M. Tech.
Polymer Engineering and Technology
Course

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

1. Introduction

The Institute is revamping its academic structure especially for the master's 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.	PROGRAM OUTCOMES (POS)
1	The graduates will be able to apply knowledge of basic sciences (Mathematics, Physics, Chemistry and Biology) and engineering courses in getting solutions to issues pertaining to chemical and allied industries.
2	The graduates should be able to systematically break up complex problems in realizable steps and solve them.
3	The graduates will be able to design a system or a component of a system or provide an engineering solution for a specific task within realistic constraints
4	The graduates will be able to design and conduct experiments as well as analyze and interpret data. The graduates should be able to systematically break up complex problems in realizable steps and solve them.
5	The graduate will be able to use modern tools, software, equipment etc. to analyze and obtain solution to the problems.
6	The graduates will be able to study the impact of process industry on the global, economic, and societal context
7	The graduates should practice their profession considering environmental protection and sustainability
8	Graduates are expected to practice professional skills in an ethical manner
9	The graduates should have competence to undertake designated task on individual or team basis as per the requirement.
10	The graduates will be able to communicate effectively their points of view
11	The graduates will acquire attitude for life- long learning
12	The graduates should actively participate in project and financial management

SR. NO.	PROGRAM SPECIFIC OUTCOMES (PSOs)
13	Graduates will be acquainted with the latest development in different fields so as to enable them to take up higher studies, research & developmental work
14	Graduates will be introduced to managerial subjects, so as to enable them to take up further studies in management subjects & function effectively as managers
15	Provide a platform to the students to interact with leading teachers, scientists and industry practitioners

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 + No. of hours of tutorials per week = L + T
(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 sometimes 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.

Department of Polymer & Surface Engineering
Four Semester
Master of Technology Degree Examination Syllabus
Polymer Engineering and Technology Course

SEMESTER I

No.		Course code	Subjects	Hr/W (L+T)	Marks	Credits
1	Core I	**PET 2101**	Polymer Processing & Technology I	**2+1**	**50**	**3**
2	Core II	**PST 2102**	Structure Property Relationship in Polymers	**2+1**	**50**	**3**
3	Core III	**PYT 2106**	Physical Methods of Analysis	**2+1**	**50**	**3**
4	Elective I	**PHT2101**	Research Methodology	**2+1**	**50**	**3**
5	Elective II	**BST 2106**	Intellectual Property Rights	**2+1**	**50**	**3**
6	Seminar	**PEP 2103**	Seminar & Critical Review of One Research Publication	**6**	**50**	**3**
7	Practical	**PEP2104**	Compounding and Polymer Processing Lab	**6**	**50**	**3**
8	Research I	**PEP 2105**	Literature Review and Research on proposed research Topic	**12**	**100**	**6**
			TOTAL	**39**	**450**	**27**

SEMESTER II

No.		Course code	Subjects	Hr/W (L+T)	Marks	Credits
1	Core I	**PET 2201**	Polymer Processing & Technology II	**2+1**	**50**	**3**
3	Core II	**PET 2202**	Polymer Blends & Alloys	**2+1**	**50**	**3**
3	Core III	**PST 2203**	High Polymer Chemistry	**2+1**	**50**	**3**
3	Elective I	**PET 25****	To be selected from pool*	**2+1**	**50**	**3**
3	Elective II	**PET 25****	To be selected from pool*	**2+1**	**50**	**3**
3	Practical	**PEP 2204**	Testing and Characterization of Polymer Lab	**6**	**50**	**3**
3	Research II	**PEP 2205**	Laboratory Project work on proposed research Topic	**18**	**150**	**9**
3			**TOTAL**	**39**	**450**	**27**

SEMESTER III

No.	Course Code	Course	Hours/Week	Marks	Credits
1	**PEP 2301**	In Plant Training	40(15 Weeks)	450	30
	TOTAL		40	450	30

SEMESTER IV

No.	Course Code	Course	Hours/Week	Marks	Credits
1	**PEP 2401**	Research Thesis and Open Defence	40	450	30
	TOTAL		40	450	30

SEM III and SEM IV will be conducted at the end of IV Semester

Total credits
Total credits 39(Sem I) + 39 (Sem II) = 78

Total credits for semesters III and IV are 30 + 30 = 60

Polymer Engineering and Technology

SEMESTER I

Code & Title of the Course	PET 2101. Polymer Processing & Technology I
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	I

Sr no.	Topic	Hrs.
1	General scenario of the Indian Plastics Processing Industry, and the plastics material for processing. Basic concepts of Rheology in polymer processing, structure of resin, flow behaviour and the end properties of finished products, properties of plastics under high pressure and temperature, PVT diagrams. Elongational and shearing flows.	**3**
2	Extrusion: Type of single/twin screw extruders, controls, venting, compounding, reactive processing, extrusion of pipers/profiles, blown film, cast film/sheets, wire and cable coating, extrusion coating/Iamination, woven sacks, monofilament and non woven articles and similar operations foam extrusion, coextrusion, multilayer coextrusion; flow models for extrusion processes, economic aspects of the process, trouble shooting and remedies. Aspects of product design	**7**
3	Injection moulding: Basics of injection moulding, machinery, moulding cycle, feeding of materials, preplasticization. Types of injection moulding machines, analysis of flow through sprue, runners, gates etc., mould loading/unloading, moulding defects, single and multistage screw/plunger machines, clamping systems, injection systems, various controls such as pneumatic, hydraulic electric or electronic; microprocessor based injection moulding machines, Gas assisted injection moulding. Retrofit and improvement. Use of computer software in understanding injection moulding and other processes, economic aspects, trouble shooting and remedies. Aspects of product design.	**7**
4	Blow Moulding: Basic machinery, moulding cycle of products made by the blow moulding stretch blow moulding, multisation blow moulding, analysis of flow in the blow moulding operations and design aspects. Blow moulding of multilayered articles, technical blow moulding, surface enhancements, economic aspects, trouble shooting and remedies. Aspects of product design.	**6**
5	Compression molding, Calendaring, Rotational Molding, Reaction Injection Molding: Different machinery and the advantages/limitations. Various operations involved, pre and post processing operations, new developments, flow analysis, economic aspects, trouble shooting guides	**8**

Course Outcomes

1.To get familiarise with polymer processing industry scenario, Rheological concept and PVT diagrams
2.Student will able to understand extrusion process types, screw designs, economics trouble shooting guides learn flow models aspects of product design.
3. Student will gets the knowledgeof Injection molding types types, screw designs, mold design ,economics trouble shooting guides learn flow models aspects of product desig
4.Student will able to tell blow molding process types, screw designs, economics trouble shooting guides learn flow models aspects of product design.
5.Student will learn and understand flow models aspects of product design, types advantages disadvantages of compression, roto and reaction Injection molding.

