

# Post Graduate

Prospectus 2018 – 2020

Department of Polymer Engineering & Technology



## **M.Phil Polymer Technology**

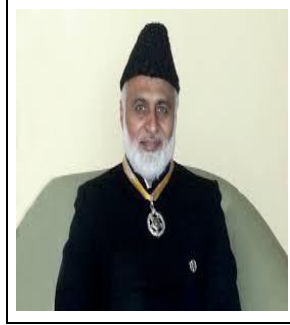
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College of Engineering & Emerging Technologies (CEET)  
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## **MESSAGE FROM WORTHY VICE-CHANCELLOR**

The University of the Punjab is the leading University of Pakistan. It has maintained its excellence in education, training and research in various fields of arts, social sciences, engineering and technology.

The University aims at high standards of quality education compatible with national needs and comparable to international universities of high repute abroad. It has always attracted talented students coming from all walks of life and regions within its territorial limits and all provinces of Pakistan under exchange program.

The University recognizes an integrated and inter-disciplinary approach to coordinate and cooperative teaching among the various disciplines belonging to different faculties of constituent parts of the University under one umbrella. The Faculty of Engineering & Technology is one of the most developed faculties of the University. It has developed since 1917 with a long history of dedicated and devoted teachers and researchers in various fields of Engineering & Technology. The alumni of this Institution are serving at higher professional positions in industrial/research organizations and universities at home and abroad.

The faculty comprises of Institute of Chemical Engineering & Technology, College of Engineering & Emerging Technologies, Institute of Quality and Technology Management, Centre for Coal Technology and Department of Textile Engineering which offer various engineering courses at graduate and post-graduate levels.

The University is committed to provide best possible facilities in terms of faculty staff, laboratories, libraries and environment for R&D activities leading to higher degrees. I hope that the talented candidates will be joining the engineering degree courses with the strong commitment to keep up the tradition of this Institution and help maintain the flag of the University high in the sky.

**Prof. Dr. Niaz Ahmad Akhtar**



### **MESSAGE FROM THE DEAN OF FACULTY**

Welcome to the Faculty of Engineering & Technology. We offer the best engineering environment coupled with the intellectual and technological resources. Faculty of Engineering and Technology is uniquely positioned to educate the technological leaders of tomorrow. Our goal is to position our engineering graduates to be problem solvers, project leaders, communicators, and ethical citizens of a global community.

In this technology-driven era, the socio-economic status of a country is directly or indirectly gauged by its potent engineering skills. Engineers are the builders of better world for mankind. The prestigious Institute of Chemical Engineering & Technology under the Faculty of Engineering & Technology, University of the Punjab, has been consistently catering to the needs of qualified and trained professional manpower in the form of chemical engineers and metallurgical engineers for the respective national industries over the past many decades. The alumni of the Institute have prodigiously contributed towards the development of process industry as well as various allied industries in Pakistan. Their performance at home and abroad is equally commendable.

In year 2005, the College of Engineering and Emerging Technologies was established under the Faculty. At present, the College is offering four years engineering degree courses in two disciplines, namely, Metallurgy & Materials Engineering and Electrical Engineering, thereto the program will be extended to other state-of-the-art disciplines.

Keeping in view the modern needs of manufacturing and services sector in the country, Institute of Quality & Technology Management was established in 2002 under this Faculty. The IQTM offers different Programs from B.Sc. (Engg.) to Ph.D level in the field of Industrial Engineering & Quality Management.

The teaching staff at the Faculty of Engineering & Technology is highly qualified, competent, dedicated, erudite, professionally experienced, and adequately capable of shaping the future engineers.

Taking this opportunity, I call upon the prospective graduates to transform the flashes of scientific imagination and engineering inspiration that form the stepping-stones, for making impossible of today the possible of tomorrow. The staunch challenge confronting the future engineers is the ultimate exploitation of national resources through indigenous engineering & technology development.

Faculty of Engineering & Technology is producing outstanding engineers, with great moral values, who are contributing in a prosperous and technologically advanced Pakistan and I look forward to scintillate future of the engineering profession and our beloved country.

**Prof. Dr. M. Taqi Zahid Butt**



### **MESSAGE FROM THE CHAIRMAN, DPE&T**

I am pleased to introduce Department of Polymer Engineering and Technology which has embarked upon a journey of unprecedented growth towards excellence. The Department of Polymer Engineering & Technology was established in 2004 but it became functional in 2006. By the fiscal support of HEC and logistical push of the Punjab University, adroitness has been established successfully within the Faculty of Engineering and Technology. About 100 million rupees were invested, in amassing various laboratory equipments for polymer & material synthesis, characterization, and processing under one roof. We have established seven high class research laboratories which are equipped with more than fifty state-of-the-art research equipments. Moreover, we are working on various research projects based on biomaterial, multifunctional composites, multipurpose membrane synthesis, novel polymer synthesis and improved paint manufacturing etc. in collaboration with various universities, R&D organizations and industries. In proximity with HEC we are at the forefront of expanding scientific knowledge through research and development. Our department is engaged in creating high impact national and international research in the field of polymer, material science and engineering.

