INTERNAL REVIEW

Department of Chemical Engineering
Indian Institute of Technology - Delhi

Website :

http://chemical.iitd.ac.in/

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Submitted to:
Indian Institute of Technology - Delhi
New Delhi - 110016

This document is prepared by dedicated effort of the faculty members, with commensurate support from staff members. Last five years (2008-2013) data were collected in-house and analyzed and compared wherever comparable data was available in the open domain for other Institutes and Universities. To the best of our knowledge, the data collected are error free and reflect the facts on hand.

The internal review document is prepared in eleven sections as given in the Contents page. Each section is presented with executive summary, data in the form of tables, charts and analyses and supplemented by information in appendices.

Feb 11, 2014

Suddhasatwa Basu
Head Chemical Engineering Department

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Contents

Vision Statement

The Department's long term vision is to become a world leader in the technologies related to energy, environmental protection, novel materials and healthcare. The Department has been prolific in the areas of materials development for energy generation and storage, catalysis and multiphase reactor engineering, process intensification in non-renewable and renewable energy sectors, modeling and simulation from molecular to process scales, and bioprocessing related to the pharmaceutical industry. We would like to build on our strengths and strive for national and international presence in these areas by continuing our fundamental research and technology development initiatives, and further strengthening our bachelors, masters and doctoral programs. We expect that these endeavors will not only attract superior faculty, but will provide and create an enabling ecosystem for students to explore, innovate and smoothly transition into the professional arena. The Department would like to build focused research programs networked with industry, institutions, universities and government agencies. We would like to develop/co-develop effective and affordable technologies scripting joint IPR in partnership with industry, or through consortia leading to spin-offs. The Department strives to promote a technology temperament in society at large, especially to young minds through extensional activities via technology enhanced video and web based distance learning courses, creation of virtual laboratory and resource centres and participating in policy making and public debates.

Section 1

CURRICULUM

Executive Summary: Curriculum

The Department has been running an academically rigorous and globally competitive curriculum to train our UG and PG (M. Tech.) students for the employment market as well as for higher education, and our research scholars for a career in academic and industrial research. While we continue in this task with full earnest, we are also facing the twin challenges of increased enrolment as well as heterogeneity in the background and training of incoming students. The benchmarking of our programme with different institutions in India and abroad suggests that our core courses content is comparable, and indeed we offer a more diverse basket of electives. The current curriculum is seen as relevant by the "core" employers, as clear from the list of companies from private sector, public sector and multinational companies who come to recruit our graduates. However, we are also cognizant of the fact that the curriculum requires periodic revision to maintain its relevance to all stakeholders (students, faculty and employers), and in that respect the Department has undertaken an elaborate review of the Curriculum in recent months. The challenge lies in its effective implementation and maintaining continued relevance.

1.1 List of degree programmes offered - UG + PG - and enrolment

	Programme Name	Current Sanctioned Strength (2013)
UG	B. Tech. in Chemical Engineering (CH1)	71
	B. Tech. in Chemical Engineering and M. Tech. in Chemical Engineering (CH7) [Dual Degree]	52
PG	M. Tech. in Chemical Engineering (CHE) and M.S.(R) in Chemical Engineering (CHY)	42*
	Ph.D. in Chemical Engineering (CHZ)	140

* Includes M.S. (R)

Number of Graduating Students in degree programmes (last 5 years):

Year	B. Tech.	Dual Degree	M. Tech.	MS(R)	Ph.D.
2013	59	34	14	1	5
2012	53	28	11	1	7
2011	48	33	23	0	4
2010	33	27	16	1	9
2009	44	28	22	3	5

Number of students currently on-roll (October, 2013):

B. Tech.	290
Dual Degree	246
M. Tech. (2-year)	60
MS(R)	2
Ph.D.	105

1.2 Consistency of curricula with academic vision of the Department

The vision statement of the Department, that has been put together recently, reads as follows:

"*The Department's long term vision is to become a world leader in the technologies related to energy, environmental protection, novel materials and healthcare. The Department has been prolific in the areas of materials development for energy generation and storage, catalysis and multiphase reactor engineering, process intensification in non-renewable and renewable energy sectors, modelling and simulation from molecular to process scales, and bio-processing related to the pharmaceutical industry. We would like to build on our strengths and strive for national and international presence in these areas by continuing our fundamental research and technology development initiatives, and further strengthening our bachelors, masters and doctoral programs. We expect that these endeavours will not only attract superior faculty, but will provide and create an enabling ecosystem for students to explore, innovate and smoothly transition into the professional arena. The Department would like to build focused research programs networked with industry, institutions, universities and government agencies. We would like to develop/co-develop effective and affordable technologies scripting joint IPR in partnership with industry, or through consortia leading to spin-offs. The Department strives to promote a technology temperament in society at large, especially to young minds through extensional activities via technology enhanced video and web based distance learning courses, creation of virtual laboratory and resource centres and participation in policy making and public debates.*"

The present curricula in operation (entrants at all levels in 2013 or earlier) is in keeping with this vision, which we have cherished and sustained for a while, and which brings a curricular mix of fundamentals and application. At all levels (UG, PG), the focus is on broad-based core courses which cover the main concepts in any sub-area of Chemical Engineering. This is followed by a list of strategically designed electives which imparts in our students the necessary skills and knowledge to specialize in a chosen sub-area of Chemical Engineering.

At present, the courses offered by our Department at UG and PG levels are listed under Section 1.3(c).

1.3 Quality of programmes

(a) Periodicity of curriculum review: UG and PG

As a Department offering both UG and PG programmes, Department of Chemical Engineering has been participating in and contributing to the Curriculum Review process

whenever it has been mandated by the Senate. The last UG and PG review was in 2003, and implementation of a revised curriculum is underway at present. In the interim period, the Department did a mid-term review (as per Institute guidelines). A PG Curriculum Review has just been started.

It is noteworthy that the Department decided in 2006 to merge two pre-existing streams for Dual Degree and 2-Year M. Tech. programmes and evolve a single B. Tech. in Chemical Engineering and M. Tech. in Chemical Engineering. This had become essential in order to make the programmes more focussed, have a more equitable distribution of teaching load in the Department, and present before the students a broad-based but technically enriching array of courses. This was implemented from academic year 2007-08. The attached DFB minutes dated 21.09.2006 and 27.09.2006 are relevant.

(b) Mechanism for review at UG and PG level

The current UG Curriculum Review process has been undertaken at the Institute level in two stages. First, an Undergraduate Curriculum Review Committee was formed in late 2011 at the Institute level, in which one faculty colleague from the Department was nominated. This Committee deliberated on and evolved a Concept Paper which envisaged the broad outline of the revised curriculum. This was discussed and eventually passed by the Senate. Subsequently, an Undergraduate Curriculum Implementation Committee was formed in which two faculty from Department are members. This Committee is responsible for smooth implementation of the revised curriculum in the Department and the Institute.

As soon as the Undergraduate Curriculum Review Committee (UCRC) was constituted, at the Department level a small committee was set up to review the curriculum of the Department and calibrate it against the evolving outline of courses at the Institute level. As the UCRC finalized its recommendations through 2013, the Department Curriculum Review Committee also undertook a thorough review of its courses, including taking a re-look at existing courses, taking feedback from current and recently graduated students, etc. This activity has been recorded in meeting minutes that have been attached, presentations made to the Department CRC and DFB, and relevant emails exchanged.

As the Institute moved towards Curriculum Implementation in 2013, the Department also undertook similar activity. For details, see DFB minutes (attached) dated 26.02.2013, 19.08.2013 and note (sent to Dean, Academics) titled "Proposal for UG Curriculum of Department of Chemical Engineering". Since the revised Department Curriculum is now finalized and has been forwarded to Dean, Academics for discussion in Senate, the List of Courses is being included as an Appendix 1.1 to this document.

PG Curriculum Review has just started and discussions are underway on how to implement this in the Department.

(c) Coursework for each UG, PG and PhD programme - Core/Elective

Note: *This is the coursework for all students who entered the UG program 2013, and PG program before 2014. For these students, the new revised Curriculum will be implemented. List of courses being included in the new Curriculum are provided in Appendix 1.1.*

UG Departmental Core (DC):

Course No.	Course Title	Credits
CHC410	Colloquium (CH)	0-3-0 (**3**)
CHD411	Major Project Part 1 (CH)	0-0-8 **(4)**
CHL110	Transport Phenomena	3-1-0 **(4)**
CHL111	Material and Energy Balance	2-2-0 **(4)**
CHL112	Chemical Process Technology	3-1-0 **(4)**
CHL121	Chemical Engineering Thermodynamics	3-1-0 **(4)**
CHL122	Chemical Reaction Engineering – I	3-1-0 **(4)**
CHL221	Chemical Reaction Engineering – II	3-1-0 **(4)**
CHL231	Fluid Mechanics for Chemical Engineers	3-1-0 **(4)**
CHL251	Heat and Mass Transfer	3-1-0 **(4)**
CHL261	Instrumentation and Process Control	3-1-0 **(4)**
CHL331	Fluid-Particle Mechanics	3-1-0 **(4)**
CHL351	Mass Transfer Operations	3-1-0 **(4)**
CHL471	Process Equipment Design and Economics	3-0-3 **(4.5)**
CHN110	Introduction to Chemical Engineering	0-0-4 **(2)**
CHP301	Fluid Mechanics and Heat Transfer Laboratory	0-0-3 **(1.5)**
CHP302	Mass Transfer and Fluid Particle Mechanics Laboratory	0-0-3 **(1.5)**
CHP303	Chemical Reaction Engineering and Process Control Laboratory	0-0-3 **(1.5)**
CHP311	Design and Laboratory Practices	0-0-4 **(2)**
CHT410	Practical Training (CH)	**(NC)**
	Total DC	**35-15-28 (64)**

UG Departmental Electives (DE):

Course No.	Course Title	Credits
CHD310	Mini Project (CH)	0-0-6 **(3)**
CHL133	Powder Processing and Technology	3-1-0 **(4)**
CHL260	Applications of Programming in Chemical Engineering	3-0-2 **(4)**
CHL275	Safety and Hazards in the Process Industries	3-1-0 **(4)**
CHL277	Materials of Construction	3-0-0 **(3)**
CHL291	Introduction to Biochemical Engineering	3-1-0 **(4)**
CHL296	Nano Engineering of Soft Materials	3-0-0 **(3)**
CHL332	Fluidization Engineering	3-1-0 **(4)**
CHL358	Modern Separation Processes	3-1-0 **(4)**
CHL390	Process Utilities and Pipeline Design	3-0-2 **(4)**
CHL392	Polymer Science and Engineering	3-1-0 **(4)**
CHL705	Electrokinetic Transport Phenomena	3-0-2 **(4)**
CHL707	Adsorption Separation Processes	3-0-0 **(3)**
CHL710	Process Dynamics and Control	3-1-2 **(5)**
CHL722	Fundamentals of Fuel Cell Technology	3-0-2 **(4)**
CHL724	Environmental Engineering and Waste Management	3-1-0 **(4)**
CHL727	Heterogeneous Catalysis and Catalytic Processes	3-0-2 **(4)**
CHL731	Introduction to Soft Matter	3-0-0 **(3)**
CHL743	Petrochemical Technology	3-0-0 **(3)**
CHL751	Multi-component Mass Transfer	3-0-0 **(3)**
CHL766	Interfacial Engineering	3-0-0 **(3)**
CHL768	Fundamentals of Computational Fluid Dynamics	2-0-2 **(3)**
CHL771	Process Operation Scheduling	3-0-2 **(4)**
CHL773	Planning of Experiments and Analysis of Engineering Data	3-0-2 **(4)**
CHL774	Process Optimization	3-0-2 **(4)**
CHL777	Bioprocessing and Bioseparations	3-0-0 **(3)**
CHL792	Structures & Properties of Polymer in Solution	3-0-0 **(3)**
CHL793	Membrane Science and Engineering	3-0-0 **(3)**
CHL794	Petroleum Refinery Engineering	3-0-2 **(4)**
CHR310	Professional Practices (CH)	0-1-2 **(2)**
CHS310	Independent Study (CH)	0-3-0 **(3)**
CHD412	Major Project Part 2 (CH)	0-0-16 **(8)**

Dual-Degree Programme Core (PC):

Course No.	Course Title	Credits
CHL 701	Process Engineering	3-0-2 **(4)**
CHL721	Advance Chemical Engineering Thermodynamics	3-1-0 **(4)**
CHD771	Minor Project	0-0-8 **(4)**
CHD871	Major Project Part 1 (CM)	0-0-12 **(6)**
CHD872	Major Project Part 2 (CM)	0-0-28 **(14)**
CHD873	Major Project Part 1 (CM)	0-0-8 **(4*)**
CHD874	Major Project Part 2 (CM)	0-0-32 **(16*)**
	Total PC	**6-1-50 (32)**

*CHD873 and CHD874 together are alternatives to CHD871 and CHD872.

Dual-Degree Programme Electives (PE):

Course No.	Course Title	Credits
CHL704	Polymer Matrix Composites- Processes and Process Modelling	3-1-0 **(4)**
CHL705	Electrokinetic Transport Phenomena	3-0-2 **(4)**
CHL710	Process Dynamics and Control	3-1-2 **(5)**
CHL711	Numerical Methods in Chemical Engineering	3-0-2 **(4)**
CHL717	Mechanical Design of Process Equipment	3-0-2 **(4)**
CHL724	Environmental Engineering & Waste Management	3-1-0 **(4)**
CHL727	Heterogeneous Catalysis & Catalytic Process	3-0-2 **(4)**
CHL731	Introduction to Soft Matter	3-0-0 **(3)**
CHL732	Soft Lithographic Methods for Nano-Fabrication	3-0-0 **(3)**
CHL735	Design of Separation Processes	3-0-0 **(3)**
CHL740	Special Topics	3-0-0 **(3)**
CHL751	Multicomponent Mass Transfer	3-0-0 **(3)**
CHL761	Chemical Engineering Mathematics	3-0-0 **(3)**
CHL766	Interfacial Engineering	3-0-0 **(3)**
CHP768	Fundamentals of Computational Fluid Dynamics	2-0-2 **(3)**
CHL771	Process Operation Scheduling	3-0-2 **(4)**
CHL774	Process Optimization	3-0-2 **(4)**
CHL792	Structure and Properties of Polymer in Solution	3-0-0 **(3)**
CHL793	Membrane Science and Engineering	3-0-0 **(3)**
CHL794	Petroleum Refinery Engineering	3-0-0 **(3)**
CHL807	Population balance modelling	3-0-0 **(3)**
CHL869	Applications of Computational Fluid Dynamics	2-0-2 **(3)**

M. Tech. (2-year) Programme Core (PC):

Course No.	Course Title	Credits
CHD771	Minor Project	0-0-8 **(4)**
CHD781	Major Project Part 1 (CHC)	0-0-12 **(6)**
CHD782	Major Project Part 2 (CHC)	0-0-24 **(14)**
CHL603	Transport Phenomena	3-0-0 **(3)**
CHL 701	Process Engineering	3-0-2 **(4)**
CHL721	Advance Chemical Engineering Thermodynamics	3-1-0 **(4)**
CHL723	Chemical Reaction and Reactor Engineering	3-0-0 **(3)**
	Total PC	**12-1-46 (36)**

M. Tech. (2-year) Programme Electives (PE):

Course No.	Course Title	Credits
CHL704	Polymer Matrix Composites – Processes and Process Modeling	3-1-0 **(4)**
CHL705	Electrokinetic Transport Phenomena	3-0-2 **(4)**
CHL710	Process Dynamics and Control	3-1-2 **(5)**
CHL711	Numerical Methods in Chemical Engineering	3-0-2 **(4)**
CHL717	Mechanical Design of Process Equipment	3-0-2 **(4)**
CHL722	Fundamentals of Fuel Cell Technology	3-0-2 **(4)**
CHL724	Environmental Engineering and Waste Management	3-1-0 **(4)**
CHL727	Heterogeneous Catalysis and Catalytic Processes	3-0-2 **(4)**
CHL731	Introduction to Soft Matter	3-0-0 **(3)**
CHL732	Soft Lithographic Methods for Nano-Fabrication	3-0-0 **(3)**
CHL735	Design of Separation Processes	3-0-2 **(4)**
CHL740	Special Topics	3-0-0 **(3)**
CHL751	Multicomponent Mass Transfer	3-0-0 **(3)**
CHL761	Chemical Engineering Mathematics	3-0-0 **(3)**
CHL766	Interfacial Engineering	3-0-0 **(3)**
CHL768	Fundamentals of Computational Fluid Dynamics	2-0-2 **(3)**
CHL771	Process Operation Scheduling	3-0-2 **(4)**
CHL774	Process Optimization	3-0-2 **(4)**
CHL793	Membrane Science and Engineering	3-0-0 **(3)**
CHL794	Petroleum Refinery Engineering	3-0-2 **(4)**
CHL807	Population balance modelling	3-0-0 **(3)**
CHL869	Applications of Computational Fluid Dynamics	2-0-2 **(3)**
CHL702	Plant Design	3-0-2 **(4)**

All 600 and 700 level courses are open as electives to PhD students (except three "core" courses, discussed in Section 1.4(d).

(d) Pre-PhD courses offered (in last 5 years):

There are no separate Pre-PhD courses offered by the Department.

From Semester I, 2010-11 onwards, all PhD students in the Department have been made to complete the following courses at least on Audit or Credit:

CHL603	Transport Phenomena
CHL721	Advance Chemical Engineering Thermodynamics
CHL723	Chemical Reaction and Reactor Engineering

Since PhD students (joining after M. Tech.) have to take 6 credits and the non-credit HUL810 Communication Skills course as part of their coursework, in case the students choose to Audit the above courses, then they have to take other courses on credit as part of their credit requirements.

The above courses are designed and delivered to bring all students entering the PhD programme, irrespective of their background and eventual specialization, at par on essential chemical engineering fundamentals. All students joining with a Chemical Engineering background have to complete this requirement by the time they do their comprehensive examination (3 semesters of residence for FT students and 4 semesters of residence for PT students). However, students who join the PhD programme with a qualifying degree other than Chemical Engineering are allowed to complete the above requirement by the time they complete their synopsis.