Textbooks/Sourcebooks:

1. Polymer Processing Fundamentals, Osswald, A. Tim, Hanser Publishers, 1998.
2. Fundamentals of Reaction Injection Moulding, C. W. Macosko, Hanser Publishers, 1989.
3. Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
4. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.
5. Fundamentals of Polymer Processing, S. Middleman, Houghton Mifflin Compony, 1997.
6. D.H.Maron-Jones, "Polymer Processing", Chapman and Hall, London(1989) or newer edition.
7. W.Michaeli, "Plastics Processing – An Introduction" Hanser Publishers, New York (1992).
8. Seymour S.Schwartz and Sidney H.Goodman, 'Plastics Materials and Process, Van Nostrand Reinhold Co., New York (1982).

Code & Title of the Course	**PST 2202 Structure Property Relationship in Polymers**
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	I

Sr no.	**Topic**	**Hrs.**
1	Atomic Packing and Structure, Consequences of Packing Effects of atoms types of bonds, bond dissociation energy and functional groups on properties of polymers. Interchain and Intrachain Forces	**4**
2	Configuration and conformation Polymer chain flexibility Effect of molecular orientation on mechanical properties ,Molecular mass heterogeneity and structure properties,Intermolecular orders: Amorphous, crystalline and oriented forms of polymers, crystallinity in polymers, factors affecting crystallinity Polymer morphology and its effect	**6**

3	Polymers solutions: thermodynamics of dissolution, factors effecting dissolution and swelling of polymers, phase equilibrium of polymer-solvent systems, polymer solution, Florry-Huggins theory	**5**
4	Rhelogical Properties of Polymer Melts and Polymer Solution	**4**
5	Thermal properties of polymers: fire retardant polymers, factors affecting glass transition (Tg) temperature, heat stability etc. with case studies	**3**
6	Degradation and stabilization: various stresses acting on polymers and their influence, method of improving the stability of polymers with case study	**3**
7	Mechanical Electrical Optical magnetic acoustic properties of polymers	**5**

Course outcomes

1. Ability to understand the general structural features of polymers, Functional groups
2. Ability to understand the Configuration and conformation and structure properties of polymers and Molecular mass heterogeneity and structure properties
3. Ability to understand the thermodynamics and factors affecting dissolution
4. Ability to understand Rheological properties of polymers
5. Ability to understand the Thermal and degradation/stabilization of polymers and to analyses the respective case studies
6. Ability to understand Mechanical Electrical Optical magnetic acoustic properties of Polymers and their structural relationship.

Text/Source Books

1. Polymer Structure, Properties and application, R.D. Deanin, American Chemical Society, 1974.
2. Relating Materials, Properties to Structure; Handbook and Software for Polymer calcilations and Materials Properties, D. J. david and Ashok Mishra, Technical Publishing Componey, Inc, 1999.
3. Properties of Polymer; Correlations with Chemical Structurees and their numerical Estimation and Predication from Additive Group Contribution van Krevelen, Elsevier Publication Company, 1990.
4. Relating Materials Properties to structure, D. J. David, Technical Publishing Company Inc, 1999.
5. Polymer Chemistry, C. E. Carrshar, Marcel Dakker Inc, 2003.
6. Physical chemistry of Polymers, A. Tager, Mir Publishers, 1978.
7. Polymer Association Structures M. A. EL-Nokally, American Chemical Society, 1989.
8. Polymer Solutions; Introduction to Physical Properties, Teraoka, Iwao, John Wiley and Sons. Inc, 2002.
9. Polymer Chemistry; An Introduction, M. P. Stevens, Oxford University Press, 1990.

Code & Title of the Course	PYT 2106 Physical Methods of Analysis
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	I

Sr no.	Topic	Hrs.
1	**Fourier Transform Infrared Spectroscopy:** Molecular vibrations, frequency shifts associated with structural changes, basic theory of FTIR spectroscopy, interferogram, digitization of interferogram, data points collection, instrumentation and advantages of FTIR spectrophotometry, qualitative and quantitative analysis using infrared spectrophotometry	5
2	**Ultraviolet and visible spectrophotometry:** Electronic transitions, spectrum, shift of bands with solvents, isolated double bonds, conjugated dienes, carbonyl compounds, aromatic and hetero-aromatic compounds, application in pollution control and chemical industry	5
3	**Nuclear Magnetic Resonan**ce: Basic principles of NMR phenomenon, relaxation processes, spin-spin interaction, chemical shifts, interpretation of NMFR spectra, correlation - hydrogen bonds to carbon and other nuclei, instrumentation, continuous and pulsed NMR, carbon-13 NMR.	5
4	**X-ray Diffraction**: Crystal geometry and structural determination, Bragg's law of X-ray diffraction, powder method, X-ray spectrometers - wide and small angle diffractometers, chemical analysis by X-ray diffraction	2
5	**Particle size analysis:** Particle size, sampling, conventional techniques of particle size measurement, light scattering, particle size measurement by light scattering techniques, dynamic light scattering (DLS), fibre-optic dynamic light scattering (FDLS)	5
6	C**hromatography:** Basic theory of separation, efficiency, resolution, liquid chromatography, high performance liquid chromatography (HPLC), gas chromatography - columns and detectors, qualitative and quantitative analysis	5
7	**Mass Spectroscopy**: Basic principles, ionization of a molecule on electron impact, fragmentation processes in organic compounds, interpretation of mass spectra, molecular weight, molecular formula, instrumentation - different types of ionization sources and magnetic analysers	3

Textbooks/Sourcebooks:

1) Vishu Shah, Hand Book of Plastics Testing Technology, John Wiley & Sons Inc. New York
2) R.P.Brown, Hand Book of Plastics Test Methods, George Godwin Ltd., London, 1981.
3) Analysis & Testing by Crompton.
4) J.S.Anand, K.Ramamurthy, K.Palanivelu how to identify Plastics by Simple Methods
5) G.C.Lves, J.A.Mead, M.M.Riley, Hand Book of Plastics Test Methods, The Plastics Institute,
6) Frank T.Traceski, Specifications & Standards for Plastics & Composites, ASM International, Metals Park, OH, 1990.