A two year multidisciplinary M.Phil Polymer Technology program has been offered. Keeping in view the modern needs of research, we are planning to extend this M.Phil Program to indigenous Ph.D program in Polymer Science and Engineering. We are in the process of re-designating the M.Phil Polymer Technology program to M.Sc Polymer Engineering for engineering students and M.Phil Polymer Technology for science students. The department is also planning to start a four year B.Sc Polymer Engineering and Technology program in near future.

The teaching staff at the Department of Polymer Engineering and Technology is highly qualified, motivated, competent and dedicated with superb professional experience to develop and groom the best scientists and engineers for industry and academia. My team is leaving no stone unturned for promoting quality education and productive research which is beneficial for the university and for the technical, economic and professional growth of the country at large.

I feel privilege and honor to invite you to be a part of the Department of Polymer Engineering & Technology so that you get acquainted with fastest rising multi-disciplinary department and its programs which offers holistic education, unparallel teaching practices, and cutting edge research opportunities. We will equip you to work as a skillful engineer and effective scientist in multidimensional environment of industries, academia, private & government sector and in personal business activities.

**Prof. Dr. Rafi Ullah Khan**

## RULES & REGULATIONS OF SEMESTER SYSTEM GRADING SYSTEM

Letter grading should only be used for representing the individual courses and not for semester GPA or CGPA.

Equivalence in numerical grades, letter grades and grade points will be as follows:

Percent Marks	Letter Grade	Grade Points
85 & above	A	4.00
80-84	A-	3.70
75-79	B+	3.30
70-74	B	3.00
65-69	B-	2.70
61-64	C+	2.30
58-60	C	2.00
55-57	C-	1.70
50-54	D	1.00
Below 50	F	0.00
Withdrawal	W	

- i. Maximum possible Grade Point Average is 4.00.
- ii. Minimum Cumulative GPA for obtaining 2 year MS/M.Phil. (course work and comprehensive) is 2.50. In order to qualify in the examination of semester a student must obtain at least GPA 2.50 and in individual subject not less than 2.30 in mid term / final examination / session work separately in written, as well as in practical.
- iii. If GPA / CGPA of a student remains <2.50 (but >2.30) the student shall be given one chance (only once) to repeat two subjects (2-6 Credit Hours) in order to improve CGPA in MS/M.Phil. If GPA /CGPA of a student remain <2.50 he/she shall be dropped from studies.
- iv. In MS/M.Phil. leading to Ph.D. only those students who maintained CGPA  $\geq 3.0$  in MS / M.Phil shall be able to opt for Ph.D. and after qualifying comprehensive examination (GPA  $\geq 3.0$ ) status of such students shall be changed to Ph.D. MS / M.Phil Degree shall not be conferred on these students
- v. Minimum Cumulative Grade Point Average for Ph.D. (course work and comprehensive) is 3.00.
- vi. A fraction of mark in a course is to be counted as '1' mark e.g. 64.1 or 64.9 is to be count as 65.
- vii. Letter Grade and Grade Point scheme for a course will be used as given above.
- viii. In order to calculate the GPA, multiply Grade Point with the Credit Hours in each Course to obtain total: grade points, add up to cumulative Grade Points and divide by the total number of Credit Hours to get the GPA for a Semester.

$$\text{GPA} = \frac{\sum (\text{GP} \times \text{Credit Hours}) \text{ courses of a semester}}{\text{Total Credit Hours of a semester}}$$

- ix. For calculating CGPA, sum total of GPs in a semester earned in different courses multiplied by respective credit hour of a course and divided by total numbers of credit hours.

$$\text{CGPA} = \frac{\sum (\text{GP} \times \text{Credit Hours}) \text{ of all courses in a program}}{\text{Total Credit Hours of all courses in that program}}$$

## **RE-SIT EXAMINATION**

The students who cannot appear in examination because of genuine excuse / reason shall be allowed to appear in re-sit examination within one week after the examination subject to the payment of special examination fee of Rupees 5000/- for each course. If the number of courses is more than 2 then a lump sum of Rs. 10000/- shall be paid as special examination fee to the department

## **RE- ADMISSION ON MEDICAL / EMERGENCY GROUNDS**

A student who discontinues studies on medical/emergency ground will be allowed to seek re-admission in the same semester next year after paying semester fees. During the period of discontinuation of studies all the facilities shall be withdrawn which are normally available to regular students.

