

Subject: Minutes of the 18<sup>th</sup> Board of Studies (BOS) Meeting

18<sup>th</sup> Meeting of Board of Studies of University School of Chemical Technology was held on July 31, 2015 at 2.30 PM in the Seminar Hall (No. 114) B, Block. The following members were present:

- |    |   |          |
|----|---|----------|
| 1. | Prof. A K. Jain<br>Dean, USCT             | Chairman |
| 2. | Dr. Chitra Rajgopala<br>DRDO, Delhi       | Member   |
| 3. | Prof. U. K. Mandal<br>Professor, USCT     | Member   |
| 4. | Dr. Neeru Anand<br>Associate Prof. USCT   | Member   |
| 5. | Dr. Rakesh Angira<br>Associate Prof. USCT | Member   |
| 6. | Dr. B. Sarkar<br>Associate Prof. USCT     | Member   |
| 7. | Dr.S.K.Sharma<br>Assistant Prof. USCT     | Member   |
| 8. | Prof. Rajesh Khanna<br>IIT, Delh          | Member   |

Prof. K.J. Mukherjee (JNU) Prof. Sri Chand (IIT Roorkee) and Dr. M.M. Mandal (USCT) could not attend the meeting due to their pre-occupation.

1. Scheme/Syllabus for PhD students was discussed and approved (Annexure -1)
2. Registration of the following PhD scholars: They have completed the desired course work (9 credits) and 2 directed courses. (Annexure -2)
  - Sanigdha Acharya
  - Shweta Gupta
  - Vrinda Goyel
  - Satya Pal Verma
3. PhD scholars are required to earn minimum nine credits. One Course is compulsory ( CT-713) and the other courses can be taken from any existing/running PG/ PhD courses from USCT or any other USS schools depending on his/her requirements with the consent of SRC.
4. BOS has approved the following two PhD courses and their syllabi. One course is compulsory and the other optional.
  - CT-713-Research Methodology & Data Analysis (Compulsory)
  - CT-715-Applied Mathematics in Chemical Engg.
5. Examiners list (for theory and practical paper was updated (Annexure -3)

Submitted for kind approval please.

*AK Jain*  
Prof. AK. Jain  
Dean, USCT

Hon'ble Vice Chancellor

*Seen*  
*Adyaji*  
21/8/2015  
*Dean USCT*

2761/F/USCT/15  
7/8/15

GGSIPUNCO  
Diary No. 1.1.02792  
Date 18.08.15

GGSIU/USCT/2015/  
July 31, 2015

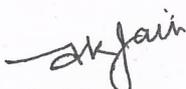
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| 7. | Dr. S.K. Sharma<br>Assistant Prof. USCT   | Member   |
| 8. | Prof. Rajesh Khanna, IITD                 | Member   |

Dr. M.M. Mandal (USCT) could not attend the meeting as she is on leave

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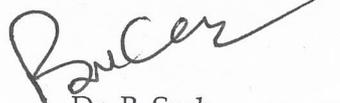
  
Prof. A.K. Jain

  
Prof. U.K. Mandal

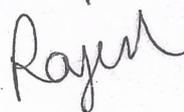
  
Dr. Chitra Rajgopal

  
Dr. Neeru Anand

  
Dr. Rakesh Angira

  
Dr. B. Sarkar

  
Dr. S.K. Sharma

  
RAJESH KHANNA

# UNIVERSITY SCHOOL OF CHEMICAL TECHNOLOGY

## SCHEME OF EXAMINATION

&

## SYLLABI

of

### Ph. D. in Chemical Engineering

(w.e.f. 2015 Onwards)



**GURU GOBIND SINGH INDRAPRASTHA UNIVERSITY**  
**Dwarka, New DELHI - 110078**

**Entrepreneurship | Employability | Skill Development**

Approved in the Board of Studies of the School in its 18<sup>th</sup> meeting held on 31-07-2015

## **Guru Gobind Singh Indraprastha University**

### **Vision**

The University will stimulate both the hearts and minds of scholars, empower them to contribute to the welfare of society at large; train them to adopt themselves to the changing needs of the economy; advocate them for cultural leadership to ensure peace, harmony and prosperity for all.