Code & Title of the Course	Elective I PHT 2101 Research Methodology
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	I

Sr.No.	Topic	Hrs.
1.	**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	4
2.	**Documentation** • "How" of Documentation • Techniques of Documentation • Importance of Documentation • Uses of computer packages in Documentation	4
3.	**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	4

4.	**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	5
5.	**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 Questionnaire	5
6.	**Protection of patents and trade marks, Designs and copyrights** • 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	5
7.	Sources for procurement of Research Grants Industrial- Institution Interaction - Industrial projects – Their feasibility reports	3

Reference books:

1. Research in Education – Johan V. Best James V. Kahn
2. Presentation skills- Michael Halton- Indian Society for Institute Education
3. A Practical Introduction to copy right – Gavin Mcfarlane
4. Thesis projects in Science and Engineering – Richard M. Davis
5. Scientists in legal system – Ann labor science
6. Thesis and Assignment writing – Jonathan Anderson
7. Writing a technical paper- Donald Menzel
8. Effective Business Report writing – Leland Brown
9. Protection of Industrial property rights- Purushottam Das and Gokul Das
10. Spelling for the million – Edna furmess
11. Preparing for publication – King Edwards Hospital fund for London
12. Information technology – The Hindu speaks
13. Documentation – Genesis & Development 3792
14. Manual for evaluation of Industrial projects – United Nations
15. Manual for the preparation of Industrial feasibility studies

Code & Title of the Course	Elective II BST 2106 Intellectual Property Rights
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	I

Sr.No.	Topic	Hrs.
1.	**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	10
2.	Techno-legal requirements for filing of Patent Drafting of Patent Specification	4
3.	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	12
4.	**Case Studies:** Cases of Herbal medicines, biomolecules, agrochemicals, and bulk drugs, oil and textile in India and abroad before Patent Office/ Courts	4

Reference books:

1. Intellectual Property Rights By Khushdeep Dharni, Neeraj Pandey

2. Indian Patent Law And Practice By K.C. Kankanala (Oxford India) 2013 Edition

Code & Title of the Course	PEP 2103 Seminar and Critical Review of One Research Publication
Marks	50
Number of Hours per Week	6
Credits	3
Class	M Tech
Semester	I

Sr.No.	Topic	Hrs.
1.	Student will be required to prepare critical reviews of selected topics in Chemical Technology and Allied subjects and submit in the form of standard typed report. The student will also be required to make an oral presentation of the review.	15
2.	Student will be required to review single research publication either published as decided by the faculty advisor. In general a written Critical Reviews report needs to be submitted in the form of standard typed report. The student will also be required to make an oral presentation of the review	15

Course Outcomes:

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 Polymer 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 flow pattern in gas-liquid-solid fluidized bed has been reported in the published literature (Murooka et al., 1982).

OR

(ii) Murooka et al. (1982) have measured flow patterns in gas-liquid-solid fluidized beds. 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.

Code & Title of the Course	PEP 2104 Compounding and Polymer Processing Lab
Marks	50
Number of Hours per Week	6
Credits	3
Class	M Tech
Semester	I

Sr no.	Topics	Hrs./week
1	Compounding of PVC using two roll mill	**6**
2	Melt compounding and processing of polymers using twin screw extruder	
3	Batch mixer and various mixing equipment	
4	FRP molding	
5	Extrusion film blowing	
6	Thermoforming	
7	Injection molding	
8	Electrospinning MFI	
9	Study Experimenmts Blow molding, Roto molding ,Casting, Reaction injection molding etc	

Course outcomes

Upon completion of this course the student is expected to:

CO1.Ability to apply Polymer engineering, Polymer science and formulate the laboratory scale experiment for composite synthesis. K2 K3 A1

CO2.Ability design and conduct experiments based on compounding processing of polymers and composites K2 K5 S2 A4 A1

CO3.Ability to analyze and interpret data, process parameters within realistic constraints of the experiment K2 K4 K6

CO4.Know polymer processing like injection molding blown film batch mixer machines etc and modern engineering tools so as to be easily adaptable to polymer industry. A1 K1 K2

CO5. An ability to communicate effectively and understanding of professional and ethical responsibility team work A3

Textbooks/Sourcebooks:

1. Polymer Processing Fundamentals, Osswald, A. Tim, Hanser Publishers, 1998.
2. Fundamentals of Reaction Injection Moulding, C. W. Macosko, Hanser Publishers, 1989.
3. Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
4. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.
5. Fundamentals of Polymer Processing, S. Middleman, Houghton Mifflin Compony, 1997.

6. D.H.Maron-Jones, "Polymer Processing", Chapman and Hall, London(1989) or newer edition.
7. Fundamentals of Modern Manufacturing: Materials, Processes, and Systems by Mikell P. Groover, 2009.
8. Polymer Extrusion by Chris Rauwendaal, Carl Hanser Verlag GmbH & Co; 3rd Revised edition edition (1 August 1994).
9. Polymer Processing: Principles and Design, 2nd Edition by Donald G. Baird, Dimitris I. Collias, Wiley-Interscience, 2014.
10. Polymer Processing and Characterization by Sabu Thomas, Deepalekshmi Ponnamma, Ajesh K. Zachariah. Apple Academic Press 2012.

