. **Syllabus:** • Injection Mould design. • Compression Mould design. • Transfer Mould design. • Extrusion dies. • 3-D modeling of machine parts ad machine components. Assembly of simple machine parts . • 3-D modelling and assembly of various types of plastic moulds and dies. • Injection mould analysis. **Reference books:** 1. Injection moulding theory and practice- By Irvin I Rubin. 2. Plastic Technology Handbook – By Manas chanda and S.K.Roy. 3. Manuals of Solidworks,unigraphics and mold X.	18 12 9 6 18 15 12
14.	**GEP 2111 – Research Project II** **Course Outcome:** 1. Systematically perform experiments/modelling activity to accomplish the set objectives **(K3)** 2. Critically analyse the results and present them in coherent manner in the form of graphs, tables etc**. (K4**) **3.** Write a technically correct report as per the suggested guidelines and present the work **(K4)** **Details:** 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 2105 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.	

The following subjects can be offered as ELECTIVES

1	**GET 2112: Processing and Mechanics of composites. (Marks 50)** • Study of various types of matrix materials, thermoplastic and thermosetting. Study of various reinforcements – long, shot fibers, particulate fillers, flakes. Review of processing techniques like hand lay up, filament winding, resin transfer molding, Pultrusion. Important processing parameters in the design of fibre reinforced plastics. • Macromechanical behaviour of a lamina : Stress strain relations for anisotropic materials, Engineering constants for orthotropic materials, Restrictions on elastic constants, Invariant properties of an orthotropic lamina, Biaxial strength theories for an orthotropic lamina, Maximum stress theory, Maximum strain theory. • Micromechanical behaviour of a lamina. Mechanics of materials approach to stiffness, Elasticity approach to stiffness, Particulate composites Mechanics of materials approach to strength.	

2	**GET 2113**: **Finite Element Analysis (Marks 50)** • . 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. • 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. • Higher order and Isoparametric elements: Introduction, higher order one dimensional elements, higher order elements in terms of natural coordinates, Isoparametric 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. • 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.	
3	**GET 2116**:**Advanced Processing Technologies**. **(Marks 50)** • Advanced injection moulding techniques Microprocessor controlled Injection moulding – Multi colour Injection mouldling 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. • Multi-layer Moulding, Counter flow moulding, Liquid Injection Moulding processes. Structural foam moulding – Low pressure and high pressure processes – Merits & demerits. • 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 • Advanced Blow Moulding – Stretch blow moulding – Injection stretch blow moulding – Extrusion stretch blow moulding – Process – Merits & demerits – Applications. Multi–layer Blow Moulding – Process -Applications.	
4	**GET 2117: Plastic waste Management. (Marks 50)** **Course Outcomes**: Students will be able to 1. Analyze sources of plastic waste and separation methods**. (K4)** 2. Classify various plastic waste management techniques**. (K4)** 3. Analyze impact of effect of various recycling processes. **(K4)** 4. Analyze impact of Plastic process industry on the global, economic and societal context**. (K4)** • 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. • 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. • 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. Fluidised bed incinerator with energy recovery. • 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.	
5	**GET 2118 – Mould Manufacturing Technology**. **(Marks 50)** • **Materials for Moulds :** Selection of steels– Properties of steels– common steels used for moulds–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 • **Surface treatment of mould matrials :**Introduction–Heattreatmentprocess– casehardening– throughhardening–nitriding–tips on successful heat treatment– vacuum hardening–cryogenic heat treatment Hardchromeplating–Nickelplating– chemicaletching–MouldPolishingtechniques. • **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. • **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.	
6	**GET 2119 - Advanced Polymer based Materials in Engineering applications**. **(Marks 50)** **Course Outcomes**: Students will be able to 1. Design and analysis of fiber reinforced polymer composites. **(K6)** 2. Applications of various methods of manufacturing fiber reinforced polymer composite**. (K3)** 3. Applications of performance enhancing and special purpose construction chemicals, polymer modified cement mortars for repairs. (**K3**) 4. Applications of different types of polymers in manufacturing of pipes for water supply/ waste water ,effluent transport , drainage system **.(K3)** 5. Applications of polymers in electrical applications (**K3**) 6. Applications of polymer composites in automobile and medical applications (**K3)** • 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. • 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 . • Cable insulating materials, insulators for transmission lines. Improvement of dielectric strength of capacitors. • Plastics in automotive applications. Various components in vehicles made up of rubber, plastics and composites. Glass and carbon fiber composites for improving performance of vehicles. • 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, Condoms, etc.	

7

PHT 2106 Research Methodology(Marks 50)

Research

Meaning of Research, Purpose of Research, Types of Research (Educational, Clinical, Experimental, Historical, Descriptive, Basic applied and Patent Oriented Research) – Objective of research-Literature survey – Use of Library, Books, & Journals – Medline – Internet, getting patents and reprints of articles as sources for literature survey.

Selecting a problem and preparing research proposal for different types of research mentioned above.

Methods and tools used in Research

- Qualitative studies, Quantitative Studies
- Simple data organization, Descriptive data analysis
- Limitations and sources of Error
- Inquiries in form of Questionnaire, Opinionnaire or by interview

Statistical analysis of data including variance, standard deviation, students 't' test and annova, correlation data and its interpretation, computer data analysis

Documentation

- "How" of Documentation
- Techniques of Documentation
- Importance of Documentation
- Uses of computer packages in Documentation

The Research Report / Paper writing / thesis writing

- Different parts of the Research paper
  1. Title – Title of project with author's name
  2. Abstract – Statement of the problem Background list in brief and purpose and scope
  3. Key-words-
  4. Methodology-Subject, Apparatus / Instrumentation, (if necessary) and procedure

Results – Tables, Graphs, Figures, and statistical presentation

Discussion – Support or non- support of hypothesis – practical & theoretical implications, conclusions Acknowledgements

References

Errata

Importance of spell check for Entire project

Use of footnotes

Presentation (Specially for oral)

- Importance, types, different skills
- Content of presentation, format of model, Introduction and ending
- Posture, Genstures, Eye contact, facial expressions stage fright
- Volume- pitch, speed, pauses & language
- Visual aids and seating

- The patent system in India – Present status Intellectual property Rights (IPR), Future changes expected in Indian Patents
- Advantages
- The Science in Law, Turimetrics (Introduction)
- What may be patented
- Who may apply for patent
- Preparation of patent proposal

Sources for procurement of Research Grants

Industrial- Institution Interaction

- Industrial projects – Their feasibility reports

8	**BST 2106 Intellectual Property Rights (Marks 50)** **General Introduction to IPR and Essentials of IP management** • History of Indian and International Patent System and International Treaties • Introduction to Trademark filing in India • Introduction to Design filing in India • Introduction to Geographical Indication filing in India • Introduction to Indian Patent Law • Assessment of Invention by documentation and Search Analysis of R&D Activity for Patentability Techno-legal requirements for filing of Patent Drafting of Patent Specification Patent Prosecution in India Patent Prosecution at International level (Convention and PCT Routs) Agreements & Contracts for Patent Management and drafting of same Infringements for Patent Commercialisation Search and Patentability Opinion **Case Studies:** Cases of Herbal medicines, biomolecules, agrochemicals, and bulk drugs, oil and textile in India and abroad before Patent Office/ Courts	