(e) New advanced Masters / Pre-PhD courses introduced in last 5 years:

The following courses at advanced level have been introduced in the last 5 years:

Course No.	**Course Title**	**Credits**
CHL704	Polymer Matrix Composites – Processes and Process Modeling	3-1-0 **(4)**
CHL722	Fundamentals of Fuel Cell Technology	3-0-2 **(4)**
CHL731	Introduction to Soft Matter	3-0-0 **(3)**
CHL732	Soft Lithographic Methods for Nano-Fabrication	3-0-0 **(3)**
CHL771	Process Operation Scheduling	3-0-2 **(4)**
CHL774	Process Optimization	3-0-2 **(4)**
CHL777	Bioprocessing and Bioseparations	3-0-0 **(3)**
CHL721	Advance Chemical Engineering Thermodynamics	3-1-0 **(4)**
CHL792	Structure and Properties of Polymer in Solution	3-0-0 **(3)**
CHL750	Structure, Transport and Reactions in BioNano Systems	3-0-0 **(3)**

No courses with a specific purpose of serving as Pre-PhD courses have been introduced recently. However, several new electives were introduced in last five years. More new elective courses are being planned in the Department as part of the ongoing Curriculum Review process, including some Pre-PhD courses (please see Appendix 1.1).

(f) Overlap between courses (c), (d) and (e) - including opening latter to UG

As stated, all electives and core courses that are part of the PG programme (for DD or 2-Year M. Tech. programme) are also the elective courses for PhD programme.

Most PG level (700 and 800 level) elective courses are open to UG students as well as electives, the typical pre-requisite being their completion of the background core course of the UG programme. - Some of the courses also have a pre-requisite of "EC90" or "EC120", i.e., them having earned 90 or 120 (respectively) Earned Credits in the UG programme to qualify to take them elective courses.

(g) Seminar Series

List of seminars (2008-2013) are listed below.

S. No.	Date	Speaker	Affiliation	Title of Seminar
1.	17.01.2008	Prof. M. P. Dudukovic	Washington University in St. Louis, USA	Reaction Engineering and Modern Technological Challenges
2.	21.01.2008	Ms. Harmeet Chhina	Ballard Power Systems, Canada	Proton Exchange Membrane (PEM) Fuel Cells
3.	26.02.2088	Dr. Subir Bhattacharjee	University of Alberta, Edmonton, Alberta, Canada	Application of Electrokinetics in Water Treatment
4.	29.01.2008	Mr. Andrew Sherwood	Micromeritics Instrument Corporation, USA	Instruments for Catalyst Characterisation
5.	21.02.2008	Prof. Chien-Hsiang Chang	National Cheng Kung University, Taiwan	Mixed Monolayer Behavior of Dipalmitoyl-Phosphatidyl-Choline with Plasma Proteins at Air/Liquid Interfaces
6.	25.02.2008	Dr. Santosh Gangwal	SKG Process Development USA	Gasification and Syngas Cleanup
7.	24.04.2008	Mr. Sanjay Salunkhe	Shell Technology India Pvt. Ltd. Bangalore	Chemical Safety and Environmental Management for Laboratories
8.	19.05.2008	Dr. Mano Ram Maurya	University of California, San Diego, USA	Modeling Calcium Dynamics in Macrophage Cells

9.	28.08.2008	Dr. Jasbir Juneja	Rensselaer Polytechnic Institute, USA	CVD Parylene as pore sealant for porous materials
10.	03.11.2008	Prof. Dr. Evangelos Tsotsas	Magdeburg University, Germany	Formulation of Particles by Drying Processes
11.	13.02.2009	Dr. Madhava Syamlal	National Energy Technology Laboratory, Morgantown, USA	A Brief Presentation of Ongoing Research on Gas-Solid Flow at NETL
12.	02.03.2009	Dr. A. S. Chaurasia	Imperial College, London	Developing Low Cost Cleaner Coal Technologies for Mitigating Global Climate Change
13.	05.03.2009	Prof. G.M. Evans	University of Newcastle, Australia	Hydrodynamics of Mineral Flotation Processes
14.	02.04.2009	Dr. Raghvendra Singh	Johns Hopkins Medicine, Baltimore, USA	An Integrated Reaction-Transport Model for DNA Surface Hybridization: Implications for DNA Microarrays
15.	09.04.2009	Dr. Parag Pawar	Johns Hopkins University, Baltimore, USA	Integrating Biology and Mathematics in Medical Applications Pertinent to Infection and Inflammation
16.	06.04.2009	Mr. Thierry Hannecart	Total Professeurs Associes (TPA), France	Introduction to the TPA Programme
17.	20.04.2009	Dr. Ajay Singh Panwar	University of Massachusetts, Amherst, USA	A Computational Approach to Design of Complex Macro-molecular Materials Systems
18.	01.09.2009	Dr. Navraj Hanspal	University of Manchester (UMIST), Manchester, UK	Combined Navier-Stokes / Darcy Flows – CFD Modeling and Engineering Applications
19.	23.09.2009	Dr. Gaurav Singh	Senior Engineer, INTEL Corporation	Interface Driven Phenomena at Nanoscale: Electrical Double Layer (EDL)
20.		Dr. Ujjal Ghosh	University of Melbourne, Australia	Application of Chemical Engineering Research in Environmental Remediation: a) Separation of Carbon Dioxide from Flue Gas by Chemical Absorption; b) Separation of Organics from Aqueous Solution by Membrane Pervaporation
21.	17.11.2009	Dr. Srinivas Palanki	University of South Alabama	Technology for the Hydrogen Economy
22.	03.12.2009	Mr.Sumit Sharma	Columbia University, USA	Structure and Stability of Proteins upon Adsorption to Hydrophobic Surfaces

23.	11.12.2009	Prof. Dr. Ulrich Ruede	University of Erlangen-Nuremberg, Germany	Simulation and Animation of Complex Flows on Supercomputers
24.	09.12.2009	Dr. M. K. Singh	Corus Research and Development The Netherlands	Design, Analysis and Optimization of Distributive Mixing
25.	27.01.2010	Dr. Divesh Bhatia	University of Houston, USA	Kinetic and Modeling Studies of Catalytic Monolith Reactors and Lean NOx Traps
26.	03.03.2010	Dr. Supreet Saini	University of Illinois at Urbana-Champaign, USA	Multi-Process Control and Coordinated Regulation of Flagella, Invasion, and Adhesion Gene Circuits in *Salmonella enterica*
27.	09.03.2010	Prof. Xiao-Dong Zhou	University of South Carolina, USA	Physics and Electrochemistry of Energy Systems: Examples of Solid Oxide Fuel Cells and Thermoelectrics.
28.	12.03.2010	Prof. Vibha Kalra	Drexel University, USA	Using External Fields to Control the Location of Nanoparticles in Block Co-polymers: Experiments and Simulations
29.	26.03.2010	Dr. Jyoti Phirani	University of Houston, USA	Methane Production from Hydrate Bearing Sediments
30.	29.03.2010	Dr. Amit Kumar	University of Delaware, USA	Sorption and Diffusion of Small Gas Molecules in Nanostructured Materials: A Computational Study
31.	21.04.2010	Dr. Dayadeep Monder	Queen's University, Canada	Multi-Scale Models for Sulfur Poisoning of Solid Oxide Fuel Cell Anodes
32.	11.08.2010	Dr. Shalini Gupta	Imperial College, UK	On-Chip Assembly of Novel Biosensors and Composite Functional Biomaterials from Colloidal Particles
33.	23.08.2010	Dr. Chandra Shekhar Sharma	Indian Institute of Technology, Kanpur	Carbon Microelectromechanical Systems (C-MEMS): Synthesis, Fabrication and Properties
34.	26.08.2010	Dr. S. Ramanathan	Indian Institute of Technology, Madras	Mechanistic Analysis of Electrochemical Impedance Spectra
35.	01.10.2010	Prof. Jean Paris	École Polytechnique de Montréal, Canada	Sustainability of Forest Biorefinery: Canadian Context
36.	04.01.2011	Prof. Prabir Daripa	Texas A&M University	Generalized Saffman-Taylor formula for Multi-layer Hele-Shaw and Porous Media Flows
37.	28.01.2011	Mr. Vikram Singh	Cornell University, USA	Particles in Simple Shear Flow:

				Shape Matters
38.	10.06.2011	Prof. Soumya K. Srivastava	Washington State University, Pullman, USA	DC Insulator Dielectrophoretic Blood Typing Based on Human Abo-Rh System
39.	16.06.2011	Dr. Raghvendra Gupta	University of Sydney, Australia	Gas-Liquid Flow in Micro-Channels
40.	15.09.2011	Prof. Vikas Berry	Kansas State University	Graphene: Properties, Phenomena and Applications of a 2D Network of Carbon Atoms
41.	21.09.2011	Dr. Ajay Chatterjee	Intel Corporation, USA	Innovation and Evolution in Semiconductor Electronics Manufacturing and Supply Chain
42.	13.10.2011	Dr. Prankul Middha	GexCon AS, Bergen, Norway	Use of CFD for explosion Safety Studies on Process Facilities
43.	30.01.2012	Prof. Sankaran Sundaresan	Princeton University, USA	Filtered Two-Fluid Models for Fluidized Gas-Particle Suspensions
44.	08.02.2012	Mark Denys	Tata Steel Limited, Jamshedpur	Innovation for Energy Efficiency in Iron and Steelmaking
45.	20.03.2012	Dr. Naveen Tiwari	Saint-Gobain Northborough, MA, USA	Role of Thermo-Capillary Stress in the Dynamics and Stability of Micro-Scale Coating Flows Over Locally Heated Surfaces
46.	03.04.2012	Prof. Anand Prakash	University of Western Ontario, Canada	Investigations in Bubble Column Equipped with Internals
47.	25.05.2012	Prof. Shripad T. Revankar	Pohang, South Korea; Purdue Univ. , USA	Transient Analysis of Chemical Process Plant Coupled to Nuclear Heat Source
48.	08.06.2012	Prof. Vijaya K. Rangari	Tuskegee University, Tuskegee, USA	Carbon Nanotubes and Their Applications in Polymer Composites
49.	27.09.2012	Prof. Graeme J. Jameson	University of Newcastle, Australia	New Directions in Bubble and Particle Technology
50.	07.12.2012	Dr. James McGregor	Univ. of Sheffield, UK	Re-assessing Structure-Activity Relationships in Heterogeneous Catalysis: The Role of the "Structural Environment"
51.	26.12.2012	Prof. Suresh K. Bhatia	Univ. of Queensland, Australia	(i) Atomistic Modelling of the Structure of Nanoporous Carbons (ii) Quantum Molecular Sieving of Hydrogen Isotopes
52.	29.01. 2013	Dr. Suvajyoti Guha	US-FDA, Silver Spring, MD, USA	Understanding bio-nanoparticle behavior through physical

				characterization
53.	30.01.2013	Dr. Saurav Datta	Argonne National Laboratory Chicago, USA	Membrane Technologies for Sustainable Products and Processes
54.	8.02.2013	Dr. Rafal Klajn	Weizmann Institute of Science, Israel	Dynamic Materials and Systems Based on Photoresponsive Molecules and Superparamagnetic Nanoparticles
55.	13.02.2013	Prof. Eric Climent	Institute of Fluids Mechanics, Toulouse, France	Multi-Scale Simulations of Dispersed Two-Phase Flows
56.	22.02.2013	Prof. Matthew Tirrell	University of Chicago, USA	Protein Analogous Micelles: Versatile, Modular Nanoparticles
57.	21.02.2013	Dr. Srinath Madasu	Halliburton Energy Services, Houston, USA	CFD Modeling of Interfacial and Biological Flows using Numerical Methods
58.	13.03.2013	Dr. Amit Kumar Jha	University of California, Berkeley, USA	Synthesis and Characterization of Hyaluronic Acid-Based Hydrogel Systems for Tissue Regeneration and Drug Delivery
59.	28.03.2013	Dr. M. Ali Haider	University of Virginia, USA	Reaction Mechanisms and the Design of Heterogeneous Catalysts for Sustainable Energy
60.	18.04.2013	Prof. Aibing Yu	University of New South Wales, Australia	Simulation and Modeling of Particulate Systems
61.	1.05.2013	Dr. Ankur Gaur	MNNIT, Allahabad	
62.	3.05.2013	Dr. Swarup Y. Jejurkar	Indian Institute of Technology, Kanpur	Combustion as Power Source for Miniature Machines
63.	6.05.2013	Dr. Prabu V.	IIT Guwahati	Clean Coal Technologies based on Carbon Neutral Power Generation
64.	27.06.2013	Dr. Anil K. Mathur	UPSPCB, Agra	Biodegradation of Volatile Organic Compounds in Biofilters
65.	01.07.2013	Dr. Sushil Kumar	MNNIT, Allahabad	Reactive Extraction: An Intensifying Approach for the Recovery of Carboxylic Acids
66.	16.07.2013	Dr. Manojkumar Ramteke	IIT, Roorkee	Biomimetic Adaptations of Multi-objective Evolutionary Algorithms for the Optimization of Chemical Processes
67.	22.07.2013	Dr. Anantharaj Ramalingam	University of Malaya, Malaysia	Simultaneous Desulphurization and Denitrification of Diesel oil Using Ionic Liquids: Experiments and Predictions

68.	25.07.2013	Prof. Jean-NumaGillet	JNU	*Ab initio* Models for Lipid Mixtures and Misfolded Proteins
69.	03.10.2013	Dr. Ganesh Paramasivan	Vikram Sarabhai Space Centre, Thiruvananthapuram	Synthesis of Plant-Wide Control Strategies Using Mixed Integer Optimization
70.	04.11.2013	Mr. Satyaki Ray	Occidental Oil and Gas Corporation Houston, Texas, USA	Fundamentals Of Petrophysics and Its Application to Reservoir Modeling and Simulation
71.	07.11.2013	Dr. Divesh Bhatia	Nalco Water India Ltd. Pune.	Modeling of Concentration Fronts and Pt Dispersion Effects in A Lean NOx Trap
72.	12.11.2013	Dr.-Ing. Philip Jaeger	Technische Universität Hamburg-Harburg, Germany	Interfacial Properties Under Reservoir Conditions
73.	19.11.2013	Prof. Anthony Kucernak	Imperial College, London, UK	Getting the Most Out of Platinum: New Electrode Designs to Maximize the Performance of Electrocatalysts For Fuel Cells
74.	03.12.2013	Prof. Ned Djilali	University of Victoria, Canada	Experimental Characterization, Reconstruction and Pore Scale Modelling of Fuel Cell Catalyst Layers
75.	20.12.2013	Dr. Pankaj Sinha	Intel Corporation, USA	Semiconductor Fabrication – Trends and Opportunities

(h) Placement Details

Placement details as per required format is provided in Appendix 1.2.

(i) Relevance of UG and PG programmes to recruiters, potential and on-campus recruiters

Most of the "core" Chemical Engineering companies tend to consider CGPA as the most important criterion for shortlisting and selection of our graduates. Also, also the project and thesis work tends to be a strong factor in determining the kind of company and job profile that a graduating student is selected for. This indicates a strong correlation with the curriculum and research work of the Department and its relevance to potential recruiters.

However, a large fraction of the students are getting employed in non-core companies, which offer attractive compensation. In such job profiles, the soft skills acquired on campus

(such as analytical skills, presentation and communication skills, team work, etc.) are thought to be as relevant as the formally acquired training.

However, no formal survey data on testing the relevance of the teaching to the potential recruiter is as yet available.

(j) Benchmarking of Curriculum

Benchmarking details as per required format is provided in Appendix 1.3.

Appendix 1.1
List of Proposed Courses in New Curriculum

Department Core (UG):

S. No.	Course Title	Credits
1. (L)	Transport Phenomena	(3-1-0) 4
2. (L)	Material and Energy Balance	(2-2-0) 4
3. (L)	Chemical Engineering Thermodynamics	(3-1-0) 4
4. (L)	Chemical Process Technology	(3-1-0) 4
5. (L)	Chemical Reaction Engineering I	(3-1-0) 4
6. (L)	Chemical Reaction Engineering II	(3-0-0) 3
7. (L)	Fluid Mechanics for Chemical Engineers	(3-1-0) 4
8. (L)	Heat Transfer	(3-1-0) 4
9. (L)	Mass Transfer I	(3-0-0) 3
10. (L)	Mass Transfer II	(3-1-0) 4
11. (L)	Fluid-Particle Mechanics	(3-1-0) 4
12. (L)	Process Dynamics and Control	(3-1-0) 4
13. (L/P)	Numerical Methods in Chemical Engineering	(3-0-2) 4
14. (L)	Introduction to Industrial Biotechnology	(3-0-0) 3
15. (L)	Introduction to Chemical Engineering Materials	(3-0-0) 3
16. (P/L)	Instrumentation and Automation	(1-0-3) 2.5
17. (P)	Chemical Engineering Laboratory I	(0-0-3) 1.5
18. (P)	Chemical Engineering Laboratory II	(0-0-3) 1.5
19. (P)	Chemical Engineering Laboratory III	(0-0-3) 1.5
20. (P)	B. Tech. project	(0-0-8) 4
	Total Core Credits	**67**

Credits Distribution (B. Tech.):

Category	Total Credits	Remarks
Basic Sciences	22	As per Senate decision
Engineering Arts and Science	18	As per Senate decision
Humanities and Social Sciences	15	As per Senate decision
Programme Linked Engineering Arts & Science	7	3 CY + 4 AM materials course
Department Core	67	Includes 4 credits of B Tech project + 5 lab credits
Department Elective	12	4 courses of 3 credits each
Open Category	10	
Total	**151**	

Programme Structure (B. Tech.):

	Lecture Course 1	**Lecture Course 2**	**Lecture Course 3**	**Lecture Course 4**	**Other / Lecture Course 5**	**Other**	**Other**
Sem. I	Math 1 (3-1-0)	AM (3-1-0)	PH (3-0-0) + (0-0-4)	-	Engg. Vis. (0-0-4)	Language (0-0-2)	PE & SR (0-0-2) + Intro. To Engg. (0-0-2)
Sem. II	Maths 2 (3-1-0)	EE (3-1-0)	CY (3-0-0) + (0-0-4)	CS (3-0-2)	Prod. Rel (0-0-4)	Language (0-0-2)	PE & SR (0-0-2) + Intro. To Engg. (0-0-2)
Sem. III	CYL121 (3-0-0)	Num. Meth. (3-0-2)	TP (3-1-0)	MEB (2-2-0)	HU	-	Intro. To Dept. (0-0-2)
Sem. IV	Thermo (3-1-0)	CRE-I (3-1-0)	FM (3-1-0)	HT (3-1-0)	Biology (3-0-2) / Env. (2-0-0)	AM Mat. Sc. (3-1-0)	
Sem. V	MT-I (3-0-0)	CRE-II (3-0-0)	FPM (3-1-0)	ChE Mat. Sc. (3-0-0)	Control (3-1-0)	Biology (3-0-2) / Env. (2-0-0)	CHE Lab 1 (0-0-3)
Sem. VI	MT-II (3-1-0)	DE (3-0-0)	Ind. Biotech. (3-0-0)	CPT (3-1-0)	Instru. & Auto. (1-0- 3)	DE (3-0-0) / HU	CHE Lab. 2 (0-0-3)
Sem. VII	DE 4	DE 5 / HU	Open	Open	BTP I(0-0-8)	DE / Open / HU	CHE Lab. 3(0-0-3)
Sem. VIII	DE / Open / HU	DE / Open / HU	DE / Open / HU	DE / Open / HU	DE / Open / HU	DE / Open / HU	