## **PROCEDURE FOR APPLICATION, ADMISSION AND REGISTRATION**

1. An applicant seeking admission to MS / MS leading to Ph.D; M.Phil / M.Phil leading to Ph.D and Ph.D. programmes shall apply on a prescribed form within the due date given in the advertisement for admission.
2. The application shall be submitted to the administrative office of the respective Department/ Institute/Centre/College/School in which the student wishes to pursue his/her studies.
3. The Departmental Doctoral Programme Committee (DPC - Chairman, all Professors & Associate Professors, one senior most Assistant Professor/Lecturer, holding Ph.D. degree) shall scrutinize the applications received for eligibility. In departments where there is no Professor/Associate Professor, Doctoral Programme Committee (DPC) will be constituted by the Vice-Chancellor on the recommendations of the Dean of the Faculty/Chairperson DPCC. In such cases for the evaluation of synopsis, 2-3 experts will be co-opted.
4. An applicant shall be judged on the basis of the following criteria for admission: -
  - a) Academic qualifications\* 40 Marks
  - b) Publications in HEC approved journals - (1 Mark per publication)-05 Marks
  - c) Professional experience in relevant field - 05 Marks (One Mark for each year for job in the relevant field / as per Departmental preference)
  - d) Written/Entry test (comprehension of the subject, General aptitude for research) - 40 Marks
  - e) Interview -10 Marks

Minimum marks for qualifying the written test & interview separately - 50%. Only those candidates who qualify the written test [designed by the respective department] will be called for an interview.

The Doctoral Programme Committee shall recommend to the Dean of Faculty concerned/ Chairperson DPCC for approval of the names of applicants, who are found eligible for studies leading to MS / MS leading to Ph.D M.Phil / M.Phil leading to Ph.D and Ph.D. degrees along with the name of supervisor/s for research. The selected candidates shall pay their dues (Annex-I) within stipulated time, failing which their admission shall be liable to be cancelled. Students of MS / MS leading to Ph.D; M.Phil / M.Phil leading to Ph.D have to complete 24-30 credit hour course work before converting to Ph.D, where Ph.D students have to complete 18 credit hour course work. The DPC/Faculty Council (as the case may be) will approve the title/synopsis. Final approval will be by Advanced Studies and Research Board (ASRB).

\*Break up of 40 marks for academic qualifications:

**M.S/M.Phil**

Course/Degree		%age marks					
		<b>45%</b>	<b>50%</b>	<b>55%</b>	<b>60%</b>	<b>70%</b>	<b>≥80%</b>
Matric	Marks	2	4	5	7.5	8.5	10
F.A / F.Sc.	Marks	2	4	5	7.5	8.5	10
B.A / B.Sc	Marks	2	4	5	7.5	8.5	10
M.A / M.Sc (Annual System)	Marks	2	4	5	7.5	8.5	10
M.A / M.Sc (Semester System)		CGPA					
		<b>2.5</b>	<b>2.7</b>	<b>3.0</b>	<b>3.40</b>	<b>≥3.80</b>	
B.S (Hons) 4 year / B.Sc( Hons) 4 year (16 year Education)	Marks	5	6	7.5	8.5	10	
	Marks	10	12	15	17	20	

**Note:** Qualification from Institutions other than the University of the Punjab will be equalized by the Equivalence Committee of the University of the Punjab.



## POSTGRADUATE PROGRAM FACULTY

### Professors

- 1. Prof. Dr. Rafi Ullah Khan**  
B.Sc Chemical Engineering  
M. Sc Computer Science  
M.Sc Chemical Engineering  
Ph.D Chemical Engineering (Germany)s

### Assistant Professors

- 1. Dr. Shahzad Maqsood Khan**  
B. Sc. (Engg) Chemical Engineering  
M. Sc (Engg) Chemical Engineering  
Ph. D (Engg) Chemical Engineering
- 2. Dr. Aneela Sabir**  
B. Sc. (Engg) Chemical Engineering  
M. Sc (Engg) Chemical Engineering  
Ph. D (Engg) Chemical Engineering
- 3. Dr. Atif Islam**  
M. Sc Chemistry  
Ph.D Materials Engg. / Polymer Chemistry
- 4. Dr. Sadia Sagar Iqbal**  
M.Sc (Master of Physics)  
MS (Materials and Surface Engineering)  
PhD (Materials and Surface Engineering)