Code & Title of the Course	**PEP 2105 Research I**
Marks	100
Number of Hours per Week	12
Credits	6
Class	M Tech
Semester	I

Sr.No.	**Topic**	**Hrs.**
1.	Literature Review and Research on proposed research Topic	30

Course Outcomes:

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 PEP 2103 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

Code & Title of the Course	PET 2201. Polymer Processing & Technology II
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	II

Sr. No.	Topic	Hrs.
1	Types of reinforcement, resins.and additives used in FRP Composite mechanics Degree of Cure gel time.Composite Testing.	3
2	Pultrusion : Basic process, reinforcement, resins, die post pultrusion operations, analysis of flow/curing, pultrusion of thermoplastics and trends,	5
3	Pull winding Process and engineering aspect, Prepegs Vaccum bag molding economic aspects, trouble shooting and remedies. Aspects of product design	5
4	Processing of polyurethane, elastomers, speciality polymers, foam etc.	5
5	Fibre Spinning – Basic operations of fibre spinning; trouble shooting and remedies. Aspects of product design	4
6	Resin Transfer Moulding (RTM): The operation, materials, economic aspects, mould making.	3
7	Thermoforming: The basic process, flow analysis, suitability of materials, applications, economic aspects, trouble shooting and remedies. Aspects of product design.	4

Course outcomes

Upon completion of this course the student is expected to:

CO1.Ability to apply Polymer engineering, Polymer science knowledge for the manufacturing reinforcement like glass fibers carbon fibers K1 K2 A1

CO2.Ability to understand properties of polymer Composites, Mechanics their structure properties and relation as well as to analyze and interpret data K4 K1 K2 A1

CO3.Ability to identify, formulate and know practical applications of Polymer Composites K4 K1 K2 A1

CO4.Ability to know decoration and coating of plastic substrates , so as to be easily adaptable to polymer industry and coating industry A1 K1 K2

CO5. Understanding basics and principals in bonding and welding ,degradation of plastic

and their impact on environment, engineering community and society at large K1 K2 S2

Text/ Source Books

1. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.
2. Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falcetta, Wiley – Interscience Publication, 1977
3. Handbook of Polyethylene, A. J. Peacock, Marcel Dakker Inc,2000
4. Engineering Thermoplastics Polycarbonates Polyacetals Cellulose Esters, L. Bottenbruch, Hanser Publishers, 1996.
5. Composite Polymeric Material, R. P. Sheldon, Applied Science Publishers, 1982.
6. Composites: Design Guide, Industrial Press Inc, 1987.
7. Composite Material Handbook, M. M. Schwartz, McGraw-Hill company, 1984.
8. Handbook of Thermoplastics, O. Olabisi, Marcel Dekker, 1997.
9. Polymer and Resins; Their Chemistry and Chemical Engg, Brage Golding, D.Van Nostrand Company Inc, 1959
10. Billmeyer Jr.; Fred W., Synthetic Polymers, Doubleday and Co. Inc., New York (1972).
11. Gupta, V.B., and Kothari, V.K., Manufactured Fibre Technology, Chapman & Hall, 1997.
12. Fourne, Franz, "Synthetic Fibres, Machines and Equipment, Manufacture, Properties", Hanser Publishes, 1999.
13. Text book of Polymer Science by Billmeyer, John Wiley ans Sons 1984.
14. Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
15. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.

Code & Title of the Course	**PET 2202. Polymer Blends and Alloys**
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	II

Sr. no.	**Topics**	**Hrs.**
1	Definations of polymer blends & alloys (PBAs), compatibility, miscibility etc. Classification of PBAs	2
2	Why blending is done & comparison of blends/ alloys with copolymers. Thermodynamics of miscibility/ compatibility. Floory- Huggins theory, Scott theory for miscibility.	7
3	Methods of determining miscibility & compatibility. Steps followed for preparation of polymer blends and alloys.	3
4	Methods of Compatibilization/ IPNs. Selection criterion for blends, physical chemistry of polymers and their blends phase diagrams UCST/ LCST	5

5	Factors affecting properties of PBAs, rheological criteria, interfacial criteria. Synergy & additivity, log additivity & inverse additivity rules effect of interaction parameters on properties. Processing of blends/alloys,	8
6	Different PBAs and their applications with case studies.	5

Course outcomes

Upon completion of this course the student is expected to:

CO1.Ability to apply Polymer engineering, Polymer science knowledge for the manufacturing Polymer blends and alloys K1 K2 A1

CO2.Ability to understand compatibilization terminologies, thermodynamics theory of miscibility structure properties and relation as well as to analyze and interpret data K4 K1 K2 A1

CO3.Ability to identify, formulate and know practical applications of Polymer Blends K4 K1 K2 A1

CO4. Ability to blend phase diagram selection criterionfor blends , so as to be easily adaptable to polymer industry A1 K1 K2

CO5. Understanding rheological criteria interfacial criteria additivity rules processing, recycling and their impact on environment, engineering community and society at large K1 K2 S2

Textbooks/Sourcebooks:

1. Raw Materials for Industrial Polymers by H Ulrich, Hanser Publication1989.
2. Biopolymers, Wiley, VCH Verlag, 2003
3. Principles of Polymer Science, by Bahadur and Sastry, Narosa Publishing House 2002.
4. Fundamentals of Polymer Processing, S. Middleman, Houghton Mifflin Compony, 1997.
5. Plastics Materials J. A. Brydson, Butterworth Scintific, 1990.
6. Polymer Science by Gowarikar, Johan wiley and Sons 1986.
7. Safety Management in Industry : N.V.Krishnan, Jaico Publishing House, 1997.
8. Plastics and the Environment Anthony L. Andrady, John Willy & Sons 2003.
9. Mc Grawhills Hazardss Chemicals safety guide for the plastics industry. Plastics for Environment & Sustainable Development ICPE & CIPET Publication 2003 Ed.
10. G.J.L. Griffin, Chemistry and Technology of Biodegradable Polymers, Blackie Academic Professional, 1994.
11. Gerald Scott & Dan Gilad, Degradable Polymer – Principles & Applications, Chapman & Hall,
12. Y.Doi and K.Fukuda (Eds), Biodegradable Plastics and Polymers, Elsevier (1994).
13. Absorbabale & Biodegradable Polymers – S.N.Shalaby & K.J.L. Burg, CRC Press (2003).
14. R.J.Ehrig (Ed.), "Plastics Recycling – Products and Processes" Hanser Publication, Munich

Code & Title of the Course	PST 2105 High Polymer Chemistry
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	II