List of Electives (UG, M. Tech./DD, Ph.D.):

S. No.	Course Title	Credits
1.	Powder Processing and Technology	(3-0-0) 3
2.	Safety and Hazards in Process Industries	(3-0-0) 3
3.	Materials of Construction	(3-0-0) 3
4.	Nano-engineering of Soft Materials	(3-0-0) 3
5.	Multi-component Mass Transfer and Staged Operations	(3-0-0) 3
6.	Process Utilities and Pipeline Design	(3-0-0) 3
7.	Environmental Engineering and Waste Management	(3-0-0) 3
8.	Heterogeneous Catalysis and Catalytic Processes	(3-0-0) 3
9.	Petrochemical Technology	(3-0-0) 3
10.	Interfacial Engineering	(3-0-0) 3
11.	Fundamentals of Computational Fluid Dynamics	(2-0-2) 3
12.	Process Operations Scheduling	(3-0-0) 3
13.	Process Optimization	(3-0-0) 3
14.	Bioprocessing and Bioseparations	(3-0-0) 3
15.	Structures and Properties of Polymers	(3-0-0) 3
16.	Membrane Science and Engineering	(3-0-0) 3
17.	Petroleum Refinery Engineering	(3-0-0) 3
18.	Polymer Matrix Composites – Processes and Process Modeling	(3-0-0) 3
19.	Chemical Engineering Mathematics	(3-0-0) 3
20.	Population Balance Modeling	(3-0-0) 3
21.	Advanced Computational Techniques in Chemical Engineering	(2-0-2) 3
22.	Plant Design	(3-0-0) 3
23.	Product Development and Commercialization	(3-0-0) 3
24.	Principles of Electrochemical Engineering	(3-0-0) 3
25.	Electrochemical Methods	(3-0-0) 3
26.	Electrochemical Conversion and Storage Devices	(3-0-0) 3
27.	Applied Reservoir Engineering	(3-0-0) 3
28.	Reservoir Production Engineering	(3-0-0) 3
29.	Biomass Conversion and Utilization	(3-0-0) 3
30.	Introduction to Complex Fluids	(3-0-0) 3
31.	Transport Phenomena in Complex Fluids	(3-0-0) 3
32.	Thermodynamics of Complex Fluids	(3-0-0) 3
33.	Simulation Techniques for Complex Fluids	(3-0-0) 3
34.	Polymerization Process Modeling	(3-0-0) 3
35.	Granular Materials	(3-0-0) 3
36.	Complex Fluids Technology	(3-0-0) 3
37.	Kinetics and Molecular Modeling of Heterogeneous Catalytic Reactions	(3-0-0) 3
38.	Industrial Multiphase Reactors	(3-0-0) 3
39.	Process Intensification and Novel Reactors	(3-0-0) 3
40.	Experimental Characterization of Multiphase Reactors	(3-0-0) 3

41.	Experimental Characterization of BioMacromolecules	(3-0-0) 3
42.	Product and Process Integration	(3-0-0) 3
43.	Interfacial Behaviour of BioMacromolecules	(3-0-0) 3
44.	Molecular Biotechnology and in-vitro Diagnostics	(3-0-0) 3
45.	Advanced Process Synthesis	(3-0-0) 3
46.	Advanced Process Control	(3-0-0) 3
47.	Process Modeling and Simulation	(3-0-0) 3
48.	Process Plant Simulation	(3-0-0) 3
49.	Evolutionary Computation	(3-0-0) 3
50.	Air Pollution Control Engineering	(3-0-0) 3
51.	Fine Chemicals Technology	(3-0-0) 3
52.	Structure, Transport and Reactions in BioNano Systems	(3-0-0) 3
53.	Advanced Thermodynamics	(3-0-0) 3
54.	Advanced Transport Phenomena	(3-0-0) 3
55.	Interfacial Behaviour and Transport of Biomolecules	(3-0-0) 3
56.	Fundamentals of Fuel Cell Technology	(3-0-0) 3
57.	Applications of Computational Fluid Dynamics	(2-0-2) 3
58.	Special Topics in Chemical Engineering	(3-0-0) 3

For the PhD programme, the following structure of courses is being proposed.

1. Two "bridge" courses to address the varied background of incoming research scholars, which must be done by all PhD students on credit (each course is for 2 credits):
    - Bridge course 1, which will contain two equal weightage modules of UG level Transport Phenomena and Numerical Methods
    - Bridge course 1, which will contain two equal weightage modules of UG level Reaction Engineering and Thermodynamics

2. At least one of the following courses (3 credits), on credit (depending on background of student, research interest and in consultation with supervisor)
    - Advanced Transport Phenomena
    - Advanced Thermodynamics
    - Industrial Multiphase Reactors
    - Interfacial Behaviour and Transport of Biomolecules

3. A third course (3 or more credits) from Department of Chemical Engineering or any other Department (depending on background of student, research interest and in consultation with supervisor).

Appendix 1.2

Placement Details: On-Campus (From 2010 to 2013)[1]

Program Type	Program Name	No. of graduating students	Number of core companies that asked for prog. by name	No. of students selected in core companies	No. of non-core companies that selected students	No. of students placed in non-core companies	No. of students not placed at graduation time
B. Tech	B. Tech in Chemical Engg.	193	32	86	44	78	29
Dual Degree*	B. Tech. in Chemical Engg. and M. Tech. in Process Engg & Design	88[2]	5	15	16	22	14
	B. Tech. in Chemical Engg and M. Tech. in Computer Applications in Chemical Engg	88[2]	6	11	20	26	14
	B. Tech. in Chemical Engg and M. Tech. in Chemical Engg	34	7	9	12	14	11
M. Tech.	M. Tech. in Chemical Engg.	64	17	22	2	3	40

* Department offered two streams of dual degree programs until recently. Final batches graduated in 2012. Now Department offers a single stream of Dual Degree program named B. Tech. in Chemical Engineering and M. Tech. in Chemical Engineering. First batch of this program graduated in 2013.

[1] Includes students placed through Training & placement section only. Some students may have opted for further studies

[2] Total number of graduating students in the two programs

List of Core Companies: B. Tech. in Chemical Engineering

Private Sector Companies		
S. No.	**Company Name**	**No. of students recruited**
1	Air Liquide, India	1
2	Ballarpur Industries Limited	2
3	Reliance Industries Limited	25
4	ITC	4
5	L&T	1
6	Sabic Innovative Plastics Ltd.	1
7	Continental Carbon India Ltd.	1
8	Shell Technology India Pvt. Ltd.	3
9	JSPL	1
10	Teva API India Ltd.	1
11	Johnson Matthey India Pvt. Ltd.	1
12	KBR-Kellogg Brown & Root Engineering & Construction India Pvt. Ltd.	5
13	Dr. Reddy's Labs Ltd.	3
14	Sharp Menthol India Ltd.	1
15	Alstom Power	1
16	BG Exploration and Production India Ltd.	1
17	Schlumberger Asia Services Ltd.	2
18	P&G	2
19	Oriental Carbon & Chemicals Ltd.	2
20	Hindustan Unilever Limited	3
21	SRF Ltd.	1
22	UOP India Pvt. Ltd.	1
23	MECON Ltd.	1
24	Cairn India Ltd.	2

25	Jaiprakash Associates	1
26	Chambal Fertilisers and Chemicals Ltd	2
27	Wipro Ltd	2

PSU companies		
S. No.	**Company Name**	**No. of students recruited**
28	IOC Ltd.	7
29	SAIL	1
30	HPCL Mittal Energy Ltd.	2
31	NALCO	1
32	BPCL	2
33	BHEL	2

List of Core Companies for Dual Degree Program: B. Tech. in Chemical Engg. and M. Tech. in Process Engg. & Design

S. No.	Company Name	No. of students recruited
1	Reliance Industries Limited	10
2	De Core Sc. & Tech. Ltd.	1
3	3M India Ltd.	1
4	Shell Technology India Pvt. Ltd.	1
5	KBR-Kellogg Brown & Root Engineering & Construction India Pvt. Ltd.	1
6	Chambal Fertilizers and Chemicals Ltd.	1

List of core companies for Dual Degree Program: B. Tech. in Chemical Engg. and M. Tech. in Computer Applications In Chemical Engg.

S. No.	Company Name	No. of students recruited
1	Reliance Industries Limited	6
2	De Core Sc. & Tech. Ltd.	2
3	Dr. Reddy's Labs Ltd.	1
4	Mercedes-Benz R&D India Pvt. Ltd.	1
5	Technip KT India	1

List of Core Companies for Dual Degree Program: B. Tech. in Chemical Engg. and M. Tech. in Chemical Engg.

S. No.	Company Name	No. of students recruited
1	Reliance Industries Limited	2
2	Dr. Reddy's Labs Ltd.	1
3	Johnson Matthey India Pvt. Ltd.	1
4	Tata Industries Ltd.	1
5	Kohler India Corporation Pvt. Ltd.	2
6	Schlumberger Asia Services Ltd.	1
7	UOP India Pvt. Ltd.	1

List of Core Companies: M. Tech. in Chemical Engineering

Private Sector Companies		
S. No.	**Company Name**	**No. of students recruited**
1	L&T	3
2	De Core Sc. & Tech. Ltd.	1
3	3M India Ltd.	1
4	TCE Consulting Engineers Ltd.	1
5	Oriental Carbon & Chemicals Ltd.	1
6	P&G	1
7	UOP India Pvt. Ltd.	2
8	Technip KT India	1
9	Sumitomo Chemical CO., Ltd., Japan	2
10	Biocon Ltd.	1
11	Halliburton Technology India Pvt. Ltd.	1
12	Aditya Birla Science & Technology Co. Ltd.	1
13	Relaxo Footwear Ltd.	1
14	Tata Steel	1
15	Sharda Group of Institutions	1
PSU Companies		
16	CSIR Labs	1
17	HPCL	1

List of Non-Core Companies: B. Tech. in Chemical Engineering

S. No.	Company Name	No. of students recruited
1	Globrin	1
2	Futures First Info Services Pvt. Ltd.	5
3	Bain and Company	1
4	I3 Consulting Pvt. Ltd.	1
5	RBS India Development Center Pvt. Ltd.	3
6	Verity Knowledge Solutions Pvt. Ltd. (UBS Affiliate)	1
7	Evalueserve.com Pvt. Ltd.	2
8	KPMG IT Advisory Services	3
9	The Boston Consulting Group (India) Pvt. Ltd.	3
10	Geiper Consulting Pvt. Ltd.	4
11	Monitor Group	1
12	Deloitte Consulting	6
13	Jaypee Capital Services	1
14	Ernst & Young	4
15	Ubiquiti Consultants Pvt. Ltd.	1
16	Credit Suisse	2
17	Essex Lake Group LLC	1
18	Oracle India Pvt. Ltd.	1
19	Price Waterhouse Coopers	1
20	Flipkart Online Services (P) Ltd.	7
21	ZS Associates India Pvt. Ltd.	2
22	Opera Solutions	1
23	BA Continuum India Pvt. Ltd.	1
24	McKinsey & Company	2
25	Breakthrough Management Group International	1
26	KyaZoonga	1

27	SumTotal Systems	1
28	Deutsche CIB Centre Pvt. Ltd.	2
29	Applied Research International Pvt. Ltd.	1
30	Egain Communications	1
31	Angara Ecommerce Pvt. Ltd.	1
32	KPMG Management Services	1
33	Sapient Global Markets	1
34	Diamond Management & Technology Consultants	1
35	Bank of India	1
36	GulfTalent.com	1
37	Educational Initiatives Pvt. Ltd.	1
38	Itaas India Pvt. Ltd.	2
39	Oski Technology Ltd.	1
40	Fractal Analytics Ltd.	1
41	AT Kearney	2
42	M H Alshaya CO. WLL	1
43	Indus Insights	1
44	Citi India	1

List of Non-Core Companies for Dual Degree Program: B. Tech. in Chemical Engg. and M. Tech. in Process Engg. & Design

S. No.	Company Name	No. of students recruited
1	SCA Technologies India Pvt. Ltd.	1
2	Futures First Info Services Pvt. Ltd.	2
3	Bain and Company	2
4	Geiper Consulting Pvt. Ltd.	1
5	Credit Suisse	2
6	Flipkart Online Services (P) Ltd.	1
7	ZS Associates India Pvt. Ltd.	1
8	BA Continuum India Pvt. Ltd.	2
9	McKinsey & Company	1
10	KPMG Management Services	1
11	Diamond Management & Technology Consultants	1
12	Bank of India	2
13	Fractal Analytics Ltd.	1
14	MarketRx - a cognizant Co	2
15	Global Analytics India Pvt. Ltd.	1
16	Accenture Services	1

List of Non-Core Companies for Dual Degree Program: B. Tech. in Chemical Engg. and M. Tech. in Computer Applications in Chemical Engg.

S. No.	Company Name	No. of students recruited
1	Deloitte Consulting	3
2	Futures First Info Services Pvt. Ltd.	2
3	Bain and Company	1
4	Flipkart Online Services (P) Ltd.	2
5	Diamond Management & Technology Consultants	1
6	Bank of India	1
7	MarketRx - a cognizant Co	2
8	Grail Research India Ltd.	1
9	Opera Solutions Management Consulting Pvt. Ltd.	1
10	EXL DA	1
11	Kinapse Scientific Services Pvt. Ltd.	1
12	RBS India Development Center Pvt. Ltd.	2
13	Nagarro Software Pvt. Ltd.	1
14	Open Solutions Software Services Pvt. Ltd.	1
15	Essex Lake Group LLC	1
16	Tribal Fusion R&D Pvt. Ltd.	1
17	Citicorp Services India Ltd.	1
18	American Express India Pvt. Ltd.	1
19	Fractal Analytics Ltd.	1
20	Deutsche CIB Centre Pvt. Ltd.	1

List of Non-Core Companies for Dual Degree Program: B. Tech. in Chemical Engg and M. Tech. in Chemical Engg.

S. No.	Company Name	No. of students recruited
1	Deloitte Consulting	2
2	Bain and Company	1
3	American Express India Pvt. Ltd.	1
4	Fractal Analytics Ltd.	1
5	Barclays Shared Services Pvt. Ltd.	2
6	The Boston Consulting Group (India) Pvt. Ltd.	1
7	Sodel Solutions	1
8	Times Internet	1
9	Axtria Inc.	1
10	McKinsey Knowledge Centre	1
11	AT Kearney	1
12	United Health Information Services Pvt. Ltd.	1

List of Non-Core Companies: M. Tech. in Chemical Engineering

S. No.	Company Name	No. of students recruited
1	Cognizant	2
2	Evalueserve	1

Appendix 1.3

Benchmarking of Curriculum: Undergraduate Programme

Benchmarking parameters	**IIT Delhi**	**National**				
		Two old IITs		**One new IIT**	**One NIT**	**One Private**
		IIT Bombay	**IIT Madras**	**IIT Hyderabad**	**NIT Karnataka, Suratkal**	**Thapar University**
Total credit requirement	180	259/289* * 2 credits equivalent to 1 IITD credit	178	157/172 (Honors)	191	185
Core credits	110	223/241	136	132/144	144	168.5
Elective credits	70	36/48	42	25/28	34	16.5
Core credit as % of total credits	61.1	86.1/83.4	76.4	84.0/83.7	75.4	91.1
Comparison of core cores across institutions	See section 1.3 (c)					
Textbook used in core courses						
No. of assignment submitted by students	No info	No info	No info	No info	No info	No info
No. of theory courses in core curriculum	24	27/30	29	37 (several 1 or 2 credit courses)	31	41

Benchmarking of Curriculum: Undergraduate program (Continued)

Benchmarking parameters	IIT Delhi	National				
		Two old IITs		One new IIT	One NIT	One Private
		IIT Bombay	IIT Madras	IIT Hyderabad	NIT Karnataka, Suratkal	Thapar University
No. and nature of laboratories	8(4 from other departments, 3 credit Colloquium and industrial training compulsory)	11 (6 are from other departments two are design lab)	9 (5 from other Departments) (summer training & project two semester each are part of core)	9 (three from other dept. In addition two design courses also have majority lab component (1-0-3) structure	10 (six from other Departments. In addition 2 credit each seminar and practical training course are part of core requirement)	15 (No purely i.e. 0-0-3 laboratory course hence difficultly in identifying these courses)
Thesis requirements	One semester project (6 credits)	NA/Elective	Two semester (total 9 credits)	No/Two Semester (Total 6 credits)	Two semester (Total 10 credits)	Either entire semester (16 credits) or of smaller credit n one semester(6 credits)
Important differences with peers	Dual Degree offered additional 38 credits (32 core credits, one thesis of 20 credits spread over two semester. In addition a 4 credit project course)	Dual Degree offered additional 96 credits, 72 core credits, 72 credits project spread over two semesters)	DD offered			

Benchmarking of Curriculum: Undergraduate program (Continued)

Benchmarking parameters	IIT Delhi	Overseas				
		One in top 10	Two ranked 10-50		One top from China	One top from Brazil
		Stanford University (QS Rank 5)	Purdue University (QS Rank 26)	Mcgill University (QS Rank 47)	Shanghai Jiao Tong University (QS Rank 51-100)	Polytechnioque school University of Sao Paulo
Total credit requirement	180	120-130	130	116	159.5	234 (10 semesters)
Core credits	110	111-117	101	98	97.5 (33 credits for specialty internship, teaching practice, military training, graduate paper etc. not included)	-
Elective credits	70	13-19	29	18	62	-
Core credit as % of total credits	61.1	90%	77.7	84.4	77.5	95.2
Comparison of core cores across institutions	-	Restricted choice of maths courses, Quarterly system	Restricted choice of maths & biology in IInd & third year	-	-	-
Textbook used in core courses	**Appendix 1.4**	-	-	-	-	-