### Lecturers

- 1. Engr. Muhammad Shafiq**  
B. Sc. (Engg) Chemical Engineering  
M. Sc (Engg) Chemical Engineering  
Ph. D (In Process)
- 2. Ms. Saba Zia**  
M. Phil Polymer Technology  
Ph.D Polymer Technology (In Process)

## VISITING FACULTY

- 1. Prof. Dr. Muhammad Zubair**  
M. Sc Chemistry, M. Phil Chemistry,  
Ph.D Chemistry,  
Chairman, Applied Chemistry Government College University Faisalabad
- 2. Prof. Dr. Asif Ali Qaiser**  
B. Sc. (Engg) Chemical Engineering  
M. Sc. (Engg) Chemical Engineering  
Ph.D. (Engg) Chemical Engineering  
Chairman, Department of Polymer and Process Engineering UET Lahore
- 5. Dr. Tanveer Iqbal**  
B. Sc. (Engg) Chemical Engineering  
M. Sc. (Engg) Chemical Engineering  
Ph.D. (Engg) Chemical Engineering  
Chairman, Department of Polymer and Process and Composite Engineering UET  
KSK Lahore
- 3. Dr. Atif Javed**  
B.Sc. (Engg) Polymer and Process Engineering  
Ph.D. Chemical Engineering  
Assistant Professor, Department of Polymer and Process Engineering UET Lahore
- 4. Dr. Abdul Ghaffar**  
M. Sc. Chemistry, M. Phil. Chemistry  
Ph.D Chemistry  
Assistant Professor, Institute of Chemistry UET Lahore
- 5. Dr. Farhan Saeed**  
B. Sc. (Engg) Chemical Engineering  
M. Sc. (Engg) Polymer and Process Engineering  
Ph. D. Chemical Engineering  
Department of Polymer and Process Engineering UET Lahore

### Research Officer

- 1. Ms. Nafisa Gull**  
M.Sc Chemistry  
M.Phil Polymer Technology  
Ph.D Polymer Technology (in progress)
- 2. Engr. Adnan Ahmad**  
B. Sc. (Engg) Chemical Engineering  
M. Phil Polymer Technology  
Ph. D Polymer Technology (in progress)

## **Research Scholar**

- 1. Engr. Fahd Jamshaid**  
B.Sc Chemical Engineering (Polymer)  
M.Phil Polymer Technology  
Ph.D Polymer Technology (in progress)
- 2. Ms. Sadaf Hafeez**  
B.Sc (Hons) Chemistry (organic)  
M.Phil Polymer Technology  
Ph.D Polymer Technology (in progress)
- 3. Ms. Saba Urooge Khan**  
M.Sc Chemistry  
M.Phil Polymer Technology  
Ph.D Polymer Technology (in progress)
- 4. Ms. Sehrish Jabeen**  
M.Phil Applied Chemistry

# M. Phil. Polymer Technology

## Eligibility Criteria for M.Phil Polymer Technology (Self Supporting Evening Program 2 Years)

- Students of following Disciplines are eligible to apply

B. Sc Engineering (Polymer, Chemical, Petroleum, Metallurgy & Materials, Civil, Mechanical, Textile & Environmental), M. Sc (Chemistry, Physics, Environmental Sciences, Biological Sciences and B. Sc Honors (Chemistry, Physics, Environmental Sciences)

### No. of Seats M. Phil Polymer Technology

40

### Admission Criteria

As per University Rules

### Fee Structure of M.Phil Polymer Technology

<b>1<sup>st</sup> Semester</b>	Rs. 53425/-	<b>2<sup>nd</sup> Semester</b>	Rs. 49500/-
<b>3<sup>rd</sup> Semester</b>	Rs. 51925/-	<b>4<sup>th</sup> Semester</b>	Rs. 49500/-

**COURSE WORK  
FOR  
M. Phil POLYMER TECHNOLOGY**

**DEPARTMENT OF POLYMER ENGINEERING & TECHNOLOGY**

**College of Engineering & Emerging Technologies**

**UNIVERSITY OF THE PUNJAB, LAHORE**

**(2018)**

**CURRICULUM OF**  
**M.PHIL POLYMER TECHNOLOGY PROGRAMME**

**Course Code: M.Phil Polymer Technology (PET)**

**1<sup>st</sup> Semester**

Course Code	Course Title	Credit Hours		
		Theory	Lab	Total
PET 601	Polymer Synthesis and Characterization	3	0	3
PET 602	Polymer Synthesis and Characterization (Lab)	0	1	1
PET 603	Polymer Rheology & Processing	3	0	3
PET 604	Polymer Rheology & Processing (LAB)	0	1	1
PET 605	Advance Composite Materials	2	0	2
PET 606	Research Methodology	1	0	1
	<b>Total</b>	<b>9</b>	<b>2</b>	<b>11</b>