Sr. no.	Topics	Hrs.
1	New methods of synthesis of polymers like atom transfer polymerization, RAFT	5
2	Plasma polymerization	2
3	Group transfer polymerization	3
4	Nitroxide mediated polymerization	2
5	Solid state polymerization	3
6	Phase transfer polymerization	2
7	Metallocene catalysts for polymerization of polyolefins	3
8	Hyperbranched polymers	2
9	Healable polymers	2
10	Semiconducting polymers	2
11	Anionic and cationic polymerization	4

Course Outcomes

1.Student should understand the newer methods of synthesis, chemistry, mechanisms advantages and disadvantages, environmental concern of CRP

2. Student should understand the newer methods of synthesis, chemistry, mechanisms advantages and disadvantages, environmental concern of Plasma Polymerization and GTP

3. Student should understand the newer methods of synthesis, chemistry, mechanisms advantages and disadvantages, environmental concern of SSP and phase transfer polymerization

4. Student should understand the newer methods of synthesis, chemistry, mechanisms advantages and disadvantages, environmental concern, structure property relationship of of catalyst used in polyolefines manufacturing.

5.Able to understand chemistry synthesis, mechanism types properties and applications of Hyper branched healable and semiconducting polymers.

Textbooks/Sourcebooks:

1) Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1985.
2) Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.
3) Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.
4) Introduction to Polymer Science and Technology by H. S. Kaufman and J. J. Falcetta, Wiley – Interscience Publication, 1977
5) Handbook of Polyethylene, A. J. Peacock, Marcel Dakker Inc,2000
6)
7) R.P.Brown, Hand Book of Plastics Test Methods, George Godwin Ltd., London, 1981.
8) Analysis & Testing by Crompton.
9) J.S.Anand, K.Ramamurthy, K.Palanivelu how to identify Plastics by Simple Methods
10) G.C.Lves, J.A.Mead, M.M.Riley, Hand Book of Plastics Test Methods, The Plastics Institute,
11) Frank T.Traceski, Specifications & Standards for Plastics & Composites, ASM International, Metals Park, OH, 1990.
12) J.Hasiam, H.A. Willis, Identification & Analysis of Plastics, London lliffe Books Ltd., New Jersy,

Code & Title of the Course	PEP 2204 Testing and Characterization of Polymer Lab
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	II

Sr. no.	Topics	Hrs./week
1	To find MFI of given material	6
2	Mechanical testing like tensile flexural and impact strength % elongation	
3	Thermal study of polymers using DSC TGA DMTA	
4	Molecular weight determination using GPC	
5	XRD FTIR Particle size analysis surface tension and contact angle study	
6	Rheology of polymers using cone and plate viscometer	
7	Electrical testing like break down voltage arc resistance SR and VR	
8	Limiting oxygen index, weather resistance and Permeability	
9	Color testing, zeta potential	

Course outcomes

Upon completion of this course the student is expected to:

CO1. Ability to use select analytical and physical testing equipment and modern engineering tools necessary for characterization of polymers A1 K1 K5 K6 A1 A2

CO2.Ability to analyze and interpret data, process parameters and characterize additives and polymers within realistic constraints of the experiment K2 K4 K6

CO3. An ability to communicate effectively and understanding of professional and ethical responsibility team work A3

CO4.Use/select analytical and physical testing equipment to carry out suitable experiments

1. Polymer Morphology: Principles, Characterization,and Processing by Qipeng Guo, Wiely 2016
2. Handbook of Plastics Testing and Failure Analysis, 3rd Edition by Vishu Shah, Wiely 2007
3. Handbook of Plastics Analysis by H. Lobo CRC Press 2003
4. Polymer Charecterization Laboratory Techniques and Analysis by *Nicholas P. Cheremisinoff*,William Andrew Inc,1996
5. Polymer Characterization: Physical Techniques, 2nd Edition by Dan Campbell CRC Press 2000
6. Modern Methods of Polymer Characterization by Howard Barth John Wiley & Sons 1991

Code & Title of the Course	PEP 2205 Research II
Marks	150
Number of Hours per Week	18
Credits	9
Class	M Tech
Semester	II

Course Outcome:

1. Systematically perform experiments/modeling 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 PEP 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.

ELECTIVES (Semester I & II) **

Polymer Engineering and Technology

(These are open for offer to students of other disciplines also)

Code & Title of the Course	**PET 2501. Environment & Polymer technology ***
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	

Sr. no.	**Topics**	**Hrs.**
1	Role of polymers as replacement to various materials like glass, metal and wood	10
2	Polymers as energy savers in various fields. Their strength to weight ratio, advantages & limitations of polymers, misconceptions about polymers.	10
3	Recycling of polymers and environment, their coding. Different methods of recycling (physical and chemical)	10

Course outcomes

Upon completion of this course the student is expected to:

CO1. Ability to understand the properties and structure of polymer, which can overcome materials, like glass, metal and wood and also replace its application.
CO2. Ability to understand principle of conducting and insulating polymers along with mechanism. Types of polymers and with their advantage and disadvantage. Application of polymer.
CO3. Ability to understand different grades of polymer for recycling and their recycling code. Different methods of recycling polymer (physical and chemical) with respect to their recycling codes.
CO4. Ability to understand the impact of polymer recycling on environment.

Textbooks/Sourcebooks:

1. Plastics Materials J. A. Brydson, Butterworth Scintific, 1990.
2. Polymer chemistry, Seymour and Carraher, Marcel Dekker, 2003.
3. Polymer and Resins; Their Chemistry and Chemical Engg, Brage Golding, D.Van Nostrand Company Inc, 1959.
4. Polymer Blends & Alloys – An Overview: RP Singh, CK Das, S.K.Mustafi, Asian Books Published 1st ed. 2002.
5. Polymer Blends & Alloys: Folkes & Hopes Blackie academic Professional 1993.

6. Advance in Polymer Blends & Alloys Technology by Malvyn Kohudic, Technomic, 1988.
7. L.A. Utracki, Commercial Polymer Blends, Chapman & Hall, London, 1998.
8. D.R.Paul & Seymour Newman, Polymer Blends, Vo. 1 & 2, Academic Press, New York, 1978.
9. Chris Rauwendaal, Polymer Mixing a self study guide, Hanser Publishers, Munich, 1998.