### **Mission**

Guru Gobind Singh Indraprastha University shall strive hard to provide a market oriented professional education to the student community of India in general and of Delhi in particular, with a view to serving the cause of higher education as well as to meet the needs of the Indian industries by promoting establishment of colleges and Schools of Studies as Centers of Excellence in emerging areas of education with focus on professional education in disciplines of engineering, technology, medicine, education, pharmacy, nursing, law, etc.

### **Quality Policy**

Guru Gobind Singh Indraprastha University is committed to providing professional education with thrust on creativity, innovation, continuous change and motivating environment for knowledge creation and dissemination through its effective quality management system. Rules & Regulations University administration functions while dealing with various issues of administrative and academic significance, within the provisions of the University Act, rules and regulations (Statutes & Ordinances) framed thereunder.

## University School of Chemical Technology

The University School of Chemical Technology recognizes the importance of chemical industry and the need for trained manpower, since establishment of the University in 1999, THE UNIVERSITY has taken the bold and visionary decision to start the University School of Chemical Technology, the only one of its kind in this part of the country after IIT, DELHI. The founding fathers concerned with education required in chemical industry showed extraordinary vision 100 years ago to recognize that education to provide trained manpower could be provided under two broad areas namely Unit Operations and Unit Processes. This framework still holds although it has evolved, expanded and continuously tuned over the last 10 decades to progressively include thermodynamics, reaction engineering, process control, process economics, mathematical and numerical methods, computers, process engineering, separation processes, catalysis hazard and safety etc. each one advancing in its own right with extensive research work both in academia and in industry. The school was established with the twin objectives of generating effective trained professionals and to keep pace with the R & D activities of this fast- changing field of Chemical Technology. The B.Tech. and M. Tech (Chemical and Biochemical) programme being offered by the school are based on the pattern of I.I.T.'s and other national and international institutions of repute. The well-structured programmes are meant to impart comprehensive knowledge of various core chemical and biochemical engineering subjects, interdisciplinary courses in Biotechnology, Information Technology, Environment Management, Management Studies through Electives, and industrial exposure through practical training in laboratories and Industrial Units.

### **Vision**

Achieving excellence through active teaching, skill development and research in the areas of chemical and biochemical engineering and allied areas to become a recognized center for education and research.

### **Mission**

- To generate new knowledge by offering graduate and post graduate programme and provide quality manpower with high employment potential in the present liberalized economic climate in the era of globalization.
- To generate new knowledge by offering graduate and post graduate programme.
- Impart quality teaching and train students in addressing the challenges in the Chemical and Biochemical Engineering and allied areas.
- Provide quality manpower with high employment to achieve proficiency in Chemical and Biochemical Engineering through innovative teaching and state of the art laboratories.
- Develop inclusive technologies with a focus on sustainability.
- Team up with industries and research institutes to cater community needs.

## **Doctor of Philosophy** **(Chemical Engineering)**

The school was established since the foundation of the university in 1999. It is now a center for teaching and research in the modern field of chemical technology and biochemical engineering. Considering the dynamism of science and engineering, the school started the post graduate course in chemical engineering since the conception of the university. The purpose was creating well-trained human resources to fulfil the growing demand in the fields of chemical processes development. The course emphasized to synthesize and evolve chemical process technology towards sustainable development and trained work force for research and development. The curriculum has been designed in order to provide education to the students with background of Chemical Engineering/ Biochemical Engineering/ Chemical Technology/Biotechnology/Environmental Engineering or allied fields. The Ph.D. in Chemical Engineering has been designed to prepare each student to actively participate in the development and growth of the field of chemical engineering at all levels in the industry or in research and teaching in a university or a research organization. Students can enter the Ph.D. program either with a master's or a bachelor's degree in engineering and select their research areas at the end of the first semester. Research is being carried out in a wide range of modern chemical engineering areas ranging from separation technology, nanotechnology, bioengineering, energy and sustainability, transport and reaction engineering etc.. Students are exposed to advanced experimental and theoretical techniques, attend national and international conferences as well as workshops and specialized schools during the program. Several research areas are interdisciplinary in nature and others are funded by industry/Govt. funding agencies, giving students a flavor for both applied and basic research. Students with a Ph.D. degree either pursue a post-doctoral position aiming for an academic career or find employment in industries at different level including R & D. Also students will gain competence to serve the various higher educational institutions for both teaching and research.