**2<sup>nd</sup> Semester**

Course Code	Course Title	Credit Hours		
		Theory	Lab	Total
PET 607	Polymer Process Technologies	2	0	2
PET 608	Membrane Science and Application	3	0	3
PET 609	Polymer Plant & Control	3	0	3
PET 610	Elastomeric Materials	2	0	2
PET 611	Nano-Materials and Application	3	0	3
	<b>Total</b>	<b>13</b>	<b>0</b>	<b>13</b>

**3<sup>rd</sup> Semester**

Course Code	Course Title	Credit Hours	
		Thesis	Total
PET 620	Research Thesis	3	3
	<b>Total</b>	<b>3</b>	<b>3</b>

**4<sup>th</sup> Semester**

Course Code	Course Title	Credit Hours	
		Thesis	Total
PET 620	Research Thesis (Continued)	3	3
	<b>Total</b>	<b>3</b>	<b>3</b>

**Total Credit Hours = 30**

## First Semester

### **PET 601 POLYMER SYNTHESIS AND CHARACTERIZATION**

Polymer structure, classification of polymerization reactions, theory and practice of step growth polymerization, radical polymerization, ionic polymerization, ring-opening polymerization, polymerization by transition metal catalysts. Stereo-regulation and conformation of polymers. Structure property relation. Polymers degradation and stability with special emphasis on thermal and photo-degradation. Experimental techniques in polymer characterization: Investigation of polymer structure by infrared (IR) spectroscopy. Molecular weight characterization by gel permeation chromatography (GPC) and viscosimetry; Rheological properties by Rheometer; Morphological characterization by Thermal Methods: Differential Scanning Calorimetry (DSC), Thermogravimetric Analysis (TGA), Dynamic Mechanical Analysis (DMA), Thermomechanical Analysis (TMA). Characterization of mechanical properties by tensile testing.

#### **RECOMMENDED BOOKS:**

1. Allan H. Fawcett (Editor): Polymer Spectroscopy: Wiley, ©1996.
2. Barbara H. Stuart: Polymer analysis. Chichester ; New York : J. Wiley, ©2002.
3. Ferdinand Rodriguez et al.: Principles of polymer systems. New York : Taylor & Francis, 2003
4. Fred W. Billmeyer: Textbook of Polymer Science. New York : Wiley, ©1984.
5. Y Furusho; et al: **Polymer synthesis**. Berlin ; New York : Springer, ©2004.
6. G Odian; Principals of Polymerization ; John Wiley & Sons Inc 2004

### **PET 602 POLYMER SYNTHESIS AND CHARACTERIZATION (LAB)**

Preparation and characterization of the most important polymer types. Radical, cationic, anionic polymerization; copolymerization; Ziegler-Natta polymerization; step growth polymerization; suspension and emulsion polymerization. Characterization of polymers by up to fifteen methods, including spectroscopic (nuclear magnetic resonance, Raman, infrared), mechanical (tensile, dynamic mechanical, rheological), microscopic (electron and optical microscopy), and physiochemical (intrinsic viscosity, differential scanning, gel permeation chromatography). Lectures provide a state-of-the-art description of these and additional polymer characterization methods.

#### **RECOMMENDED BOOKS:**

- 1 Barbara H. Stuart: Polymer analysis. Chichester ; New York : J. Wiley, ©2002.
- 2 Cosima Stubenrauch (Editor): Microemulsions: Background, New Concepts, Applications, Perspectives: Wiley, 2009.
- 3 Dan Campbell; Richard A PThrick; Jim R White: Polymer Characterization (Physical Techniques). Stanley Thornes, c 2000.
- 4 Ferdinand Rodriguez et al.: Principles of polymer systems. New York : Taylor & Francis, 2003
- 5 Fred W. Billmeyer: Textbook of Polymer Science. New York : Wiley, ©1984.
- 6 Michael Buback; A. M. van Herk: Radical Polymerization: Kinetics and Mechanism. Weinheim Wiley-VCH 2007
- 7 Paul C Hiemenz; Timothy Lodge: Polymer Chemistry. Boca Raton : CRC Press, ©2007
- 8 Stephen L. Rosen: Fundamental Principles of Polymeric Materials. New York : Wiley, ©1982.