Benchmarking of Curriculum: Undergraduate program (Continued)

Benchmarking parameters	IIT Delhi	Overseas				
		One in top 10	Two ranked 10-50		One top from China	One top from Brazil
		Stanford University (QS Rank 5)	Purdue University (QS Rank 26)	Mcgill University (QS Rank 47)	Shanghai Jiao Tong University (QS Rank 51-100)	Polytechnioque school University of Sao Paulo
No. of assignment submitted	-	-	-	-	-	-
No. of theory courses in core curriculum	24	30	28	27	No info	-
No. and nature of laboratories	8 (4 from other Deptt., 3 credit Colloq. & industrial training)	3 (teaching labs, total credits: 11)	3	No info	No info	-
Thesis requirements	One semester project (6 credits)	For honors degree	No	7 credits, 2 Semester Design project	One and half semester (27 weeks) graduate paper (design)	-
Important differences with peers	-	1. Minor program 2. Dual Degree (named Coterminal batchelor and master degree in Chem Engg.)	-	Minor program (18-24 credits but because of overlap 9-15 additional credit required)	-	-

Benchmarking of Curriculum: Graduate program - Master's Degree

Benchmarking parameters	**IIT Delhi**	**National Institutes**					
		Two old IITs			**One new IIT**	**One NIT**	**One Private**
		IIT Bombay	**IIT Madras Two streams**		**IIT Hyderabad Two specializations**	**NIT Karnataka, Suratkal**	**Thapar University**
Total credit requirement	60	164	64/71		62	60	62
Core credits	36	140	52/53		51	51	51.5
Elective credits	24	24	12/18		11	9	10.5
Core credit as % of total credits	60.0	85	81.2/74.6		82.2	85	83.0
Comparison of core cores across institutions	Adv. Thermo Adv. TP Adv. CRE Proc. Engg.	Adv. TP Math & Stat methods Adv. Rxn Engg. Adv. Thermo Comp. Methods Comm. Skills Exper. Methods	CRE Adv. Thermo Maths Methods TP Proc. Sim Lab Adv. Chem. Engg. Lab	Fund. Ads & Catal. Princ. Solid Surf. CRE Stat Des. & Anal Exp. Exp. Meth. Catal. Princ. Surf. Anal. Catal. Prep. & Character. TP	Adv TP Computational Methods for Engineers Adv. Chem. Engg.Thermo Adv. Chem. Rxn Engg. Adv. Proc. Control Adv. Chem. Engg. Lab	TP Proc. Equip. Des. I & II Proc. Dyn. & Control Modeling & Sim. CRE Appl. Stat & Num methods	Thermo TP Sep. Proc. CRE Res. Methodology Comp. Methods Proc. Modeling Sim Bioproc. Engg. Proc. Dyn Control

Benchmarking of Curriculum: Graduate program - Master's Degree (Continued)

Benchmarking parameters	**IIT Delhi**	**National Institutes**				
		Two old IITs		**One new IIT**	**One NIT**	**One Private**
		IIT Bombay	**IIT Madras Two streams**	**IIT Hyderabad Two specializations**	**NIT Karnataka, Suratkal**	**Thapar University**
No. of assignment submitted by students	-	-	-	-	-	-
No. of theory courses in core curriculum	4	7	4/7	5	7	9
No. and nature of laboratories	0	1	2/1	1	0	0
Thesis requirements	Two semester project (18 credits, In addtion minor project of 4 credits)	Two semester and summer (90 credits)	Two semester (total 23 credits. In addition a project of 3 credits and a seminar of 2 credits)	Two semester (total 26 credits in two semesters. In addition a seminar of 1 credit)	Three semester (Total 33 credits). In addition a two credit Seminar course	Two semester (20 credits, seminar 2 and Minor project/practical training of 2 credits each also compulsory)	Two semester (Total 12 credits, in addition a minor project of 4 credits compulsory)
Important differences with peers	-	-	-		-	--	-
Maths requirement	None	2 core courses	1 core course	1 core course	One math core course in each program	1 core course	1 core course
Interdisciplinary/breadth	6 credits from other dept.	None	None	None	3 credits		

Benchmarking of Curriculum: Graduate program - Master's Degree (Continued)

Benchmarking parameters	IIT Delhi	Overseas Universities					
		One in top 10	Two ranked 10-50			One top from China	One top from Brazil
		Stanford University (QS Rank 5)	Purdue University (QS Rank 26) Ms(thesis)/ MS(non-thesis)	Mcgill University (QS Rank 47) M. Eng(proj)/M.Eng(thesis)		Shanghai Jiao Tong University (QS Rank 51-100)	Polytechnioque school University of Sao Paulo
Total credit requirement	60	45	15*/30 * includes only course credits, thesis separate	45/45		-	
Core credits	36	15	12/12	12/37* *31 are thesis related		-	
Elective credits	24	30	3/18	27*/9 *16 are restricted electives		-	
Core credit as % of total credits	60.0	33.33	80/40	25/82		-	
Comparison of core cores across institutions	Adv. Thermo Adv. TP Adv. CRE Proc. Engg.	Any Four of Appl. Maths, Microhydrody, Chem. Kin & Rxn Engg., Molec Thermo, Fund & Appl. of Spectroscopy, Adv. Biochem Engg.	Adv. Thermo Adv. TP Appl. Maths Chem. Rxn Engg.	Env. Eng. Sem. Env. Bioremediation	Lab Safety 1 & 2 & one of Heat & Mass Transf., Thermo, Found. of Fluid Mech, Adv Eiochem Engg., CRE, Computational Methods, Proc. Dyn & Control	-	

Benchmarking of Curriculum: Graduate program - Master's Degree (Continued)

Benchmarking parameters	IIT Delhi	Overseas Universities				
		One in top 10	Two ranked 10-50		One top from China	One top from Brazil
		Stanford University (QS Rank 5)	Purdue University (QS Rank 26) Ms(thesis)/ MS(non-thesis)	Mcgill University (QS Rank 47) M. Eng(proj)/M.Eng(thesis)	Shanghai Jiao Tong University (QS Rank 51-100)	Polytechnioque school University of Sao Paulo
Textbook used in core courses	**Appendix 1.4**	-	-	-	-	-
No. of assignment submitted	-	-	-	-	-	-
No. of theory courses in core curriculum	4	4	4	1/1	-	-
No. and nature of laboratories	0	0	0	0/2	-	-
Thesis requirements	Two semester project (18 credits. In addition another 4 credits project compulsory)	Optional (6 credits thesis of 6 credits course work)	Compulsory/optional	Project of 6 credits/ Thesis of 31 credits	-	-
Important differences with peers	-	-	-	-	-	-
Maths requirement	None	None	1 core course	None	-	-
Interdisciplinary/breadth	6 credits from other dept.	-	-	-	-	-

Benchmarking of Curriculum: Graduate program - Ph.D. Degree

Benchmarking parameters	IIT Delhi	National Institutes				
		Two old IITs		One new IIT	One NIT	One Private
		IIT Bombay	IIT Madras	IIT Hyderabad	NIT Karnataka, Suratkal	Thapar University
Ph.D. course work requirement and typical actual course work	6 for M. Tech and 20 for B. Tech. & M.Sc. (3 compulsory courses and an additional course on communication skills)	12 credits for M.Tech 50 credits for B.Tech.	12 credits for M. Tech. (2 core & 2 elective courses) 24 credits (5 core and 3 elective courses) for B. Tech., M.Sc.	12 credits (Four courses spread over two semesters)	12 (of which 4 credits can be a self-study course)	11 (including 4 credit seminar course)
Core courses	Adv. Thermo Adv. TP Adv. CRE	**A. Ch.E background** TP, Thermo, Rxn Engg., Maths Methods **B. Others** Intro. Chem. Engg., Maths Methods for Biologists, Bioproc. Princ., Molec. Biology, Metabolism & Bioenergetics, Intro. Bio-Maths, Maths Methods, Thermo, TP, Optimization, Multivar. Statistics	-	-	TP Proc. Equip. Des. I & II, Proc. Dyn. & Control, Modeling & Sim., CRE, Appl. Stat & Num methods	Research methodology, One specified by Dept.

Benchmarking of Curriculum: Graduate program - Ph.D. Degree (Continued)

Benchmarking parameters	IIT Delhi	National Institutes				
		Two old IITs		One new IIT	One NIT	One Private
		IIT Bombay	IIT Madras	IIT Hyderabad	NIT Karnataka, Suratkal	Thapar University
Ph.D. requirement of publishing a paper	None	Two international journal papers or one in journal and one in peer reviewed conference or two in international conferences and One oral presentation in symposium	One paper in refereed journal	None	At least one in refereed journal of conference	Two research paper in refereed journal(s)
Ph.D. teaching requirement	None	None	-	None	None	None
Interdisciplinary/breadth requirement	-	-	-	-	-	-
Thesis requirements	Compulsory	Compulsory	Compulsory	Compulsory	Compulsory	Compulsory
Important differences with peers	-	-	-	-	-	-
Maths requirement	None	-	-	-	-	-
No. and nature of laboratories	-	-	-	-	-	-
Important differences with peers	-	-	-	-	-	-
Maths requirement	-	-	-	-	-	-

Benchmarking of Curriculum: Graduate program - Ph.D. Degree (Continued)

Benchmarking parameters	IIT Delhi	Overseas Universities				
		One in top 10	Two ranked 10-50		One top from China	One top from Brazil
		Stanford University (QS Rank 5) Ms(thesis)/ MS(non-thesis)	Purdue University (QS Rank 26) M. Eng(proj)/M.Eng(thesis)	Mcgill University (QS Rank 47)	Shanghai Jiao Tong University (QS Rank 51-100)	Polytechnioque school University of Sao Paulo
Ph.D. course work requirement and typical actual course work	6 (three compulsory courses either credit or audit and an addition humanities course on communication skills)	135 credits (counting M.S. credits) of which minimum 45 in lecture coursework	30 (four core chemical engineering courses) In addition zero credit seminar and lab safety courses	Safety courses and three from list of fundamental courses. If these/equivalent already done then at least two courses from 500 level Chem Engg course.		
Core courses	Adv. Thermo Adv. TP Adv. CRE	Appl. Maths Microhydrodyn Chem. Kin & Rxn Engg., Mol. Thermo., Fund & appl. of Spectroscopy Adv. Biochem Engg.	Adv. Thermo Adv. TP Appl. Maths Chem. Rxn Engg.	Lab safety 1 & 2 and Three of Heat and Mass transf. Thermo Found of fluid mech Adv Biochem Engg., CRE Comp. methods, Proc. Dyn & Control		

Benchmarking of Curriculum: Graduate program - Ph.D. Degree (Continued)

Benchmarking parameters	**IIT Delhi**	**Overseas Universities**				
		One in top 10	**Two ranked 10-50**		**One top from China**	**One top from Brazil**
		Stanford University (QS Rank 5)	**Purdue University (QS Rank 26)** **Ms(thesis)/ MS(non-thesis)**	**McGill University (QS Rank 47)** **M. Eng(proj)/M.Eng(thesis)**	**Shanghai Jiao Tong University (QS Rank 51-100)**	**Polytechnioque School University of Sao Paulo**
Ph.D. requirement of publishing a paper	None	Research poster in third year	None	None		
Ph.D. teaching requirement	None	Assist teaching in minimum of two Chem. Engg. courses	Assist teaching every alternate semester starting third semester	None		
Interdisciplinary/breadth requirement		Usually take other Dept. courses to complete credit requirement				
Thesis requirements	Compulsory	Compulsory	Compulsory	Compulsory		
Important differences with peers						
Maths requirement	None	One course	1 core course	None		

Appendix 1.4

Books for IIT Delhi Core Courses: UG

CHL110 Transport Phenomena (3-1-0):

Text book:

1. R. B. Bird, W. E. Stewart, and E. S. Lightfoot. Transport Phenomena, 2nd ed., Wiley India Pvt. Ltd., 2002

Reference Books:

1. W. M. Deen, Analysis of Transport Phenomena, Oxford University Press, 1998.
2. J. Welty, C. E. Wicks, R. E. Wilson, and G. L. Rorrer. Fundamentals of Momentum, Heat, and Mass Transfer. 5th ed., Wiley India Pvt. Ltd., 2007.
3. W. J. Thompson, Introduction to Transport Phenomena, Prentice Hall, 2000.

CHL111 Material and Energy Balance (2-2-0)

Text Books:

1. Himmelblau, David M., Riggs, James B. Basic Principles and Calculations in Chemical Engineering, Seventh Ed., Prentice Hall of India, 2011
2. Felder, Richard M.; Rousseau, Ronald W.; Elementary Principles of Chemical Processes, Third Edition, John Wiley & Sons, 2000

Reference Books:

1. Bhatt, B. I., Vora, S. M.; Stoichiometry, Fourth Edition, Tata McGraw Hill Publishing Company Ltd.,2004
2. Hougen, O.A., Watson, K. M., Ragatz, R. A., Chemical Process Principles, Part-I Material & Energy Balances, Second Edition, CBS Publishers & Distributors, 2004

CHL112 Chemical Process Technology (3-1-0)

Text Books:

1. George T. Austin, "Shreve's Chemical Process Industries" fifth edition, McGraw Hill International Editions,1984
2. Gopala Rao M., Marshall Sittig "Dryden's Outline of Chemical Process Technology" third Edition, Affliated East-West Press, India 1997.
3. Jacob A. Moulijn, Nichiel Makkee, Annelies Van Diepen, "Chemical Process Technology" 1st Edition, John Wiley & Sons Ltd. 2008

Reference Books:

1. Wilbur Lundine Nelson, "Petroleum Refinery Engineering", 4th Ed., McGraw Hill, NY, 1958.
2. James G. Speight, Baki Ozum "Petroleum Refining Processes" Marcel Dekker, NY, 2002.
3. James H. Gary, Glenn E. Handwerk "Petroleum Refining (Technology and Economics)" , fifth edition, Marcel Dekker, NY, 2007
4. G. Margaret Wells "Handbook of petrochemicals and processes", second edition, Ashgate Publishing Ltd., 1999.
5. James E. Bailey, David F. Ollis "Biochemical Engineering fundamentals", second edition, Mc Graw Hill International Editions, 1986.
6. Kirk and Othmer "Encyclopedia of Chemical Technology"- 27 Volume set, fifth edition, John Wiley & Sons Ltd. 2004.

CHL121 Chemical Engineering Thermodynamics (3-1-0)

1. Smith & Van Ness: Introduction to Chemical Engineering Thermodynamics, McGraw Hill

CHL122 Chemical Reaction Engineering – I (3-1-0)

Text books:

1. Elements of Chemical Reaction Engineering by H. Scott Fogler, 2nd Edition, Prentice Hall, 2001
2. Chemical Reaction Engineering by Octave Levenspiel, 3rd Edition, John Wiley & Sons 2001

Reference books:

1. The Engineering of Chemical Reactions by Lanny D. Schmidt, 2nd Edition, Oxford University Press, 1998
2. Applied Mathematics and Modeling for Chemical Engineers by R. G. Rice and D. D. Do, John Wiley & Sons, 1995

CHL221 Chemical Reaction Engineering – II (3-1-0)

Text Book:

1. Fogler H.S, 'Elements of chemical reaction engineering' Prentice Hall

Reference Books:

1. O. Levensipiel ' Chemical Reaction Engineering , Wiley Publisher
2. Smith J.M., 'Chemical Engineering Kinetics', Prentice hall, Mcgraw Hill, Gutterfield
3. Carberry, 'Chemical and Catalytic Reaction Engineering' Mcgraw Hill
4. Froment G.F and Bischoff K.B., 'Chemical Reactor Analysis and Design' John Wiley
5. C.G. Hill, 'An Introduction to Chemical Engineering Kinetics and Reactor Design'
6. Satterfield, "Heterogeneous Catalysis in Practice" McGraw Hill,
7. M. M. Sharma and L.K. Doraiswamy, :Heterogeneous Reactions", Vol1 and Vol II.

CHL231 Fluid Mechanics for Chemical Engineers (3-1-0)

Text Books:

1. F. M. White, Fluid Mechanics, 7th Edition, Tata-McGraw Hill, 2011.
2. R. W. Fox, P. J. Pritchard and A. T. McDonald, Introduction to Fluid Mechanics, 7th Edition, Wiley-India 2010.

Reference Books:

1. B. R. Munson, D. F. Young, T. H. Okiishi and W. W. Huebsch, 6th Edition, Wiley-India 2010.
2. V. Gupta and S. K. Gupta, Fundamentals of Fluid Mechanics, 2nd Edition, New Age International 2011.
3. R. L. Panton, Incompressible Flow, 3rd Edition, Wiley-India 2005.
4. R. B. Bird, W. E. Stewart and E. N. Lightfoot, Transport Phenomena, 2nd Edition, Wiley-India 2002.
5. W. L. McCabe, J. C. Smith and P. Harriot, Unit Operations of Chemical Engineering, 7th Edition, McGraw-Hill International Edition 2005.

CHL251 Heat and Mass Transfer (3-1-0)

Text Books:

1. R. E. Treybal, Mass Transfer Operations, Third Edition, Tata McGRaw Hill, 2012
2. E. L. Cussler, Diffusion Mass Transfer in Fluid Systems, Third Edition, CUP, 2009
3. J. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 4th Ed.,Wiley (2007).

4. W. J. McCabe, J. Smith, P. Harriot, Unit Operations of Chemical Engineering, Sixth Edition, McGRaw Hill (2005).
5. D. Q. Kern, Process Heat Transfer, Tata-McGraw Hill (1997).

Reference Books:

1. Bejan, A., A. D. Kraus, Heat Transfer Handbook, John Wiley (2003).
2. Holman, J. P., S. Bhattacharya, Heat Transfer, 10th Ed., Tata McGraw-Hill (2011).