Code & Title of the Course	**PET 2502. Smart Polymers ***
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	

Sr. no.	**Topics**	**Hrs.**
1	Definitions, shape memory polymers**,** polymers responding to various stimuli such as heat, light, pressure, fluids/chemicals etc.	10
2	Conducting polymers classification/ requirements for conductivity, doping of polymers, light emitting polymers, liquid crystal polymers, their classification (LCPs).	10
3	Advantages & limitations of these polymers. Synthesis of some of these polymers & their structure property relationship.	10

Course outcomes
Upon completion of this course the student is expected to:

CO1. Ability to understand the concept of smart polymers like shape memory, which respond to different stimuli like heat, light, pressure etc.
CO2. Ability to understand the principle and mechanism of smart polymers. Change in their physical and chemical property when them come in contact with external stimuli.
CO3. Ability to understand the classification of conducting polymers with their application and use. Principle and mechanism of conducting polymers along with doping of polymers to make them conducting.
CO4. Ability to understand the light emitting polymers and liquid crystal polymers along with there classification.

CO5. Ability to understand advantages and disadvantages of these polymers along with their structural property relationship.

Textbooks/Sourcebooks:

1. Smart Polymers: Applications In Biotechnology And Biomedicine by Igor. Galaev, Bo Mattiasson
2. Smart polymers for bioseparation and bioprocessing **by** Igor Yu Galaev, Igor Galaev, Bo Mattiasson
3. Coated Textiles: Principles and Applications by Ashish Kumar Sen
4. Bioconjugation protocols: strategies and methods by Christof M. Niemeyer

Code & Title of the Course	**PET2503 Packaging Technology**
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	

Sr. no.	**Topics**	**Hrs.**
1	Classification Polymeric Packaging Materials & types of packaging- rigid / flexible, characterization, determination of permeability. etc.	3
2	Packaging as a method for conservation of foods, pharmaceuticals, oils & other materials.	2
3	Packaging materials and their physico-chemical characteristics; their barrier properties, mechanical/ optical & other properties.	3
4	Methods of manufacturing of various packaging materials such as oriented films, bottles, multilayer films, tetrapacks etc. Additives used in these packaging materials to improve shelf life of packed material.	3
5	Evaluation of quality of packaging materials; Package design; Test procedures for packages; Cushioning materials	4
6	Selection of packaging materials and package design for various products; printing & decoration of packaging materials.	4
7	Packaging materials for newer techniques like radiation processing, microwave and radiowave processing, high pressure processing, modified atmosphere and thermal processing as retortable pouches; Biodegradable packing materials. Utilisation of waste packing materials	5
8	Modified and controlled atmosphere packing. Design of packaging materials based on product characteristic, lamination and coextrusion priority on plastics packing materials.	3
9	Multilayered films,. Metallization & orientation of films. Rigid packaging. Physical characteristics and testing of packing materials.	3

Course outcomes
Upon completion of this course the student is expected to:

CO1. Ability to understand different types of polymer material for packaging. Physical and chemical properties of polymer material use for packaging. Characterization of polymer packaging material.
CO2. Ability to understand the different method use to make packaging material like bottles, films, multilayer films, tetra pack etc. from different polymers. Adhesives used in making packaging materials to increase self-life and there properties.
CO3. Ability to understand different test of packaging material and design of packaging material.
CO4. Ability to understand concept of smart packaging like modified and controlled atmosphere packaging. Effect of this packing on the substrate. Lamination and coextrusion properties on the plastic packaging material.
CO5. Ability to understand physical characteristics and testing of multilayer films packaging, Biodegradable packaging. Utilization and management of waste packaging material.

Textbooks/Sourcebooks:

1. A.S.Athalye, "Plastics in Packaging", Tata McGraw – Hill Publishing Co. Ltd., New Delhi (1992).
2. A.S.Athalye, "Plastics in Flexible Packaging", Multi Tech Publishing Co. Bombay (1992).
3. Polymer Science and Technology of Plastics and Rubbers, P. Ghosh,
4. Principles of Polymer Systems, Rodriguez, Hemisphere Publishing Corpn, 1982.
5. Polymer Science and Technology by J. R. Fried, Prentice-Hall, Inc 1995.
6. Fundamentals of Polymer Processing, S. Middleman, Houghton Mifflin Compony, 1997.
7. Composite Material Handbook, M. M. Schwartz, McGraw-Hill company, 1984.
8. Composites: Design Guide, Industrial Press Inc, 1987.

Code & Title of the Course	**PET2504. Polymeric Nanocomposites ***
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	

Sr. no.	**Topics**	**Hrs.**
1	Definitions of composites & nano composites. Classification of nano-composites & their comparison with normal composites & blends	10
2	Different materials used to manufacture nano-composites & their grades.	10
3	Methods of manufacturing characterization techniques, processing of nano composites, current challenges, health and safety,	10

Course outcomes
Upon completion of this course the student is expected to:

CO1. Ability to understand the concept of polymer composite and polymer nano composite and there comparison. Alteration in physical and chemical properties of polymer nano composite from normal composite and blends.
CO2. Ability to understand manufacturing process of different polymer nano composites and composition of different polymer in polymer nano composite blend.
CO3. Ability to understand the advantages and disadvantages of polymer Nano-composites along with there application.
CO4. Ability to understand the impact of polymer Nano-Composites on Health and Environment and challenges to face in maintain polymer waster.

Textbooks/Sourcebooks:

1. Polymer Science and Technology of Plastics and Rubbers, P. Ghosh,
2. Principles of Polymer Systems, Rodriguez, Hemisphere Publishing Corpn, 1982.
3. Polymer Science and Technology by J. R. Fried, Prentice-Hall, Inc 1995.
4. Fundamentals of Polymer Processing, S. Middleman, Houghton Mifflin Compony, 1997.
5. Composite Material Handbook, M. M. Schwartz, McGraw-Hill company, 1984.
6. Composites: Design Guide, Industrial Press Inc, 1987.
7. Composite Polymeric Material, R. P. Sheldon, Applied Science Publishers, 1982.
8. Understanding Extrusion by Chris rauwendaal, Hanser Publishers, 1998
9. Fillers and Filled Polymers, J. F. Gerard, Wiley-VCH verlag GmbH, 2001.
10. Composites: Design Guide, Industrial Press Inc, 1987.
11. Composite Material Handbook, M. M. Schwartz, McGraw-Hill company, 1984.
12. Composite Polymeric Material, R. P. Sheldon, Applied Science Publishers, 1982.