**Program Educational Objectives (PEO)**

PEO1	Pursue successful industrial/academic/research careers in chemical engineering and allied fields. Contribute as Chemical Engineer by conceptualizing various engineering principles to improve technology.
PEO2	Apply the knowledge of advanced topics in chemical engineering to meet contemporary needs of industry and research. Pursue higher education, and contribute to research and development, through innovation and continuous learning.
PEO3	Exhibit project management skills with the multifaceted aspects of using modern software, equipment/ analytical instrument, and ability to work in collaborative environment.
PEO4	To make professionals to apply principles of chemical engineering in solving practical problems related to safety, energy and environment.
PEO5	Pursue self-learning to remain abreast with latest developments for continuous technical and professional growth. Exhibit leadership skills and entrepreneurial qualities for the welfare of society.
PEO6	Research is carried out in a wide range of modern chemical engineering areas ranging from biochemical engineering, energy and sustainability, environment engineering. To apply a significant range of advanced and specialized skills and be able to act autonomously in the planning and implementation of research.
PEO7	Explain aspects of instrumentation such as, Spectroscopic detection Techniques, Chromatographic techniques, and students will be proficient in utilizing the various equipment in the department.
PEO8	To educate students to be scientifically literate and provide them opportunities for professional growth through designing and executing chemical research projects.

**Programme Outcomes (POs)**

At the end of the program the student will be able to:

PO1	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences
PO2	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO3	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to arrive at scientifically acceptable conclusions.
PO4	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO5	Function on multidisciplinary team or to lead a technical group.
PO6	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
PO7	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings
PO8	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological challenges.

**Programme specific outcomes (PSOs)**

PSO1	Apply the knowledge of basic science and engineering principles to identify, formulate and analyze Chemical engineering and allied industrial problems as a successful employee/employer. Apply the principles and practices of Chemical Engineering discipline along with the basic sciences and humanities to solve the complex engineering problems concerning the issues of environment, safety, economics, culture and society etc.
PSO2	The students acquire the design solutions for engineering problems and processes with due consideration for transport operations, control systems, environmental concern safety and waste minimization by appropriate technology and process simulation tools. Design, develop and modify the chemical processes and to analyze these by applying the physicochemical and biological techniques.
PSO3	The students will be expertise to synthesizing the information of recent advancement in chemical engineering for conducting research in the wider fields of theoretical development, current issues and strategies planning.
PSO4	The students will comprehend to function effectively as an individual, researcher and as a member or leader in multidisciplinary settings of engineering community and society. Acquire and apply the new knowledge with professional responsibility and ethics towards the advancement of academic and research pursuits in chemical and allied disciplines in the societal contexts.

<b>Theory Papers</b>					
<b>S. No</b>	<b>Paper Code</b>	<b>Paper</b>	<b>L</b>	<b>T</b>	<b>Credits</b>
<b>Compulsory Courses</b>					
1	CT-713	Research Methodology and Data Analysis	3	1	4
	CT-715	Applied Mathematics in Chemical Engineering	3	1	4
<b>Optional Courses</b>					
2		Elective*			
3	CT717	Self-Study	0	1	1

\*(**Elective Course**): Students can select from any existing/running PG/Ph.D. courses from USCT or any other University school studies depending on student's requirements with the consent of RAC/SRC.

**Elective course credits can be 2/3/4 depending on the subject chosen for study.**

The student is required to complete the course work requirements as per Ph.D. Ordinance of GGSIPU applicable from time to time.