### **PET 603 POLYMER RHEOLOGY & PROCESSING**

Definition and measurement of the material functions of complex fluids, continuum mechanics of stress and deformation, constitutive equations derived from continuum and molecular theories, interrelation of material functions for shear and elongational flows, linear and nonlinear elasticity and viscoelasticity, material functions of important classes of polymeric fluids, the role of rheological properties in material characterization and polymer processing. Application of

engineering principles to the analysis of polymer processes such as extrusion, roll coating, mixing, etc. Applied fluid dynamics, with attention to heat and mass transfer processes. Basic technique for the rheological characterization of thermoplastic and thermoset resins; "hands-on" experience with the equipment used in polymer processing methods such as extrusion, injection molding, compression molding; techniques for mechanical characterization and basic principles of statistical quality control.

#### **RECOMMENDED BOOKS:**

1. B R Gupta: **Polymer processing technology**. Asian Books, 2008.
2. Chang Dae Han; **Polymer processing**. Oxford University Press, 2007.
3. James Lindsay White: **Principles of Polymer Engineering Rheology**. Wiley, ©1990
4. Jan C J Bart: **Plastics additives : advanced industrial analysis**. IOS Press, ©2006
5. Junji Furukawa; **Physical chemistry of polymer rheology**. Springer, ©2003.
6. Lawrence E Nielsen; **Polymer rheology**. M. Dekker, ©1977.
7. Macosko, Christopher W.: **Rheology: Principles, Measurements, and Applications**. VCH, ©1994
8. Nicholas P CheremisiCodeff; Paul N CheremisiCodeff: **Handbook of applied polymer processing technology**. M. Dekker, ©1996
9. R S Lenk; **Polymer rheology**. Applied Science Publishers, ©1978.
10. Sabu Thomas; Weimin Yang; **Advances in polymer processing**. CRC Press, 2009.

#### **PET 604 POLYMER RHEOLOGY & PROCESSING LAB**

Basic technique for the rheological characterization of thermoplastic and thermoset resins; "hands-on" experience with the equipment used in polymer processing methods such as extrusion, injection molding, compression molding; techniques for mechanical characterization and basic principles of statistical quality control.

#### **RECOMMENDED BOOKS**

1. B R Gupta: **Polymer processing technology**. Asian Books, 2008.
2. Chang Dae Han; **Polymer processing**. Oxford University Press, 2007.
3. James Lindsay White: **Principles of Polymer Engineering Rheology**. Wiley, ©1990
4. Jan C J Bart: **Plastics additives : advanced industrial analysis**. IOS Press, ©2006
5. Junji Furukawa; **Physical chemistry of polymer rheology**. Springer, ©2003.
6. Lawrence E Nielsen; **Polymer rheology**. M. Dekker, ©1977.
7. Macosko, Christopher W.: **Rheology: Principles, Measurements, and Applications**. VCH, ©1994
8. Nicholas P CheremisiCodeff; Paul N CheremisiCodeff: **Handbook of applied polymer processing technology**. M. Dekker, ©1996
9. R S Lenk; **Polymer rheology**. Applied Science Publishers, ©1978.
10. Sabu Thomas; Weimin Yang; **Advances in polymer processing**. CRC Press, 2009.

#### **PET 605 ADVANCED COMPOSITE MATERIALS**

Definitions and classification, natural composites. Property enhancement by reinforcement and orientation, matrix interface, synthetic fibers, properties and processing of composites with metallic, ceramic and polymeric matrices, interface reactions, mechanical and thermal properties of composite materials, stress relaxation and creep studies, dynamical mechanical properties, toughening mechanism and mechanical failure in polymeric materials.

#### **RECOMMENDED BOOKS**

1. Alan Kin-tak Lau; Farzana Hussain, Khalid Lafdi: **nano- and Biocomposites**. CRC Press, ©2010.
2. Lawrence E Nielsen: **Mechanical Properties of Polymers and Composites**. Dekker, 1974.



3. P K Mallick: Fiber-Reinforced Composites Materials, Manufacturing, and Design. CRC Press, 2008.
4. Pierre Delhaes: Fibers and Composites, Taylor & Francis, 2003.
5. Rakesh Kumar Gupta, Elliot Kennel, Kwang-Jea Kim: Polymer nanocomposites Handbook. CRC Press, ©2010.
6. Rao, C.N.R. Muller, A. and Cheetham, A.K. 2007. nanomaterials Chemistry: Wiley-VCH: John Wiley, 2007.
7. Sergeev, G.B: nanochemistry: Elsevier, 2006.
8. Vincent K S Choo: Fundamentals of Composite Materials: Knowen Academic Press, ©1990.
9. Yury Gogotsi: nanomaterials Handbook, CRC, Taylor & Francis, 2006.