CHL261 Instrumentation and Process Control (3-1-0)

Text Book:

1. Coughanowr, D. R., LeBlanc, S. "Process Systems Analysis and Control", 3rd edition, McGrawHill, 2008.

Reference Books:

1. Seborg, D.E., Edgar, T.F., Mellichamp, D.A. "Process Dynamics and Control", 2nd edition, John Wiley (2003)
2. Stephanopoulos, G. "Chemical Process Control: An Introduction to Theory and Practice", Pearson Education (1984)

CHL331 Fluid Particle Mechanics (3-1-0)

Text Books:

1. Rhodes, M. J. , Introduction to particle technology, 2nd edition, John Wiley, Chichester; New York, 2008 .
2. Coulson and Richardson's CHEMICAL ENGINEERING, VOLUME 2, Butterworth-Heinemann, Fifth edition 2002.
3. McCabe, W., Smith, J. and Harriott, P. Unit Operations of Chemical Engineering, 6th edition., McGraw Hill
4. Terence Allen, Powder Sampling and Particle size Determination, Elsevier, 2003
5. Hiroaki Masuda, Ko Higashitani, Hideto Yoshida, Powder Technology Handbook, CRC, Taylor and Francis, 2006.

CHL351 Mass Transfer Operations (3-1-0)

Text Books:

1. W. McCabe, J. Smith, P. Harriot, Unit Operations of Chemical Engineering, Sixth Edition, McGRaw HIll, 2005
2. R. E. Treybal, Mass Transfer Operations, Third Edition, Tata McGRaw Hill, 2012
3. J. D. Seader and E. J. Henley, Separation Process Principles, Second Edition, Wiley India, 2010
4. R. K. Sinnott, Coulson Richardson's Chemical Engineering Volume 6, Fourth Edition, Cbs Publ Dists, 2005
5. E. L. Cussler, Diffusion Mass Transfer in Fluid Systems, Third Edition, CUP, 2009

CHL471 Process Equipment Design and Economics (3-0-3)

Text Books:

1. Max S. Peters, Klaus Timmerhaus, Ronald E. West, "Plant design and Economics for Chemical Engineers", fifth edition, McGraw-Hill Higher education, 2003.
2. James H. Gary, Glenn E. Handwerk "Petroleum Refining (Technology and Economics)" , fifth edition, Marcel Dekker, NY, 2007

Books for IIT Delhi Core Courses: PG

CHL603 Advanced Transport Phenomena (3-0-0):

Text Books:

1. R. B. Bird, W. E. Stewart, and E. S. Lightfoot. Transport Phenomena, 2nd ed., Wiley India Pvt. Ltd., 2002
2. Deen W. M., Analysis of Transport Phenomena, Oxford University Press, New York, 1998.

Reference Books:

1. Slattery J. C., Advanced Transport Phenomena, Cambridge University Press, 1999.
2. W. J. Thompson, Introduction to Transport Phenomena, Prentice Hall, 2000.

CHL721 Advanced Chemical Engineering Thermodynamics (3-0-0):

Text Books:

1. McQuarrie, D. A., Statistical Thermodynamics, 1st Edition, University Science Books, 2000
2. Huang, K., Statistical Mechanics, John Wiley and Sons, 2000

CHL723 Chemical Reaction and Reactor Engineering (3-0-0):

Text Books:

1. Froment G.F and Bischoff K.B., 'Chemical Reactor Analysis and Design' John Wiley
2. C.G. Hill, 'An Introduction to Chemical Engineering Kinetics and Reactor Design'

Section 2

TEACHING ENVIRONMENT

Executive Summary: Teaching Environment

The student strength in the department has increased between 10-20% across UG, PG and PhD programs in the last 5 years. The average class size is 96 for UG courses and 56 for PG courses. The teaching program has a strong set of core courses, a strong laboratory program closely tying about 30 laboratory experiments with theoretical concepts in Transport courses, thermodynamics, chemical kinetics and reaction engineering and process control. Multiple project courses in the curriculum provide opportunities for hands on training. In addition, significant time is kept aside to by the faculty to allow for discussions with students, including through Teaching Assistants helping students, through tutorials where faculty are present as well as when students meet with faculty for discussing concepts. To inspire and sustain the interest of the students in this branch, field visits to the nearest Chemical Plants, namely, IOCL and NFL are included in the curriculum of some of the courses. Experts from industry (EIL, Lurgi, Bechtel, UOP) and Alumni of the department working in industry deliver lectures /seminars either as part of a particular course or in general, for the whole department, to further motivate the students.

2.1 Student teacher ratio separately and total for UG, PG, PhD (based on gross number and on class size basis)

Table 2.1.1 Student to teacher average across lecture courses

	2008	2009	2010	2011	2012
UG	68	71	81	85	96
PG	34	31	36	46	56

Table 2.1.2 Average number of Student per faculty in project course

	2008	2009	2010	2011	2012
UG	1.81	1.81	2.1	2.4	2.63
MTech	2.22	2.22	1.95	2.4	2.27

Data Source: Last five year data from https://campus1.iitd.ac.in/hcmprod1/signon.html

2.2 Number of student graduated each year

Table 2.2.1 Undergraduate students graduated per year in last five years

Year	No. of UG student got degree in Chem. Engg.	Number of Dual degree student got degree in Chemical Engg.
2013	59	34
2012	53	28
2011	48	33
2010	33	27
2009	44	28
2008	42	24

Source: UG section

Table 2.2.2 Undergraduate students graduated per year in last five years

Year	No. of M Tech student got degree in Chem. Engg.	No. of MS(R) student got degree in Chem. Engg.	No. PhD students
2013	14	1	5
2012	11	1	4
2011	23	0	10
2010	16	1	9
2009	22	3	5

2.3 Student- TA (or student-hours/TA) ratio

Varies across courses in the department.

Typically, 24 students/TA per lecture course, 12 students/TA per lab course.

2.4 Number of Skilled Technical Staff

Three skilled technical staff

2.5 Gross laboratory Space: Breakup of lab space for core UG/PG teaching

The department has 11568 sq ft for UG teaching and 2304 sq ft for PG

2.6 Laboratory modernization performed in the last 5 years (i)UG core(ii)PG(core), (iii)elective courses (attach data before and after modernization)

(i) We have two UG laboratories: UG laboratory1 (HT,MT,FPM,Thermo) and UG laboratory2 (CRE & PC). Both UG Laboratories were renovated and are shown below.

Table 2.6.1 UG Laboratory Courses

UG laboratory1 (HT,MT,FPM,Thermo) Experimental Setup	
Before Renovation	**After Renovation**
Heat Transfer Experiments	Film and dropwise condensation – H7
Thermal Conductivity of liquid – H1	Heat Transfer through Forced Convection – H4
Thermal conductivity of metal bar – H2	Parallel counter heat exchanger – H5
Heat Transfer through Natural convection – H3	Shell and Tube heat exchanger
Film and dropwise condensation – H7	**Double effect evaporator**
Heat Transfer through Forced Convection – H4	
Parallel counter heat exchanger – H5	
Shell and Tube – H6	
Thermodynamics	
Refrigeration Test Rig	Refrigeration Test Rig
	Verification of ideal gas law
	Tensiometer, Vapour Pr. Osmometer
Mass Transfer Experiments	
Mass Transfer with/without chemical reaction – M2	Mass Transfer with/without chemical reaction – M2
Vapor liquid equilibria [requires water line for condenser] – M3	Vapor liquid equilibria [requires water line for condenser] – M3
Diffusion coefficient – M4	Diffusion coefficient – M4
Mass transfer coefficient – M5	Mass transfer coefficient – M5
Adsorption Column – M6	Adsorption Column – M6
Wetted Wall Column – M7	Wetted Wall Column – M7
Simple distillation [requires continuous water line for condenser] – M1	Simple distillation [requires continuous water line for condenser] – M1
Vacuum Distillation	Vacuum Distillation
Absorption – D2	Absorption – D2
Fractional rectification – D3	Fractional rectification – D3
Fluid and Particle Mechanics	
Packed Bed – F11	Packed Bed – F11
Fluidization [water-solid] – F2	Fluidization [water-solid] – F2
Blaine Permeameter – F1	Blaine Permeameter – F1
Sieve Analysis [table top one – not the existing] – F4	Sieve Analysis [table top one – not the existing] – F4
Cyclone Separator – F10	Cyclone Separator – F10

Stokes Law – F9	**Spray Drier – F6**
	Rheometer
	Plate and Frame Filter press - F7
	zeta meter
	Tensiometer
	Rotameter/venturi/orifice test rig
	Centrifugal pump test rig
	Highlighted experimental set up are purchased after renovation

UG laboratory2 (CRE & PC)Experimental Setup	
Before Renovation	**After Renovation (no change in CRE)**
Kinetics of saponification reaction from a batch reactor (CRE1)	Kinetics of saponification reaction from a batch reactor (CRE1)
Kinetics of hydrogen peroxide decomposition in a batch reactor (CRE2)	Kinetics of hydrogen peroxide decomposition in a batch reactor (CRE2)
Kinetics of saponification reaction from a semi-batch stirred reactor (CRE3)	Kinetics of saponification reaction from a semi-batch stirred reactor (CRE3)
Flow analogy for series and parallel reactions (CRE4)	Flow analogy for series and parallel reactions (CRE4)
Reaction kinetics from an adiabatic batch reactor (CRE5)	Reaction kinetics from an adiabatic batch reactor (CRE5)
Kinetics of a gas-solid non-catalytic reaction (CRE6)	Kinetics of a gas-solid non-catalytic reaction (CRE6)
Response of level in a tank (PC 1)	Dynamics of lagged thermometer (PC 1)
Second order system – response of U-tube manometer (PC 2)	Dynamics of a stirred tank heater (PC 2)
Response of distributed system – lagged thermometer (PC 3)	Temperature Control (PC 3)
Study of dynamics of a stirred tank heater (PC 4)	**Level Control (PC 4)**
Control Tuning in Temperature Control (PC 5)	**Pressure Control(PC 5)**
Experiment and Simulation of Controller Tuning in Level Control (PC 6)	**Cascade Control (PC 6)**

(ii) We do not have any PG (core) laboratory.

2.7 Course file for each course for the last five years

Available with instructor of the course

2.8 Study Materials prepared course wise

Available with instructor of the course

2.9 Research and Innovation in teaching and learning processes

In the CHL 723 course (Process Engineering Design and Economics), a large course project is assigned based on some topical research/design area. Each of the tutorial groups (each having about 20-25 students) is given one topic. Each group of students have to elect their team leaders and simulate a R&D working environment, in which the work is divided amongst people, each of whom is assigned a design task. Most of these design tasks have a certain degree of innovation, owing to the choice of assigned topics or a "twist" in the problem. Finally, the groups need to also do an

economic and feasibility analysis. A Design Project course allowing hands on design of open ended problems of relevance to industry and to society provides further learning opportunities.

The work is done in parallel with the regular lectures and tutorials and runs through the semester. Students are assigned marks based on their technical contribution as well as their ability to work with other team members.

In CHL331, Fluid particle mechanics course, an assignment (20% weightage) was given to a group of two students to identify industry with application of fluid particle system. They have to find out the size of particles in each unit and design the important process unit based on the knowledge learned in the subject.

2.10. Number of students who have spent at least a semester at another university/institute

	2008-09	**2009-10**	**2010-11**	**2011-12**	**2012-13**
UG					
PhD			1(skp)	1(skp) + 1(SR)	**1KKP**

2.11 Number of students from overseas universities who have taken classes, done project works or internship in the department

	2008-09	**2009-10**	**2010-11**	**2011-12**	**2012-13**
UG				1(SB)	
PG		1 (SR)			

2.12 Course feedback

Mechanism of taking feedback of students exists (see section 9 Feedback Systems and Results).

2.13 Industry experts who have delivered lectures, seminars, discussions as part of a core/elective course

Prof. R.P Verma (presently working for HPCL) in Petroleum Refining Course.

2.14 Industry exposure to students- Course related visits to factories, sites, industry exhibitions, field trips etc.

Field trips to NFL, Panipat and IOCL, Panipath of students registered in core course Process Technology

Section 3

RESEARCH

Executive Summary: Research

Together with its widely acclaimed UG & PG teaching programs, the Department of Chemical Engineering has a strong and vibrant research program. With its 24 faculty members known nationally and internationally for their contributions to their respective areas of research, the department has following major areas of research (1) Catalysis, (2) Energy, (3) Advanced materials, (4) Process Intensification/ Multiphase Reactor Engineering, (5) Process modelling & Optimization, (6) Complex Fluids/ Rheology, (7) Pharmaceutical Biotechnology and (8) Environment & Waste Management. A large number of Ph.D. students (a total of 105 students with an average of 4.3 students per faculty) are contributing to the strong research program that the Department is pursuing. It may be noted that about 30% of these students are funded through sponsored research projects. In last 5 years, the department has published 397 peer reviewed international journal papers with an average of 3.3 papers per faculty per year and has presented 324 papers in peer reviewed international and national conferences with an average of 2.7 papers per faculty per year. These international publications written in last 5 years were cited 3668 times leading to an average of 166 citations per faculty. In last 5 years, the department has undertaken 85 sponsored research projects worth 33.23 crores (1.38 crores per faculty) and 27 consultancy projects worth 2.03 cores (8.45 lacs per faculty). The department is pursuing a large number of interdisciplinary research projects involving participation of other departments at IIT Delhi and also other national and international universities/research institutes.

3.1 No. of Masters and Ph.D. students supported – (i) by institute assistantship, (ii) on sponsored projects/consultancies, (iii) other sources and (iv) sponsored by external organizations.

	Ph.D. Students	M. Tech. Students
Institute Assistantship	33	31 (2012-14) 27 (2013-15)
Sponsored projects/consultancies	33.5	--
Sponsored by external organizations	08 (CSIR) 03 (UGC) 01 AICTE 01 (Ethiopia) 02 (QIP)	2 (1 sponsored by BARC through DGFS fellowship for 2012-2014 and for 1 2013-2015)
Other sources	03 (self-finance) 19 (Part time)	--
Total	103.5	60

3.2 No. of Ph.D. enrolled, graduated per faculty for last 5 years

.

Year	Ph.D. Students enrolled	Ph.D. Students graduated
2009	13	5
2010	24	9
2011	16	4
2012	22	7
2013	32	5
Total	107	30
Average (per faculty) (for 24 faculty members)	**4.45**	**1.25**

3.3 Areas of research (e.g., areas listed in prospectus, and others) by (i) Volume (quantifiable parameters), (ii) Breadth, and (iii) years these have been research areas (as per format at annexure-4).

The broad research areas currently pursued at the Department of Chemical Engineering are shown in Figure 3.1. The distributions of research areas based on number of faculty, on-going Ph.D. students, international publications in last 5 years and external funding in last 5 years are shown in Annexure 4 and in Figures3.2 (a), (b), (c) and (d), respectively.

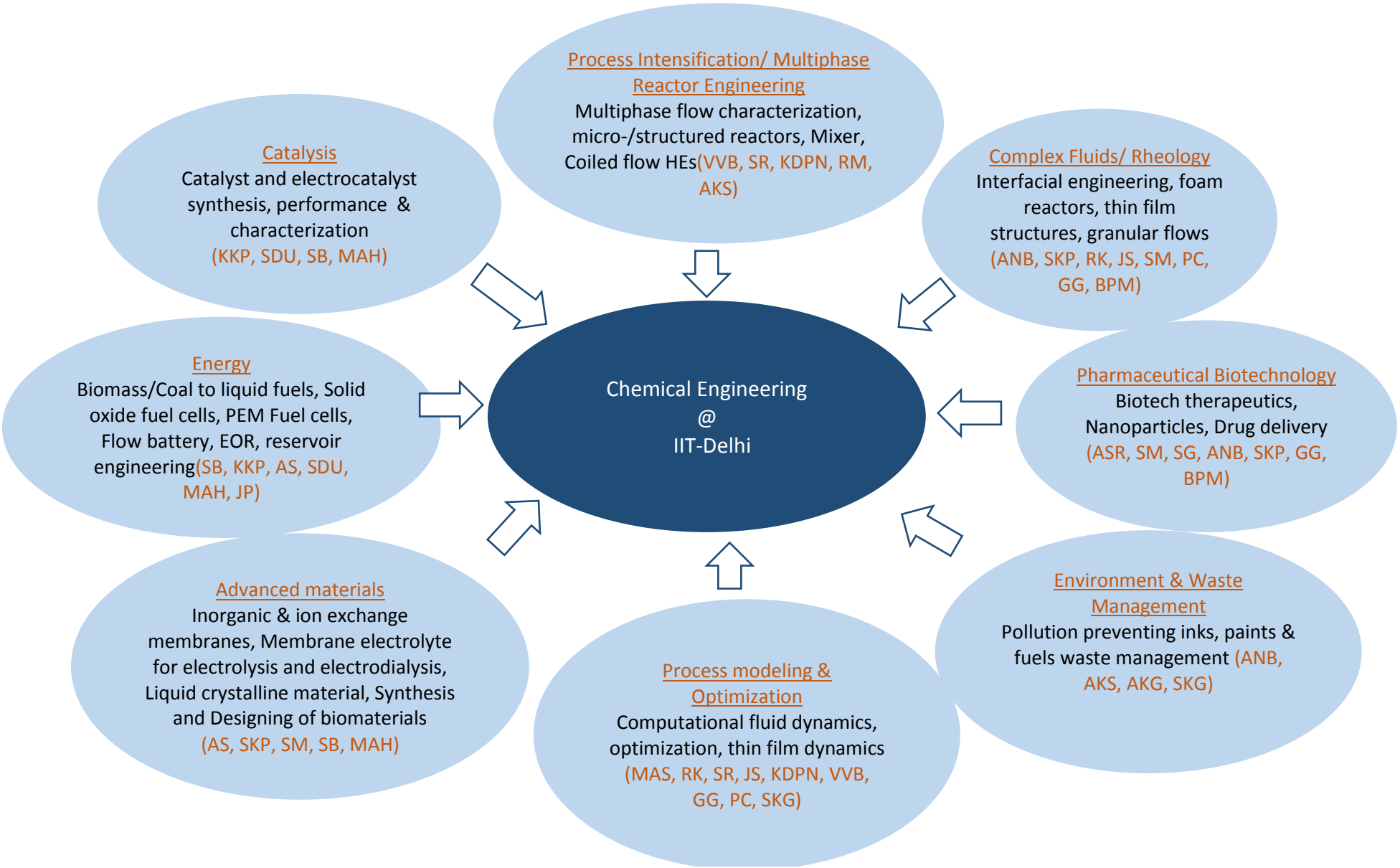
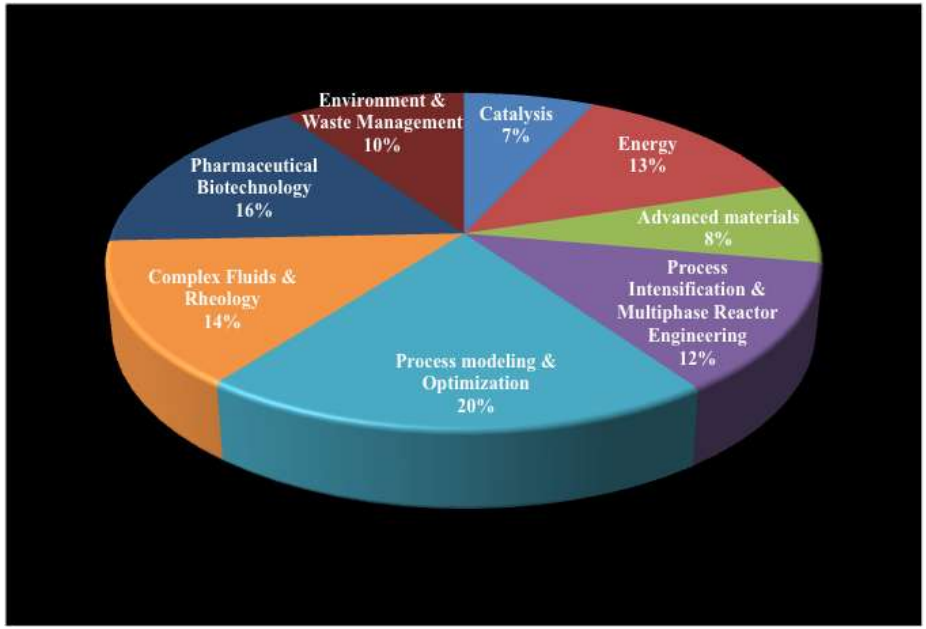
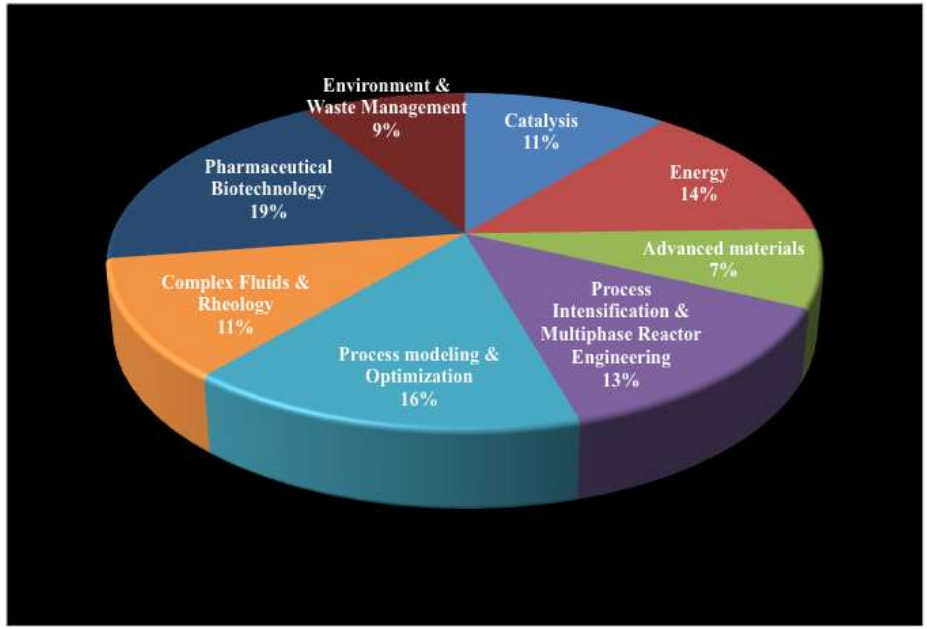