Code & Title of the Course	**PET 2505 Adhesives and Adhesion**
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	

Sr. no.	**Topics**	**Hrs.**
1	Fundamentals of surface phenomenon, surface energy and surface tension. Basics of adhesion.	10
2	Theories of adhesion, applications, advantages and limitations.	4
3	Types of substrates. Types of adhesives, surface preparations, methods of adhesive, applications, troubleshooting, various polymers used in adhesive applications.	6
4	Testing of adhesives. Industrial adhesives.	10

Textbooks/Sourcebooks:

1. Hand book of Adhesive technology, Pizzi, A. (ed); Mittal, K.L. (ed), Marcel Dekker,New York, 1996
2. Adhesion and adhesives technology: an introduction, A.V. Pocius, Hanser/Gardner, Munich, 1997.
3. Adhesion and Adhesives - Science and Technology, Kinloch, A.J., Chapman and Hall, 1987

Code & Title of the Course	**PET 2506 Physical and Structural Characterization of Polymers**
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	

Sr. no.	**Topics**	**Hrs.**
1	Fourier Transform Infrared Spectroscopy: Molecular vibrations, basic theory of Fourier transform spectroscopy, inter-ferogram, data points collection; Instrumentation and advantages of FTIR spectrophotometry; Structural and conformational changes in polymers stress induced changes in polymer, chemical transformation and degradation in polymers, surface studies by ATR.	5
2	Thermal Analysis: Thermal transitions and their classification in polymers, glass transition temperature and its mechanism; Melting point of semi crystalline polymers; Characterizing polymer and polymer blends using DTA, DTG and DSC techniques; Thermal conductivity in polymers.	4
3	Microscopy: Basic principal of electron microscopy; Specimen-preparation, replication, coating and surface pretreatment; Structure determination of semi crystalline polymers by SEM and TEM; Lameller, fibrillar globular and spherylite structures in polymers.	4
4	X-ray Diffraction: Bragg law of X-ray diffraction, crystal geometry; Structural determination of polymers using wide and small angle X-ray diffraction techniques.	4
5	Nuclear Magnetic Resonance Spectroscopy: Theory of NMR phenomenon, relaxation process, chemical shifts, spin-spin interaction, interpretation of NMR spectra; Instrumentation-continuous and pulsed NMR; Characterization of polymers using NMR spectroscopy	4
6	Electrical Properties: Electrical conduction in polymers, dielectric properties, electrical conductivity measurements in polymers, static charge in polymers, commercial application of conducting polymers.	4
7	Optical Properties: Interaction of light with polymers reflection and refraction of light by polymers, birefringence, birefringence in isotropic and anisotropic materials, orientation birefringence and its measurements in polymers.	5

Textbooks/Sourcebooks:

1. Polymer characterization - Physical Techniques by D.Campbell and J.R. White (Chapman and Hall)
2. The Identification of Plastics and Rubber - K.J. Saunders (Chapman & Hall).
3. Instrumental Methods of Analysis - Willard, Dean and Merr
4. Text book of Polymer Science - Billmeyer (Wiley Eastern)
5. Analysis of Rubber and Rubber like Polymers - William .C. Wake (Maclaren and sons)
6. Thermal Characterization of Polymeric materials - E. Turi (Academic Press)

Code & Title of the Course	**PET 2507 Rheology of Polymers**
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	

Sr. no.	**Topics**	**Hrs.**
1	Basic concepts of Rheology	10
2	Constitutive equations, rheometry and characterization of plastics in terms of Rheology	10
3	Role of Rheology in polymer processing. Simple shear flows, elongation flows.	10

Textbooks/Sourcebooks

1. Plastics engineering. RJ Crawford - Butterworth-Heinemann. (2002).
2. Principles of Polymer Engineering, N. G. McCrum, C. P. Buckley and C. B. Bucknall, Oxford Science publications, 1989.
3. Applied Rheology in Polymer Processing, B. R. Gupta, Asian Books Private Limited, New Delhi, 2005
4. Introduction to polymer sience, L.H.Sperling,John wily and sons, 1985

Code & Title of the Course	PET 2508. Speciality Plastics
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	

Sr. no.	Topics	Hrs.
1	Polymer synthesis	15
2	Characterization for high temperature application, engineering polymers, photo resists polymers in solar energy utilization	10
3	biodegradable polymers, hydrolysis, and other newer type of polymers.	5

Textbooks/Sourcebooks:

1. Raw Materials for Industrial Polymers by H Ulrich, Hanser Publication1989.
2. Principles of Polymer Science, by Bahadur and Sastry, Narosa Publishing House 2002.
3. Polymer Science by Gowarikar, Johan wiley and Sons 1986.
4. Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc 1965.
5. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc 1988.
6. Petrochemicals The Rise of an Industry by Peter H. Spitz, Johan Wiley and sons 1988.
7. Polymer Chemistry by Malcolm P. Stevens, Oxford University Press, Inc, 1990.
8. Principles of Polymer Science, Bahadur and Sastry, Narosa Publishing House 2002.
9. Polymer Science , Gowarikar, Johan wiley and Sons 1986.

Code & Title of the Course	PET 2509 Biodegradable Polymers*
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	

Sr. no.	Topics	Hrs.
1	Problem associated with non biodegradable polymers, methods of recycling of polymers, importance of biopolymers.	10
2	Definition & classification of bio-degradable polymers natural & synthetic – bio-degradable polymers, factors affecting biodegradation, polymer modification	10
3	biodegradable polymer blends, biodegradation conditions and test procedures, bio-nano composites, applications of bio-degradable polymers in medical, agriculture, packaging etc.	10

Course outcomes

Upon completion of this course the student is expected to:

CO1. Ability to understand the concept of biodegradable polymer and the difference between Biodegradable and Non-Biodegradable polymers.
CO2. Ability to understand the principle and mechanism of biodegradable polymer.
CO3. Ability to understand the classification of biodegradable polymer and factors affecting its biodegradability.
CO4. Ability to understand the application of biodegradable polymer with different polymer blends and composite and their use in various fields.
CO5. Ability to understand the testing of various biodegradable polymer along with there impact on Environment and Health.