Practical/Viva Voce						
Paper ID	Paper Code	Title	L	T	P	Credit
	CT-717	Self-Study	0	1	0	1
		<b>Total</b>	<b>0</b>	<b>1</b>	<b>0</b>	<b>1</b>

**Course Objectives:**

- To acquire hands-on experience in the application of theoretical techniques to engineering problems.
- To educate the students in understanding the multifaceted aspects of chemical engineering and in applying the various computational methods studied, for problem analysis and solution.
- To use research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of the information to provide valid conclusions.
- Create, select, and apply appropriate techniques, resources, and modern engineering and research tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

**Course Outcomes:**

- The students will be able to deliver well-organized technical presentations at conferences and other symposia.
- Undertake real life projects in process industries and allied fields.
- Students will gain the understanding of selected classic and current topics in theoretical aspects.
- Communicate effectively on complex engineering activities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

**Course Content**

- Students should give atleast three presentations per semester to his/her research topic.

Code	Course name	L	T	P	Total credits
CT -713	Research Methodology and Data Analysis	3	1	0	4

### Course Objective

- To develop an understanding of various techniques used in research and data analysis

### Course Outcomes

- Understand research process, different research methods and techniques
- Understand and apply statistical concepts and statistical interference to analyze data that can assist in future researches
- Explore regression analysis and learn to develop models
- Enable the students to conduct the design of experiments

### Course content:

**Unit 1: Scientific research:** Meaning, characteristics, and significance of the scientific research. Steps of research process, Research presentation, Data/ Literature sources and their access.

**(4 Hrs)**

**Unit 2: Descriptive Statistics and Measures of Variability:** Representation of data: Mean absolute deviation, variance, standard deviation and their calculation; z-scores; Coefficient of variation.

**(8 Hrs)**

**Unit 3: Regression Analysis and Correlation:** Correlation; Single and multiple regression analysis; Residual analysis; Standard error of estimate; Coefficient of determination; Estimates.

**(10 Hrs)**

**Statistical Interference:** Hypothesis testing; z- statistics and t-statistics; Sampling and data collection: Analysis of variance (ANOVA).

**(10 Hrs)**

**Unit 4: Research Design:** Basis principles of experimental design: Types of experimental design; Factorial design of experiment; Box Wilson method; Response surface analysis: Design of experiments and analysis of data using statistical software like Design Expert etc. with application to chemical/biochemical engineering problems.

**(10 Hrs)**

**Text & Reference Books:**

1. C.R. Kothari, and Gaurav Garg, Research Methodology Methods and Techniques, Fourth edition, New Age International (P) Limited, Publishers, 2020.
2. Ken Black, Applied Business Statistics, Seventh Edition Wiley India, 2012.
3. C. George Thomas, Research Methodology and Scientific Writing, 2nd Edition, ANE Books India and Springer Nature Switzerland AG, 2021.
4. R.E. Walpole, Myers, R.H., Myers, S.L. and Ye, K., Probability and Statistics for Engineers and Scientists, Ninth edition Pearson Education (2012).

CT – 715      **Applied Mathematics in Chemical Engineering**

**L T P Credits**

**2 1 0      3**

Mathematical formulation of chemical engineering problems with the application of law of conservation of mass, momentum and energy.

(6 Hrs.)

Vector and tensor spaces; metric, norm and inner products; orthonormalization; matrices, operators and transformations; eigenvalues and eigenvectors; and its application to chemical engineering systems for solving linear algebraic equation, homogeneous and non-homogeneous ordinary differential equation (Initial value problem)

(12 Hrs.)

Classification of second order partial differential equation (PDE) and types of boundary condition. Analytical solution techniques (Integral method, Separation of variables, Laplace transform) for solving PDE in chemical engineering. Linear stability and limit cycles.

(12 Hrs.)

Solution of linear algebraic equation, non-linear algebraic equation, ODE (IVP and BVP) and PDE using MATLAB.

(12 Hrs.)

**Books:**

1. Applied Mathematics in Chemical Engineering, Mickley, H. s. Sherwood, T. K., and Reed, C. E., McGraw Hill, N. Y.
2. Mathematical Methods in Chemical Engineering. Pushpavanam, S., PHI
3. Mathematical Methods in Chemical Engineering. Jason V. G. and Jeffreys, G. V. Academic Press, 2012.
4. Numerical Methods for Engineers, Gupta S. K., New Age International (P) Ltd., Publishers, 2010.