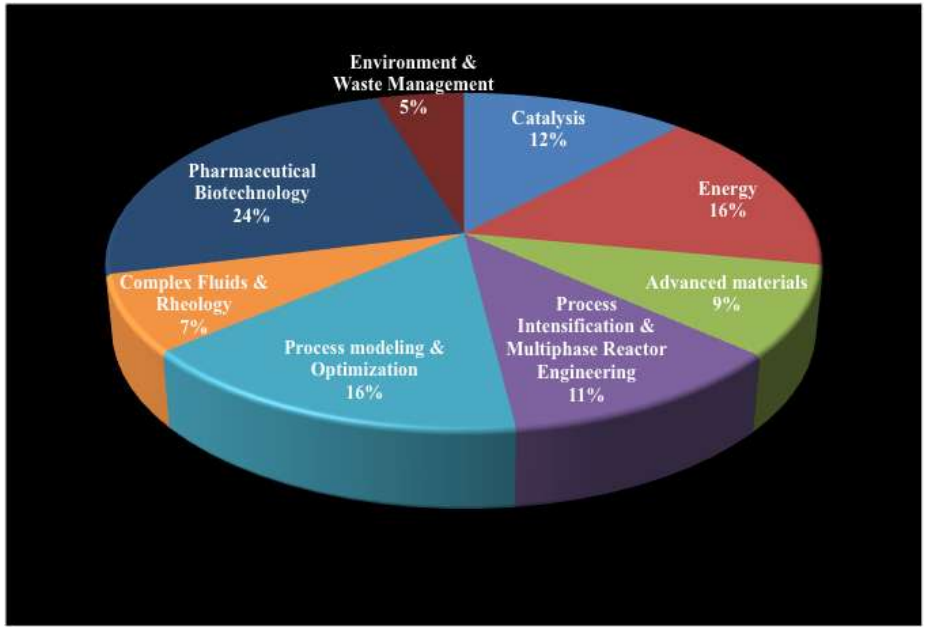
Figure 3.1: Present research areas



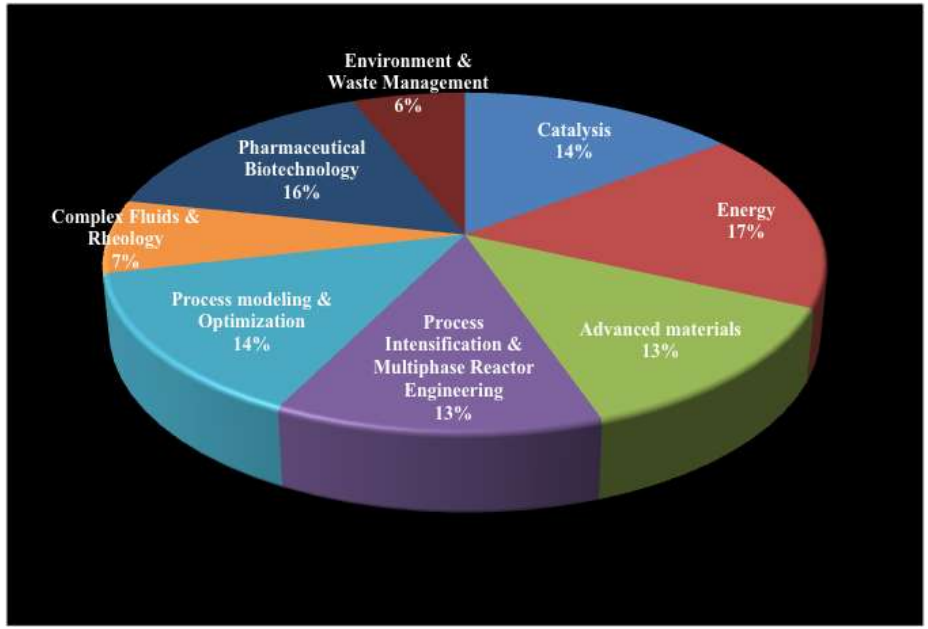
(a) Distribution of research areas by number of faculty members



(b) Distribution of research areas by number of on-going Ph. D. students



(c) Distribution of research areas by number of international publications in last 5 years



(d) Distribution of research areas by external funding received in last 5 years

Figure 3.2: Distribution of research areas by (a) number of faculty members, (b) number of on-going Ph. D. students, (c) number of international publications in last 5 years and (d) external funding received in last 5 years

3.4 Publications per faculty: 3.3 per year per faculty (as per details given below)

Sr. No.	Faculty	Total (last 5 years)		Total (all years)	
		Peer reviewed Journals (international) Average per year	Peer reviewed conferences (international+ national) Average per year	Peer reviewed Journals (international)	Peer reviewed conferences (international+ national)
1	Suddhasatwa Basu	46	19	80	44
2	Ashok N Bhaskarwar	9	13	45	32
3	Kamal K Pant	50	60	82	120
4	Rajesh Khanna	16	14	39	26
5	Ratan Mohan	4	4	14	16
6	Sharad K Gupta	6	7	41	28
7	Anil K Saroha	15	19	34	40
8	Anupam Shukla	20	10	30	16
9	Anurag S Rathore	71	14	121	40
10	Sanat Mohanty	10	4	20	15
11	Shantanu Roy	25	51	45	85
12	Sreedevi U.	10	13	20	27
13	Vivek V Buwa	9	20	23	43
14	Gaurav Goel	8	6	10	11
15	Jayati Sarkar	4	14	11	17
16	Munawar A Shaik	11	25	19	40
17	Paresh P Chokshi	4	1	7	1
18	Shalini Gupta	8	0	9	1
19	Sudip Pattanayek	10	12	21	22
20	Jyoti Phirani	6	1	6	1
21	M Ali Haider	7	0	8	0
22	K D P Nigam	33	9	131	n.a.
23	B P Mani	10	8	95	60
24	Ashok K Gupta	5	0	37	20
Total		**397**	**324**	**948**	**705**
Average (per faculty per year)		**3.3**	**2.7**		

n.a.: not available

3.5 Publications in last 5 years (Peer reviewed international Journals and peer reviewed international + national conferences)

Sr. No.	Faculty	Total	Total PhD	Per PhD	Total M. Tech	Per M. Tech	Total B. Tech	Per B. Tech
1	Suddhasatwa Basu	65	36	4	5	0.33	2	0.2
2	Ashok Bhaskarwar	22	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
3	Kamal K Pant	110	40	6	10	1	4	1
4	Rajesh Khanna	30	29	6	1	1	0	0
5	Ratan Mohan	8	7	0	1	0	0	0
6	Sharad K Gupta	13	15	0	1	0	0	0
7	Anil K Saroha	34	29	0	1	0	2	0
8	Anupam Shukla	30	28	5	2	0.25	0	0
9	Anurag S Rathore	85	23	6	12	2	3	0.3
10	Sanat Mohanty	14	8.5	1.7	1.5	0.15	0	0
11	Shantanu Roy	76	41	3.63	11	0.85	6	0.46

12	Sreedevi U.	23	2	10	3	1	0	0
13	Vivek V Buwa	29	13	2	9	0.2	1	0
14	Gaurav Goel	14	0	0	0	0	0	0
15	Jayati Sarkar	18	3	3.67	12	0	10	0
16	Munawar A Shaik	36	12	6	12	0.92	5	0.45
17	Paresh P Chokshi	5	0	0	0	0	0	0
18	Shalini Gupta	8	0	0	1	0.2	0	0
19	Sudip K Pattanayek	22	17	5	1	0.2	0	0
20	Jyoti Phirani	7	0	0	0	0	0	0
21	M Ali Haider	7	0	0	0	0	0	0
22	K D P Nigam	42	44	5	6	1	1	
23	B P Mani	18	10	3.33	4	1.33	7	1.4
24	Ashok K Gupta	5	5	2.5	0	0	0	0

3.6 Best 3 papers in last 5 years (individual best)

Sr. No.	Faculty	Papers	Citations
1	Suddhasatwa Basu	Basu, S., 2007. Recent Trends in Fuel Cell Science and Technology, (Ed) Springer, New York. Book released in 2008	129
		Basu, D., Basu S., 2010. A study on direct glucose and fructose alkaline fuel cell. Electrochimica Acta 55 (20), 5775-5779.	27
		Tayal, J., Rawat, B., Basu, S., 2011. Bi-metallic and tri-metallic Pt–Sn/C, Pt–Ir/C, Pt–Ir–Sn/C catalysts for electro-oxidation of ethanol in direct ethanol fuel cell. International Journal of Hydrogen Energy 36 (22), 14884-14897.	32
2	Ashok N Bhaskarwar	Gaikwad, A.A., Niyantha, C., and Bhaskarwar, A.N., 2009. Carbonation of barium sulfide in a foam-bed reactor. Chemical Engineering Communications. Chem. Eng. Comm. 197(6), 804-829.	22
		Jana, S.K., Bhaskarwar, A.N., 2010. Modeling gas absorption accompanied by chemical reaction in bubble column and foam-bed slurry reactors. Chemical Engineering Science, 65(11), 3649-3659.	3
		Sangeeta, A.K., Urbani, M., Medel, M., Ince, M., Gonzalez-Rodriguez, D., Arvind Kumar, C., Bhaskarwar, A., Torres, T., Nazeeruddin, M., and Gratzel, M., 2014. Adapting ruthenium sensitizers to cobalt electrolyte systems. The Journal of Physical Chemistry Letters. (Accepted).	-
3	Kamal K Pant	Byrd A. J., Pant, K. K. and Gupta R. B., 2008. Hydrogen production from glycerol by reforming in supercritical water over Ru/Al2O3 Catalyst. Fuel. 87 (13-14), 2956-2960.	130
		Patel, S., and Pant, K. K., 2009. Kinetic modeling of oxidative steam reforming of methanol over Cu/ZnO/CeO2/Al2O3 catalyst. Applied Catalyst A. 356 (2), 189-200	24
		Sachdeva, T. O., Pant, K. K., 2010. Deep desulfurization of diesel via peroxide oxidation using phosphotungstic acid as phase transfer catalyst. Fuel Process Technology. 91(9), 1133-1138.	26
4	Rajesh Khanna	Khanna, R., Agnihotri, N., Vashishtha, M., Sharma, A., Jaiswal, P K., Puri, S., 2011. Kinetics of spinodal phase separation in unstable thin liquid films. Physical Review-Section E-Statistical Nonlinear and Soft Matter Physics 82 (1).	6
		Roy, P., Khanna, R., Subbarao, D., Granulation time in fluidized bed granulators. 2010 Powder Technology 199 (1), 95-99.	5
		Jaiswal, P.K., Vashishtha, M., Khanna, R., Puri, S., 2011.Amplification of Fluctuations in Unstable Systems with Disorder. The Journal of Physical Chemistry B 115 (15), 4399-4403.	2

5	Ratan Mohan	Aggarwal, A., Mohan, R., 2010. Aspect ratio analysis using image processing for rice grain quality. Int. J. Food Engg. 6(A8).	
		Arunkumar, U.K., Mohan, R., 2011. Liquid - liquid equilibria measurement of systems involving alkanes (heptane and dodecane), aromatics (benzene and toluene) and furfural. J. Chem. Engg. Data 56, 485-490.	3
		Jeevarathinam, D., Gupta, A. K., Pitchumani, B., Mohan, R.,2011.Effect of gas and liquid flow rates on the size distribution of barium sulphate nano-particles precipitated in a two phase flow capillary microreactor. Chemical Engg. J. 173,606-611	9
6	Sharad K Gupta	Shukla, P., Gupta, S.K., Sreekrishnan, T.R., Maitra, S.S., 2013. DNA based methods reveal complex kinetics of MSW leachate anaerobic digestion. J. Hazardous, Toxic, and Radioactive Waste Management (ACSE), 17,156-162.	-
		Bajpai, S., Dey, A., Jha, M. K., Gupta, S.K. and Gupta, A., 2012. Removal of hazardous hexavalent chromium from aqueous solution using divinylbenzene copolymer resin'. Int. J. Sci. Technology, 9. 683-690.	2
		Bajpai, S., Gupta, S. K., Dey, A., Jha, M. K., Bajpai, Viduchi, Gupta, Arvind and Gupta, A., 2012. Application of central composite design approach for removal of chromium) VI) from aqueous solution using weakly anionic resin: Modeling, Optimization, and study of interactive variables. Journal of Hazardous Materials, 227-228,436-444	2
7	Anil K Saroha	Khandegar, V., Saroha, A. K., 2013. Electrocoagulation for the Treatment of Textile Industry Effluent – A Review. J. Env. Management, 128, 949-963.	1
		Varma, S. K., Khandegar, V., Saroha, A.K., 2013. Removal of Chromium from Electroplating Industry Effluent using Electrocoagulation. J. Hazardous, Toxic and Radioactive Waste, 17,146-152.	2
		Saroha, A. K., 2010. Solid-Liquid Mass Transfer in Trickle-bed Reactors, Chem. Engg. Res. & Des., 88,744.	3
8	Anupam Shukla	Immanuel, V., Shukla, A., 2012. Effect of operating variables on performance of membrane electrolysis cell for carrying out Bunsen reaction of I–S Cycle. International Journal of Hydrogen Energy 37 (6), 4829-4842.	6
		Workneh, V., Shukla, A., 2008. Synthesis of sodaliteoctahydrate zeolite-clay composite membrane and its use in separation of SDS. Journal of Membrane Science 309 (1), 189-195.	10
		Kumar, S., Kumar, A., Shukla, A., Devi, G.R., Gupta, A.K., 2009. Thermal-diffusivity measurement of 3D-stitched C–SiC composites. Journal of the European Ceramic Society 29 (3), 489-495.	13
9	Anurag S Rathore	Rathore, A.S., Winkle, H., 2009. Quality by design for biopharmaceuticals. Nature biotechnology 27 (1), 26.	187
		Rathore, A.S., 2009. Roadmap for implementation of quality by design (QbD) for biotechnology products. Trends in biotechnology 27 (9), 546-553.	86
		Read, E.K., Park, J.T., Shah, R.B., Riley, B.S., Brorson, K.A., Rathore, A.S., 2010. Process analytical technology (PAT) for biopharmaceutical products: Part I. concepts and applications. Biotechnology and bioengineering 105 (2), 276-284.	50
10	Sanat Mohanty	Merheb, B., Deymier, P.A., Jain, M., Aloshyna-Lesuffleur, M., Mohanty, S., Berker, A., 2008.Elastic and viscoelastic effects in rubber/air acoustic band gap structures: A theoretical and experimental study. Journal of Applied Physics 104 (6), 064913-064913-9.	25
		Merheb, B., Deymier, P.A., Jain, M., Muralidharan, K., Bucay, J., Aloshyna-Lesuffleur, M., Mohanty, S., 2009. Viscoelastic effect on acoustic band gaps in polymer-fluid composites. Modelling and Simulation in Materials Science and Engineering 17 (7), 075013.	6
		Motkar, G., Lonare, M., Patil, O., Mohanty, S., 2013.Self-assembly of folic acid in aqueous media. AIChE Journal, 59(4), 1360-1368.	1