Text/ Source Books

1. The Role Of Peroxides In The Photo-Degradation Of Polymers, Developments In Polymer Degradation, G Scott, N. Grassie, App. Sci. Pub., London , 1979
2. Mechanism Of Antioxidant Action, Developments In Polymer Stabilization, G.Scott, Scott, App. Sci. Publication. London, 1981, Chapter 1.
3. G.J.L. Griffin, Chemistry and Technology Of Biodegradable Polymers, Blackie Academic Professional, 1994.
4. Gerald Scott & Dan Gilad, Degradable Polymer – Principles & Applications, Chapman & Hall,
5. Y.Doi And K.Fukuda (Eds), Biodegradable Plastics And Polymers, Elsevier (1994)

6. Absorbabale & Biodegradable Polymers – S.N.Shalaby & K.J.L. Burg, CRC Press (2003).
7. Handbook of biodegradable polymers by Abraham J. Domb, Joseph Kost, David M. Wiseman
8. Biodegradable polymers and plastics by Emo Chiellini, Roberto Solaro
9. Advances in Biodegradable Polymersby G. F. Moore, S. M. Saunders

Code & Title of the Course	**PET 2510 Polymer Post processing**
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	

Sr. no.	**Topics**	**Hrs.**
1	Decoration of plastics-Vaccum metalization,Electroplating of ABS	4
2	Printing and painting on plastics screen printing, offset printing, flexo/gravure printing	6
3	Surface preparation for such processes like plasma treatment	5
4	Hot stamp foil printing,In lay molding	5
5	Colouring of plastics, master batchers and their use in processing metallizing of plastics and similar operations.	5
6	Joining, welding, bonding of Plastics	5

Textbooks/Sourcebooks:

1. Encyclopedia of Composites,2nd Edition by Stuart Lee Wiely 2012
2. Fundamentals of Fibre Reinforced Composite Materials, Bunsell, Anthony R., Renard, J., Berger, M.H.Taylor Francis Ltd 2000
3. Encyclopedia of Polymer Science and Technology, Johan Wiley and Sons, Inc1965.
4. Encyclopedia of Polymer Science and Engineering, Johan Wiley and Sons, Inc1988.
5. Joining of Plastics By K.W. Allen Smithers Rapra Publishing 1988
6. Plastics finishing and decoration by Donatas Satas,Van Nostrand Inc, 1986
7. Decoration and Assembly of Plastic PartsBy Edward A. Muccio, ASM International 1999.
8. Designing with Plastics and Composites: A Handbook By Donald Rosato Springer Science & Business Media 2014
9. Composite Polymeric Material, R. P. Sheldon, Applied SciencePublishers,1982.
10. Composites: Design Guide, Industrial Press Inc, 1987.
11. Composite Material Handbook, M. M. Schwartz, McGraw-Hill company, 1984

Code & Title of the Course	PET 2511. Additives for Polymers
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	

Sr. no.	Topics	Hrs.
1	Classification of additives, properties, applications & mechanism of additives like uv stabilizers, antioxidants, anti-ozonents, oxygen scavengers, coupling agents	10
2	Rheology modifiers, anti-microbial, ethylene scavengers, coupling agents compatibilizers & other additives etc.	10
3	Chemistry of additives, evaluation of additives, mechanism of additives, newer trends in additives, functional additives.	10

Textbooks/Sourcebooks:

1) R.Gachter and H. Muller, "Plastics Additives Hand Books", Hanser Publications, Munich (1993).
2) J.A. Brydson, "Plastics Materials" Buterworth – Heinmann, Oxford (1999).
3) J.Murphy, "The additives for Plastics Hand Book", Elsevier, Odxford (1996).
4) R.P.Brown, Hand Book of Plastics Test Methods, George Godwin Ltd., London, 1981.

Code & Title of the Course	PHT 2106 Research Methodology
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	I

Sr.No.	Topic	Hrs.
8.	**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	4
9.	**Documentation** • "How" of Documentation • Techniques of Documentation • Importance of Documentation • Uses of computer packages in Documentation	4
10.	**The Research Report / Paper writing / thesis writing** • Different parts of the Research paper 5. Title – Title of project with author's name 6. Abstract – Statement of the problem Background list in brief and purpose and scope 7. Key-words- 8. Methodology-Subject, Apparatus / Instrumentation, (if necessary) and procedure	4

11.	**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	5
12.	**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 Questionnaire	5
13.	**Protection of patents and trade marks, Designs and copyrights** • 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	5
14.	Sources for procurement of Research Grants Industrial- Institution Interaction - Industrial projects – Their feasibility reports	3

Reference books:

16. Research in Education – Johan V. Best James V. Kahn
17. Presentation skills- Michael Halton- Indian Society for Institute Education
18. A Practical Introduction to copy right – Gavin Mcfarlane
19. Thesis projects in Science and Engineering – Richard M. Davis
20. Scientists in legal system – Ann labor science
21. Thesis and Assignment writing – Jonathan Anderson
22. Writing a technical paper- Donald Menzel
23. Effective Business Report writing – Leland Brown
24. Protection of Industrial property rights- Purushottam Das and Gokul Das
25. Spelling for the million – Edna furmess
26. Preparing for publication – King Edwards Hospital fund for London
27. Information technology – The Hindu speaks
28. Documentation – Genesis & Development 3792
29. Manual for evaluation of Industrial projects – United Nations
30. Manual for the preparation of Industrial feasibility studies

Code & Title of the Course	BST 2106 Intellectual Property Rights
Marks	50
Number of Hours per Week	2+1
Credits	3
Class	M Tech
Semester	I

Sr.No.	Topic	Hrs.
5.	**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	10
6.	Techno-legal requirements for filing of Patent Drafting of Patent Specification	4
7.	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	12
8.	**Case Studies:** Cases of Herbal medicines, biomolecules, agrochemicals, and bulk drugs, oil and textile in India and abroad before Patent Office/ Courts	4

Reference books:

1. Intellectual Property Rights By Khushdeep Dharni, Neeraj Pandey
2. Indian Patent Law And Practice By K.C. Kankanala (Oxford India) 2013 Edition