### **PET 606 RESEARCH METHODOLOGY**

**Introduction of research methods, strategies and experimental design. Planning, proposing and presenting research projects. Quantitative and qualitative data analysis. Review of literature and reporting the results. Training of writing thesis and research articles for publication.**

### **RECOMMENDED BOOKS**

1. **Williamsons, K. "Research methods for students, academics and professionals: information management and system, 2<sup>nd</sup> edition, Woodhead Publishing Cambridge, UK. (2002).**
2. **Ranjeet Kumar, (2005) "Research methodology; a step-by-step guide for beginners" 2<sup>nd</sup> edition, Calif Publishing London, UK.**
3. **R. Barker Bausell (1999), "Advanced research methodology: an annotated guide to sources: Scarecrow Press Publishing, London, UK**

## Second Semester

### **PET 607 POLYMER PROCESS TECHNOLOGIES**

Technology and processing of synthetic resins (PU, PP, PE, etc), adhesive and sealants; Chemistry of Adhesives, Paints and Coatings; Polyurethane Foams, and Polymer Fibers; Surface preparation for adhesion, primers and coupling Agents. Process Techniques for various polymers for the following uses as synthetic fibers, adhesives, foams, plastics, synthetic rubber & surface coating compounds. Properties of polymers and their chemical structure, Polymer compounding, use of additives for improvement of qualities / properties of polymers.

#### **RECOMMENDED BOOKS:**

1. Andrew J Peacock; **Handbook of polyethylene: structures, properties, and applications.** Marcel Dekker, ©2000.
2. Ann-Christine Albertsson; **Polyethylene.** Springer, 2004.
3. George Woods: **Flexible polyurethane foams: chemistry and technology.** Applied Science Publishers, ©1982.
4. Harutun G Karian; **Handbook of polypropylene and polypropylene composites.** Marcel Dekker, ©1999.

### **PET 608 MEMBRANE SCIENCE AND APPLICATION**

Advanced separation processes theory, Membrane Separation Technology, Applications of Membranes, Membrane Separation Processes like Reverse Osmosis, Ultrafiltration, Nano Filtration, Preraporation, Membrane Modules, Membrane Plants

#### **RECOMMENDED BOOKS:**

1. Barry L Karger; Lloyd R Snyder; Csaba Horváth; **An introduction to separation science** , Wiley [1973]
2. C F Poole; Ian D Wilson; **Handbook of methods and instrumentation in separation science Volume 1;** Elsevier / AP Academic Press, ©2009.
3. Ian D Wilson; E R Adlard; Michael Cooke; C F Poole; **Encyclopedia of separation science;** Academic Press, ©2000.
4. K V Peinemann; S P Nunes; **Membrane technology. Volume 4, Membranes for water treatment** John Wiley [distributor], 2009.
5. Marcel Mulder; **Basic Principle of Membrane Technology;** Kluwer Academic Publishers, 2003.
6. Coderman N Li; James D Navratil; J M Calo; **Recent developments in separation science;** CRC Press, [1972]-©1986
7. Coderman N Li; KCodevel (Firm); et al **Advanced membrane technology and applications** Wiley, ©2008.
8. Richard W Baker **Membrane technology and applications.** J. Wiley, ©2004.
9. Satinder Ahuja; **Chromatography and separation science;** Academic Press, ©2003.

### **PET 609 POLYMER PLANT & CONTROL**

Unit Operation and Unit process in chemical and process engineering, heat and mass transfer in chemical /polymer engineering, flow sheeting, cost estimation, engineering principles applied to the analysis and design of polymerization processes, polymerization kinetics, ideal polymerization reactors, reactor dynamics and optimization, mixing effects, different types of reactors and their use, design parameters.

#### **Recommended books:**

1. Peter Harriot (2003) "Chemical Reactor Design", Marcel Dekker Inc. New York
2. J. F. Richardson and D. G. Peacock Vol. III (1994) "Chemical Engineering"
3. P. Tram Bouze and Jean-Paul Euzen (2002) "Chemical Reactor; from Design to Operation" editions technique france

4. Liven Spiel O (1999) Chemical Reaction Engineering 3<sup>rd</sup> Edition John Wiley and Sons Inc.
5. Deckwer W D (1992) "Bubble Column Reactors" John Wiley & Sons Inc.
6. Dale E. Seborg, T. F. Edgar, D. A. Mellichamp (2004) "Process Dynamics and Control", John Wiley & Sons Inc.
7. C.A. Smith and A.B. Corripio Third Edition (2006) "Principles and Practice of Automatic Process Control", John Wiley & sons Inc
8. Marlin, T.E 2<sup>nd</sup> Edition (2000) "Process Control: Designing Processes and Control System For dynamic Performance" Published McGraw Hill

### **PET 610 ELASTOMERIC MATERIALS**

Introduction to elastomeric material, structural requirements for elastomeric properties, theory of elasticity, Rubber Elasticity: Basic Concepts and Behavior, Chemistry of elastomeric material, Elastomer Synthesis, Modified natural elastomeric material, Polyester thermoplastic elastomers, Thermoplastic polyurethane elastomers, Advances in silicone based elastomeric material. Acrylic-based elastomers, highly saturated nitrile elastomers, Developments in diene-based Rubbers, Molecular foundations of polymer viscoelasticity. Rouse-Bueche theory, Boltzmann superposition principle, mechanical models, distribution of relaxation and retardation times, interrelationships between mechanical spectra, the glass transition, secondary relaxations, dielectric relaxations.