11	Shantanu Roy	Vaishali, S., Roy, S., Patrick L. M., 2008. Hydrodynamic simulation of gas–solids down flow reactors. Chemical Engineering Science 63 (21), 5107-5119.	23
		Upadhyay, Rajesh K., Harish J. P., Roy, S., 2013. Liquid flow patterns in rectangular air-water bubble column investigated with Radioactive Particle Tracking. Chemical Engineering Science, 96, 152-164.	1
		Gupta, Ankur, Roy, S., 2013. Euler-Euler Simulation of Bubbly Flow in a Rectangular Bubble Column: Experimental Validation with Radioactive Particle Tracking. Chemical Engineering Journal, 225, 818-836.	1
12	Sreedevi Upadhyayula	Kondamudi, K., Elavarasan, P., Paul, J. Dyson Upadhyayula, S., 2010. Alkylation of p-cresol with tert-butylalcohol using benign Bronsted acidic ionic liquid catalyst, Journal of Molecular Catalysis A: Chemical, 321(1), 34-41.	15
		Singhal, R., Singhal, C., Upadhyayula, S., 2010.Thermal-catalytic degradation of polyethylene over Silicoaluminophosphate molecular sieves- A thermogravimetric study. J. of Analytical and Applied Pyrolysis, 89, 313-317.	1
		Elavarasan, P., Kondamudi, K., Upadhyayula, S., 2011. Kinetics of phenol alkylation with tert-butyl alcohol using sulfonic acid. Chemical Engineering Journal, 166, 340–347.	13
13	Vivek V Buwa	Rabha, S. and Buwa, V. V., 2010.Volume-of-Fluid (VOF) Simulations of Rise of Single/Multiple Bubbles in sheared liquid, Chemical Engineering Science, 65(1), 527-537.	27
		Raj, R., Mathur, N. and Buwa, V. V., 2010. Numerical Simulations of Liquid-Liquid Flows in Microchannels. Industrial and Engineering Chemistry Research, 49 (21), 10606–10614.	10
		Goel, D. and Buwa, V. V., 2009. Numerical Simulations of Bubble Formation and Rise in Micro-Channels. Industrial and Engineering Chemistry Research, 48, 8109–8120.	08
14	Gaurav Goel	Goel G., Krekelberg W.P., Errington J.P., Truskett T.M., 2008.Physical Review Letters 100 (10), 106001	31
		Goel G., Krekelberg W.P., Pond M.J., Mittal J., Shen V.K., Errington J.P., Truskett T.M., 2009. Journal of Statistical Mechanics: Theory and Experiment P04006.	13
		Goel G., Zhang L., Lacks D.J., Van Orman J.A., 2012.Geochimica et Cosmochimica Acta, 93, 205-213.	2
15	Jayati Sarkar	Sarkar, J., Annepu, H., Sharma, A., 2011. Contact Instability of a Soft Elastic Film Bonded to a Patterned Substrate. JOURNAL OF ADHESION 87, 214.	2
		Sarkar,J., Sharma, J.,Shenoy,V., 2010. A Unified Theory of Instabilities in Viscoelastic Thin Films: FromWetting to Confined Films, From Viscous to Elastic Films, From Short To Long Waves. LANGMUIR, 26, 8464.	20
		Sarkar, J., Sharma,A.,Shenoy, V., 2008. Electric-field induced instabilities and morphological phase transitions in soft elastic films. PHYSICAL REVIEW E, 77, 031604.	32
16	Munawar A Shaik	Munawar, A. S.,Christodoulos, A., Floudas, 2008. Unit-Specific Event-based Continuous-Time Approach for Short-Term Scheduling of Batch Plants using RTN Framework, Computers & Chemical Engineering,32, 260-274.	53
		Munawar A. S., Christodoulos, A., Floudas, 2009.Novel Unified Modeling Approach for Short-term Scheduling, Industrial & Engineering Chemistry Research, 48, 2947-2964.	42
		Munawar A. S.,Christodoulos, A., Floudas, Kallrath, J. Pitz, H.J., 2009. Production Scheduling of a Large-Scale Industrial Continuous Plant: Short-Term and Medium-Term Scheduling, Computers & Chemical Engineering, 32, 670-686.	39

17	Paresh P Chokshi	Adachi,T.,Brazard, J., Chokshi, P.,Ganesan,V., Bolinger,J., Barbara,P., 2010. Highly ordered single conjugated polymer chain rod morphologies, *J. Phys. Chem. C*, 114, 20896-20902.	26
		Chokshi, P.,Kumaran, V., 2008. Weakly nonlinear analysis of viscous instability in flow past a neo-Hookean surface. *Phys. Rev. E*, 77, 056303.	3
		Chokshi,P., Kumaran, V., 2008. Weakly nonlinear stability analysis of a flow past a neo-Hookean solid at arbitrary Reynolds number, *Physics of Fluids*, 20, 094109.	3
18	Shalini Gupta	Jain, S., Gupta,S., 2013. DielectrophoreticCo-assembly of Binary Colloidal Mixtures in AC Electric Fields, Langmuir 29, 16105-16112.	0
		Velev, O.D., Gupta. S., 2009. Advanced Materials 21, 1-9.	157
		Gupta S., Alargova R.G., Kilpatrick P.K., Velev O.D., 2008. Soft Matter 4, 726-730.	31
19	Sudip K Paatanayek	Pandey, L.M., Pattanayek, S.K., 2011. Hybrid surface fromself-assembled layer and its effect on protein adsorption. Applied SurfaceScience, 257, 4731.	11
		Pandey, L.M., Denmat , S. L., Delabouglise, D., Bruckert F.,Pattanayek, S.K., Weidenhaupt, M., 2012. Surface chemistry at the nanometer scale influences insulin aggregation. Colloids and Surfaces B: Biointerfaces 100, 69.	4
		Pandey, L.M., Pattanayek, S.K., Delabouglise, D., 2013. Properties ofAdsorbed Bovine Serum Albumin and Fibrinogen on Self-AssembledMonolayers, J. Phys. Chem. C, 117, 6151.	4
20	Jyoti Phirani	Phirani, J., Mohanty, K.K.,Hirasaki, G.J., 2009.Warm water flooding of unconfined gas hydrate reservoirs, Energy & Fuels 23 (9), 4507-4514.	12
		Phirani,J., Mohanty, K.K.,2009. Warm water flooding of confined gas hydrate reservoirs.Chemical Engineering Science 64 (10), 2361-2369.	9
		Phirani,J., Mohanty, K.K., 2010. Kinetic Simulation of CO2 Flooding of methane hydrates. SPE Annual Technical Conference and Exhibition.	3
21	M Ali Haider	Chia, M.,Haider, M. Ali,Pollock,G. III, George A. K., Neurock, M., James, A., Dumesic, 2013. Mechanistic Insights into Ring-Opening and Decarboxylation of 2-Pyrones in Liquid Water and Tetrahydrofuran. Journal of the American Chemical Society, 135 (15), 5699-5708.	-
		Haider,M.Ali,Makarand, R., Gogate, Robert, J., Davis, 2009. Fe-promotion of supported Rh catalysts for direct conversion of syngas to ethanol Journal of Catalysis, 261 9–16.	83
		Haider, M. Ali, McIntosh, S., 2009. Evidence for Two Activation Mechanisms in LSM SOFC Cathodes. Journal of The Electrochemical Society, 156(12), B1369-B1375.	22
22	K D P Nigam	Kumar, V.,Shirke,V., Nigam, K.D.P., 2008. Performance of Kenics Static Mixer at higher Reynolds number. Chemical Engineering Journal, 139, 284-295.	37
		Kumar, V.,Mridha, M.,Faizee, B., Nigam, K. D. P., 2008. Numerical Studies of a Tube-in-Tube Helically Coiled Heat Exchanger.Chemical Engineering and Processing: Process Intensification, 47, 2287-2295.	36
		Kumar, V., Nigam, K.D.P., 2011. Single-Phase Fluid Flow and Mixing in Microchannels. Chemical Engineering Science, 66, 1329-1373.	46
23	B P Mani	Sakthivel, S., Krishnan, Venkatesan, V., Pitchumani, B., 2008. Influence of Suspension Stability on wet grinding for production of mineral nano particles. Particuology, 2, 6,120-124.	15
		Shrivastava, A., Sakthivel, S., Pitchumani, B.,Rathore, A.S., 2011. A statistical approach for estimation of significant variables in wet attrition milling, Powder Technology, 211, Issue 1, 46-53.	6

		Rajan, K.S., Dhasandhan, K., Srivastava, S.N., Pitchumani, B., 2008. Studies on gas-solid heat transfer during pneumatic conveying, International Journal of Heat and Mass Transfer, 51 (11-12), 2801-2813.	26
24	Ashok K Gupta	Kumar, S., Kumar, A., Shukla, A., Gupta, A. K.,RohiniG., 2009. Capillary infiltration studies of liquids into 3D stitched C-C performs. Part A: Internal pore characterization by solvent infiltration, mercury porosimetery and permeability studies. J. European Ceramic Society, 29, 2643-2650.	-
		Kumar, S., Kumar, A., Shukla, A., Gupta, A. K.,RohiniG., 2009. Capillary infiltration studies of liquids into 3D stitched C-C performs. Part B: Kinetics of silicon infiltration. J. European Ceramic Society, 29, 2651-2657	
		Jeevarathinam, D., Gupta, A. K., Pitchumani, B. R., Mohan, 2011. Effect of gas and liquid flow rates on the size distribution of barium sulphate nano-particles precipitated in a two phase flow capillary microreactor, Chemical Engg. J. 173, 606-611	9

3.7 Total citations of papers

	Faculty	Total (for papers published in last 5 years)	Total (for all published papers for all years)
1	Suddhasatwa Basu	352	1136
2	Ashok N Bhaskarwar	29	n.a.
3	Kamal K Pant	820	2531
4	Rajesh Khanna	30	1400
5	Ratan Mohan	n.a.	n.a.
6	Sharad K Gupta	n.a.	500
7	Anil K Saroha	40	257
8	Anupam Shukla	93	172
9	Anurag S Rathore	826	2260
10	Sanat Mohanty	52	246
11	Shantanu Roy	105	684
12	Sreedevi Upadhyayula	32	68
13	Vivek V Buwa	59	578
14	Gaurav Goel	101	181
15	Jayati Sarkar	54	206
16	Munawar A Shaik	158	533
17	Paresh P Chokshi	34	36
18	Shalini Gupta	249	349
19	Sudip K Pattanayek	29	129
20	Jyoti Phirani	42	42
21	M Ali Haider	160	168
22	K D P Nigam	264	2100
23	B P Mani	95	186
24	Ashok K Gupta	44	n.a
Total		**3668**	**13762**
Average (per faculty)		**166**	**655**

3.8 Changes, Modifications, etc. done to improve the quality of (i) M. Tech. and (ii) Ph.D. graduates

Ph. D. Program:

1. Pre-PhD courses: In addition of 6 credits (equivalent to 2 course) prescribed by the institute, department has introduced additional courses (Advanced Transport Phenomena, Advanced Chemical Reaction and Reactor Engineering, Advanced Thermodynamics) to be completed by all Ph.D. students on audit basis.
2. Mandatory progress seminar to be given at the end of every semester. Quantitative evaluation of work by awarding grades.
3. Seminar to be given by all Ph.D. students, called as "ChE graduate seminars", to the department in every 1.5 to 2 years.
4. Seminars given by invited speakers, visitors to the departments.
5. Encouragement/support to students to attend national/international symposiums/seminars/workshops.
6. Presentation of doctoral research on "Open House Day", typically held in April every year and "best poster awards" to encourage outstanding research contributions.

M. Tech. Program:

1. Mini-project of 4 credits introduced in second semester for early exposure to research/M.Tech. thesis.
2. Seminars given by invited speakers, visitors to the departments
3. Presentation of graduate research on "Open House Day", typically held in April every year and "best poster awards" to encourage outstanding research contributions.
4. Monthly evaluation of project by supervisor.
5. Encouragement/support to students to attend national symposiums/seminars/workshops.

3.9 Sponsored Projects (April 1, 2008 – March 31, 2013)

S. No.	Faculty name	No. of Projects as PI	Total value (as PI) (lacs)	No. of Projects as Co-PI
1	Suddhasatwa Basu	12	746.01	0
2	Anil. K Saroha	2	29.76	0
3	Anupam Shukla	6	174.69	3
4	Anurag S Rathore	10	289.14	1
5	Ashok K Gupta	0	0	0
6	Ashok N Bhaskarwar	6	355.55	2
7	B Pitchumani	0	0	0
8	Gaurav Goel	0	0	0
9	Jayati Sarkar	1	29.16	0
10	Jyoti Phirani	0	0	0
11	K D P Nigam	4	257.22	1
12	Kamal K Pant	8	199.09	5

13	M Ali Haider	0	0	0
14	Paresh P Chokshi	0	0	0
15	Munawar A Shaik	5	50.29	0
16	Rajesh Khanna	1	12.18	2
17	Ratan Mohan	1	12	2
18	Sanat Mohanty	2	43.34	0
19	Shalini Gupta	1	22.5	0
20	Shantanu Roy	15	322.66	6
21	Sharad K. Gupta	1	49.94	0
22	Sreedevi Upadhyayula	4	147.37	1
23	Sudip K Pattanayek	1	43.93	2
24	Vivek V Buwa	3	81.4	1
25	Department of Chemical Engineering	2	457	
Total		**84**	**3323.3**	**26**
Average (per faculty)		**3.5**	**138.47**	**1.08**

3.10 Industry Consultancies (April 1, 2008 – March 31, 2013)

(i) Consultancy Projects

Industry sponsored projects are included in 3.9 above.

(ii) Consultancy Work

S. No.	Faculty name	PI	Total value (PI) (lacs)	Co-PI
1	Suddhasatwa Basu	3	13.96	2
2	Anil. K Saroha	0	0	2
3	Anupam Shukla	0	0	3
4	Anurag S Rathore	2	40	0
5	Ashok K Gupta	2	10.89	0
6	Ashok N Bhaskarwar	2	10.5755	3
7	B Pitchumani	1	9	0
8	Gaurav Goel	0	0	0
9	Jayati Sarkar	0	0	0
10	Jyoti Phirani	0	0	0
11	K D P Nigam	1	1.18	0
12	Kamal K Pant	3	1.54	2
13	M Ali Haider	0	0	0
14	Paresh P Chokshi	0	0	0
15	Munawar A Shaik	2	3.568	2
16	Rajesh Khanna	1	0.4	2
17	Ratan Mohan	1	2.35	3
18	Sanat Mohanty	0	0	0
19	Shalini Gupta	0	0	0
20	Shantanu Roy	2	2.32	0
21	Sharad K. Gupta	3	93.36	2
22	Sreedevi Upadhyayula	0	0	0
23	Sudip K Pattanayek	1	6	2
24	Vivek V Buwa	3	8.56	2
Total		**27.00**	**203.70**	**25.00**
Average (per faculty)		**1.13**	**8.49**	**1.04**

3.11 New areas of research which are different from the faculty's PhD thesis area

Faculty	Research area
Suddhasatwa Basu	Hydrogen Energy and Fuel cell Technology, Electrochemical Eng, Electrocatalysis and support material
Ashok N Bhaskarwar	n.a.
Kamal K Pant	Gas to liquid, Fischer Tropsch synthesis, arsenic removal, F-removal, Hydrogen generation, XTL
Rajesh Khanna	Phase separation, modeling of mist reactors and wetting of solid surfaces.
Ratan Mohan	n.a.
Sharad K. Gupta	Membrane separation processes
Anil. K Saroha	Waste water treatment (advanced oxidation processes, electrocoagulation, adsorption, ozonation)
Anupam Shukla	Electrochemical engineering
Anurag S Rathore	1. Quality by Design (QbD). 2. Process Analytical Technology (PAT). 3. Multivariate Data Analysis (MVDA). 4. Computational Fluid Dynamics (CFD). 5. High-Throughput Process Development (HTPD). 5. Modeling of biotech unit operations. 6. Characterization of biosimilar products. 7. Scientific and regulatory issues around approval of biosimilars.
Sanat Mohanty	1. Drug Delivery with small molecule assemblies 2. High Performance Natural fiber composites 3. Simulation &Modeling of polymer and nano interfaces 4. High Value materials from bioresources
Shantanu Roy	(I) Monolithic and Structured Reactors (II) Dust Explosions (III) Process intensification
Sreedevi Upadhyayula	1. Methane activation over bifunctnal zeolites 2. Peptide manufacture using functionalized ionic liquids 3. Catalytic conversion of lingo biomass to 2nd generation biofuel
Vivek V Buwa	Microreactors
Gaurav Goel	1. In-silico peptide design for suppresing protein aggregation; 2. Directed assembly in complex fluids under external field.
Jayati Sarkar	Wet Granulate Matter
Munawar A Shaik	1. Application of Unit-specific Event based models for Scheduling of Batch & Continuous Processes, 2. Evolutionary Computation, 3. Heat Exchanger Network Synthesis, 4. Water Allocation Networks, 5. Optimization of Pipeless Plants, 6. Applications of Optimization based models in: Biopharmceuticals, Polymer plants, Refinery Crude-oil Operations, & Pulp Industry. 7. Solution of large-scale scheduling problems
Paresh P Chokshi	Electro-spinning, phase separation
Shalini Gupta	Microfluidics, Diagnostics
Sudip K Pattanayek	(i)Proteins near interfaces (ii)Rheology of suspension
Jyoti Phirani	Enhanced oil recovery
M Ali Haider	Biorenewable Chemicals, ab-initio modeling and simulations
K D P Nigam	Multiphase Reactors Flow in Complex Geometries Computational Fluid Dynamics Development of green technology for metal extraction
B Pitchumani	Nano particle production and fine particle handling
Ashok K Gupta	Composites

3.12 Methodology for (i) identification of new areas for future research, and (ii) identifying obsolescence in research areas

While maintaining the freedom with pursuing research areas of interests of individual faculty members; the department, through intense discussions in its faculty board meetings, decides the new/thrust areas. Keeping in mind the core expertise of the present faculty members and major research areas shown in Figure 3.1, current needs of industry/technology development and society at large, the department has identified following thrust areas of research:

- Materials development for energy generation and storage
- Catalysis and multiphase reactor engineering, process intensification in non-renewable and renewable energy sectors
- Modeling and simulation from molecular to process scales
- Bioprocessing related to the pharmaceutical industry

The new areas of research are usually identified by individual faculty members or a group of faculty members within the department or across the departments (in case of interdisciplinary research) to address specific needs of technology development or fundamental research, keeping in expertise available within that research group. The future research areas are also identified based on the specific needs of industry that emerge through industrial interactions, specific requests coming from industry, national technology development programs identified by the governmental and other agencies etc. The obsolescence of research areas is usually identified by the individual faculty members, with inputs coming from industrial interactions and level of funding in a particular research area.