#### **RECOMMENDED BOOKS:**

1. *Aleksey D. Drozdov: Viscoelastic Structures.* Academic Press, ©1998.
2. Anil K Bhowmick;. Current topics in elastomers research, Taylor & Francis Ltd, 2008.
3. Bhowmick, A.K., Stephens, H.L. 1988. Handbook of Elastomers, M. Dekker, ©2001.
4. Ciesielski, A. 1999. An Introduction to Rubber Technology, Rapra Technology Ltd., 1999.
5. Forrest, M.J. 2001. Rubber Analysis – Polymers, Compounds and Products. Rapra Technology Ltd., 2001.
6. **G. Krans ed: Reinforcement of Elastomers.** Interscience Publishers [1965]
7. **J. D. Ferry: Viscoelastic Properties of Polymers.** Wiley, ©1980.
8. James E Mark; Burak Erman;. Science and Technology of Rubber, Elsevier, 2005.
9. Montgomery T. Shaw, William J. MacKnight; Introduction to Polymer Viscoelasticity. Wiley-Interscience, 2005.
10. Moore, Albert L Fluoroelastomers Handbook: The Definitive User's Guide. William Andrew Pub., ©2006.
11. **R. P. Brown: Physical testing of Rubbers.** Applied Science Publishers, ©1979.
12. Robert C. Klingender (Editor): Handbook of Specialty Elastomers. CRC Press, ©2008.
13. Sabu Thomas, Ranimol Stephen Rubber nanocomposites: Preparation, Properties and Applications. John Wiley & Sons, ©2010.

### **PET 611 NANOMATERIALS AND APPLICATION**

Introduction, Historical perspective and classification of nanomaterials, Present and future applications of nanotechnology, Nanotechnology for Catalysis, Nanoreactors, Nanocomposites polymers, Specific heat and melting point of polycrystalline materials, Classification of Nanoparticles, Nanoparticle Synthesis; Solid-State Synthesis of Nanoparticles, Vapor-Phase Synthesis of Nanoparticles, Inert Gas Condensation of Nanoparticles, Plasma-Based Synthesis of Nanoparticles, Flame-Based Synthesis of Nanoparticles, Spray Pyrolysis of Nanoparticles, Solution Processing of Nanoparticles, Sol-Gel Processing, Solution Precipitation, Water–Oil Microemulsion (Reverse Micelle) Method, Commercial Production and Use of Nanoparticles, Fullerenes, Structure and Properties, Chemistry of Carbon Nanotubes, Nanofiber Technology,

Nanotubes in Multifunctional Polymer Nanocomposites, Nanoporous Polymers — Design and Applications, Nanotechnology and Biomaterials, Nanoparticles for Drug Delivery

**RECOMMENDED BOOKS:**

1. Sergeev, G.B. 2006. Nanochemistry, Elsevier, Inc., Amsterdam
2. Rao, C.N.R. Muller, A. and Cheetham, A.K. 2007. Nanomaterials Chemistry, Wiley-VCH
3. Bandyopadhyay, A. K. 2008. Nano Materials, New Age International (P) Ltd., Publishers, New Delhi.
4. Gogotsi, Y. 2006. Nanomaterials Handbook, Taylor & Francis Group, LLC Nanoparticles and Catalysis
5. Zhou, B., Han, S., Raja, R., Somorjai, G.A., 2007. Nanotechnology in Catalysis, Vol.3, Springer Science and Business Media, LLC
6. Klabunde, K. J. 2001. Nanoscale Materials in Chemistry, Wiley Interscience, John Wiley & Sons, Inc., New York
7. Astruc, D. 2008. Nanoparticles and Catalysis, Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim

**Third Semester**

**PET 620      Research Thesis**

The students shall collect literature and submit synopsis of prescribed research topics assigned to them in third semester.

**Fourth Semester**

**PET 620      Research Thesis (Continued)**

The students shall perform experimental investigations on the prescribed research topics assigned to them in third semester and prepare the required project thesis for submission and for viva voce examinations.

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