3.13 Number of large interdisciplinary projects (within department's area, and across the institute)

Faculty	Title	Sponsoring agency	Value	Participating departments/institutes
Suddhasatwa Basu	Solar energy based multifunctional device with integrated holographic, photovoltaic and photo-electro-chemical cells	DST	3.92 Crores	With Phy, Chem, Mech Eng of IITD
	Mind the Gap – PEMFC	DST-RCUK	4.35 Crores	with Imperial college, UCL, Newcastle Univ, IITM, CFCT, Chennai (2012-2015),
	Non-silicon based technologies for nano fabrication and nano scale devices	DIT	49 Crores	with Phy, Chem, Mech Eng, Electrical, Bio Chemical, CARE; Nano Research Facility
Ashok N Bhaskarwar	Technology development for synthetic liquid fuels	IIT Delhi	1cr	ChE, IITD
Kamal K Pant	Biomass conversion and pyrolysis	Indo-UK science bridge project	12 crores	with CRDT, CES and Aston University U. K.
Rajesh Khanna	Developing a ready automated diagnostic imaging method for distinguishing early dementia from normal ageing, with	DBT	80 lacs	NBRC, ChE

	prediction of conversion prone individuals			
Anurag S Rathore	Production of High Value Therapeutic Proteins using Pichia System	IIT Delhi	1 Cr	SBS, DBEB, CS
Sanat Mohanty	Bamboo as a green building material for rural infrastructure	ICAR/NAIP	4.8 Cr	Civil, CRDT, Chemical, IDDC (all IITD)
	Bamboo for wasteland development and processing for livelihood Generation	MORD	1.5cr	CRDT, ChE
	Chromonics based nanoparticles for drug delivery	DST	40 lacs	SBS, ChE
Shantanu Roy	Design and Development of a Unified Modeling System for Seamless Weather and Climate Predictions	Ministry of Earth Sciences, GoI	4.59cr	CAS, IITD (lead); CSE, IITD; MA, IITD; ME, IITD; CE, IITD; ChE, IITD
	Technology development for synthetic liquid fuels	IIT Delhi	1cr	ChE, IITD
Sreedevi Upadhyayula	Technology development for synthetic liquid fuels	IIT Delhi	1cr	ChE, IITD
Vivek V Buwa	Technology development for synthetic liquid fuels	IIT Delhi	1cr	ChE, IITD
Shalini Gupta	Direct Detection of Enteric Fever in Blood by Evanescent-Wave Illumination	Nanobiotech , DBT	83.19 lacs	ChE, DBEB, SBS
Sudip K Pattanayek	Development of Personal Protection Systems using Shear Thickening Fluids	DRDO/TBR L	4.9Crore	CPSE, ChE, TT, ME & NCL Pune

Annexure 4

Review of Department of Chemical Engineering

Areas of Research

(data for last 5 years)

Sr. No.	Research area	No. of Faculty	PhDs Ongoing	Publications		Sponsored Projects		Industry consultancies	
				Journal Papers	Conference Papers	Nos.	Value (in lacs)	Nos.	Value (in lacs)
1	Catalysis (KKP, SDU, SB, MAH)	1.67	11.3	47.7	42.8	10.3	485.3	2.8	17.0
2	Energy (SB, KKP, AS, SDU, MAH, JP)	3.17	14.1	63.7	48.8	13.3	572.6	2.8	17.0
3	Advanced materials (AS, SKP, SM, SB, MAH)	1.83	7.8	34.3	16.7	8.3	428.5	1.6	18.3
4	Process Intensification/ Multiphase Reactor Engineering (VVB, SR, KDPN, RM, AKS)	3.00	14.0	45.5	49.0	13.3	420.9	4.3	20.0
5	Process modelling & Optimization (MAS, RK, SR, JS, KDPN, VVB, GG, PC, SKG)	4.83	16.2	62.7	80.5	17.8	465.0	6.3	21.7
6	Complex Fluids/ Rheology (ANB, SKP, RK, JS, SM, PC, GG, BPM)	3.33	11.8	29.3	26.2	4.3	231.6	2.3	21.8
7	Pharmaceutical Biotechnology (ASR, SM, SG, ANB, SKP, GG, BPM)	3.83	19.3	96.3	25.7	14.3	522.6	3.8	61.6
8	Environment & Waste Management (ANB, AKS, AKG, SKG)	2.33	9.0	18.5	17.3	3.8	196.8	3.4	26.3
	Total	**24**	**103.5**	**398**	**307**	**85**	**3323.2**	**27**	**203.7**

Section 4

Innovation Design and Experiment

Executive Summary: Innovation Design and Experiment

The unprecedented commitment of the Department towards a plethora of high-quality academic and industrial research is undoubtedly supplemented by multi-fold encouragement in fields of innovation and design. Besides, offering an interesting combination of relevant core and elective courses to students, the Department also invests strongly in intangible assets of research, development, knowledge application and skill applicability of the students. This is evident from a high number of undergraduate and postgraduate students who are specifically funded for innovation from industry sponsorship.

The faculty is constantly engaged in technology development and transfer to its industrial counterparts, which is clearly visible in development, diffusion and transfer of globally competitive and socially viable technologies. With a vision to play a global leadership role in broad area of chemical engineering, the department is geared towards providing constant funding, support and guidance for unleashing of innovative ideas. Over the years, several innovations have been applied for seeking patents and a large fraction (08/23) of them have been successfully granted. The efforts therefore put in are applauded in the form of recognition to the students in major international and national competitions. In one specific area where the Department would like to grow is providing tinkering opportunities to undergraduate students in most of the laboratories, in order to provide a fruitful environment for growth.

4.1 Number of Student who have been funded for innovating: 34

4.2 Technology developed

1. Coiled Flow Inverter (CFI) as heat exchanger and mixer (K D P Nigam).
2. Recovery of heavy metal using chelation technology (K D P Nigam).
3. Technology developed for a Biomass Pyrolyser jointly with Aston University, UK (K. K. Pant).
4. Catalyst for H_2 production by direct decomposition of methane (K. K. Pant)
5. Pollution Preventing Printing Inks (Ashok N. Bhaskarwar)
6. Developed air intake filter for Armored personnel carrier and fighting Tank (B. Pitchumani)
7. Developed air filter for IC engine of Diesel loco for Railways (B. Pitchumani)
8. Developed air filter for IC of engine of Trucks (B. Pitchumani)
9. Creation of a novel aqueous two phase extraction process for purification of biotech therapeutics (patent application filed for US and for India), (Anurag S. Rathore)
10. Creation of a novel single step process for purification of biotech therapeutics (patent application filed for US and for India), (Anurag S. Rathore)
11. CFD modeling of a helical coil heat exchanger to aid in scale up from lab to manufacturing scale for Ranbaxy laboratories, (Anurag S. Rathore)
12. Creation of a high throughput process development (HTPD) protocol for development of biotech processes, (Anurag S. Rathore)
13. Proposed a novel approach for using multivariate data analysis (MVDA) for evaluating comparability of biotech processes and products (Anurag S. Rathore)
14. Developed a process analytical technology (PAT) based control scheme for a process chromatography column for Biocon Ltd. (Anurag S. Rathore)
15. Creation of manufacturing process for Granulocyte Colony Stimulating Factor (GCSF), a biotech therapeutic – in negotiation with Gennova Pharmaceuticals for licensing (Anurag S. Rathore)
16. Model developed for liquid detergent formulation for cleaning of utensils and fabric surface. HLL (now Hindustan Unilever) used it for liquid soap formulation for cleaning of utensils (Vim liquid). Project was funded by Unilever Research, (S. Basu)
17. A Model for the removal of mobile oil from the solid substrates" HLL report (2001), (S. Basu)
18. Non-invasive radiation based techniques: Earlier versions of radioactive particle tracking (RPT), gamma ray densitometry and dual-beam tomography have been significantly improved here owing to innovations in hardware and software, (Shantanu Roy)
19. Modular software/programs/modeling knowhow for non-invasive radiation based techniques has been developed and transferred to industry, (Shantanu Roy)
20. Open source ultrafast GPU based Molecular Dynamics Simulation Platform

(MDDarshan), (Sanat Mohanty)

21. High performance natural fiber composites, (Sanat Mohanty)
22. Tertiary butylation of phenols with tert-butyl alcohol using sulfonic acid functionalized ionic liquid catalysts (Indian Patent Applied), (Sreedevi Upadhyayula)
23. High performance supported metallic/ mixed metallic catalyst for sulfuric acid decomposition in sulphur-iodine (SI) cycle for hydrogen production. (Indian Patent application filed), (Sreedevi Upadhyayula)
24. A process for decomposition of Sulfuric acid to Sulfur dioxide (Indian Patent Applied), (Sreedevi Upadhyayula)
25. Development of novel mathematical models and further improvements for short-term scheduling of batch plants resulting in lesser number of events and compact problem formulations, (Munawar A. Shaik)
26. Development of mathematical programming based models that result in unification of state-task-network (STN) and resource-task-network (RTN) based models for scheduling of batch processes, (Munawar A. Shaik)
27. Developed STN based model for short-term scheduling of crude-oil unloading and loading operations, production processes, and gasoline blending and distribution problems, (Munawar A. Shaik)
28. Developed mathematical model for optimization and scheduling of displacement batch digesters in pulp industry for ABB (Bangalore), (Munawar A. Shaik)
29. Developed an integrated framework for integration of water and heat exchange networks in continuous plants for ABB (Bangalore), (Munawar A. Shaik)
30. Developed mathematical model for scheduling of pipe less plants for a fixed plant layout, (Munawar A. Shaik)
31. Development of miniaturized voidage probes (probe hardware and data processing algorithms) for measurement of local gas volume fraction, bubble size and rise velocity measurements, (Vivek Buwa)
32. Development of multichannel online conductivity measurement system with miniaturized probes for measurement of mixing time, (Vivek Buwa)
33. Development of multichannel measurement system using miniaturized pressure probes instantaneous local pressure fluctuations, (Vivek Buwa)
34. Development of CFD solvers to simulate two-phase flows based on open source code OpenFOAM, (Vivek Buwa)
35. Technology Development for Trickle Bed Reactors in association with EIL & IOC, sponsored by MP&NG, GOI. Based on joint project from 1997 to 2011 the First Hydrocracker was commissioned by EIL at Bongaigaon Refinery in December 2011(Prof K D P Nigam)

4.3 Technology Transferred

1. Pollution Preventing Printing Inks, (Ashok N. Bhaskarwar)

2. Innovative heat exchanger (CFI), transferred to RCF Thal, Mumbai as replacement to Shell and tube heat exchanger (K D P Nigam)
3. CFD modeling of a helical coil heat exchanger to aid in scale up from lab to manufacturing scale transferred to Ranbaxy laboratories, (Anurag S. Rathore)
4. Ranbaxy Laboratories, Creation of manufacturing process for Granulocyte Colony Stimulating Factor (GCSF) a biotech therapeutic – in negotiation with Ranbaxy Laboratories for licensing, 2011-12 (Anurag S. Rathore)
5. GE Healthcare, Creation of a high throughput process development (HTPD) protocol for development of biotech processes, 2011-12 (Anurag S. Rathore)
6. A novel approach for using multivariate data analysis (MVDA) for evaluating comparability of biotech processes and products transferred to Dr Reddy Laboratories, (Anurag S. Rathore)
7. A process analytical technology (PAT) based control scheme for a process chromatography column transferred to Biocon Ltd, (Anurag S. Rathore)
8. Developed mathematical model for optimization and scheduling of displacement batch digesters in pulp industry for ABB (Bangalore), (Munawar A. Shaik)
9. ABB Global Industries & Services Ltd., Bangalore, "Optimal Water Network Synthesis", 2012-13 (Munawar Shaik)
10. General Motors (ISL) (2007), "Theoretical model for performance of Diesel Particulate Filters", (Shantanu Roy)
11. Corning Incorporated (USA) (2007), "Theoretical model and experimentally derived correlation for filtration in porous substrates", (Shantanu Roy)
12. Corning Incorporated (USA) (2009), "Theoretical model for catalyst impregnation of monolithic substrates", (Shantanu Roy)
13. Corning Incorporated (USA) (2010), "Modeling suite for Fischer-Tropsch reactions in monolithic reactors", (Shantanu Roy)
14. Mangalore Refinery and Petrochemicals Ltd. (MRPL) (2007), "Feasibility Study of using Bare Pipelines for flowing viscous crudes in desert terrain", (Shantanu Roy)
15. Air Products and Chemicals (USA) (2008, "Validated model for flow Patterns in Corrugated Structured Packings", (Shantanu Roy)
16. Thermax Limited (2011), "Summary of hydrodynamics in rotary bioreactor with recommendations for performance improvement", (Shantanu Roy)
17. Engineers India Limited (2010), " CFD Model of Hydrodynamics of Slurry Bubble Column Reactor", (Shantanu Roy)
18. MEMC Electronic Materials (USA) (2009), "Reactor model for CVD process", (Shantanu Roy)
19. Evonik Energy Service India, "CFD model for coal fire boilers", (Vivek Buwa)
20. Open source ultrafast GPU based Molecular Dynamics Simulation Platform (MDDarshan), (Sanat Mohanty)

21. BHEL, Tirchurapalli “CFD analysis to estimate eccentric location of vortex finder in cyclone to reduce pressure drop of cyclone for CFBC combustor”, 2013, (B. Pitchumani)
22. Associated Soapstone, Udaipur “Image processing to estimate the size distribution of jaw crusher product”, 2013, (B. Pitchumani)
23. HPCL R & D, Bangalore, “Catalytic decomposition of methane for hydrogen generation” (K. K. Pant)
24. Ministry of Defense, DRDO, “Reactor design and configuration for hydrogen generation for steam reforming of bioethanol” (K. K. Pant)
25. Kalishwari Metal Powders, Sivakasi “Estimation of sphericity (flakiness) of aluminum powder particles” 2009, (B. Pitchumani)
26. Eurobond Pharmaceuticals, Hyderabad “Development of various powder characteristics with single instrument”, 2008, (B. Pitchumani)
27. Asian Paint Limited, Mumbai “Characterization of powders used in paint used by simple instrument”, 2008, (B. Pitchumani)
28. BHEL Tiruchipalli, “DEM studies to estimation of feed point for pneumatic conveying venture nozzle” 2008, (B. Pitchumani)
29. Fresenius Kabi, Process to determine CMC of polysorbate 80 in human plasma, (Rajesh Khanna)
30. Mangalore Refinery and Petrochemicals Ltd. (MRPL), "Feasibility Study of using Bare Pipelines for flowing viscous crudes in desert terrain" 2007 (Shantanu Roy & K D P Nigam).

4.4 Number of patents filed and patents granted as a fraction of patents filed

Table 4.1: Number of Patents Filed and Granted

Sr. No.	**Faculty**	**Patents**	
		Filed	Granted
1	Suddhasatwa Basu	1	1
2	Ashok N Bhaskarwar	18	-
7	Shantanu Roy		3
8	Sreedevi Upadhyayula	1	-
9	K D P Nigam	3	2
10	B P Mani		2
	Total	**23**	**8**

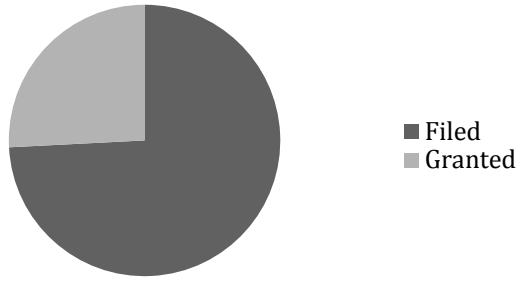


Fig. 4.1: Patents Granted as a Fraction of Filed

4.4.1 Patents Granted

1. "High efficiency cyclone", Indian Patent, (B. Pitchumani) 1106/MUM/2003 No: 207152
2. "Classifier for fine particle separation", Indian Patent, (B. Pitchumani) 1105/MUM/2003 No: 207152
3. "An Improved Process for De-dyeing of Liquid Waste", IIT Delhi, Copy right: IIT Delhi, Patent granted: DEL/377/2003, (S. Basu)
4. "System and Process for Pyrolysis Gasoline Hydrotreatment", US Patent 7,014,750, Granted March 21, 2006 (with Boger, T. and Sorensen, C. M.), (Shantanu Roy)
5. "Flow Distributor for Monolith Reactor", US Patent 7,032,894, Granted April 25, 2006 (with Adusei, G. Y., Campbell, S. A., Liu, W., and Odinak, M. E.), (Shantanu Roy)
6. "Fuel Cell Device with Varied Active Area Sizes", US Patent 7,494,732, Granted February 24, 2009 (with Ketcham, T. D., St Julien, D. J., Brown, J. L., Badding, M. E), (Shantanu Roy)
7. Indian Patent 159/DEL/2005 and Design patent 198236, Indian Institute of Technology Delhi. 2005, (K. D. P. Nigam)
8. U.S. Patent US 7337835, March 4, 2008, (K. D. P. Nigam)

4.5 Innovation of products, processes, designs, etc. in the department

1. Pollution Preventing Printing Inks, (Ashok N. Bhaskarwar)
2. Aerated Cement and Concrete, (Ashok N. Bhaskarwar)
3. Technology developed for a Biomass Pyrolyser jointly with Aston University UK, (K. K. Pant)
4. Catalyst for H_2 production by direct decomposition of methane, (K. K. Pant)
5. Recovery of Oil from extraction effluent of steel rolling mills, (Ashok N. Bhaskarwar)
6. Developed instrument to measure flowability of powders, (B. Pitchumani)
7. Developed software to estimate size distribution of fine particles from Angle of repose of powder, (B. Pitchumani)

8. Developed instrument to measure Repose density of powder, (B. Pitchumani)
9. Developed instrument measure sphericity and other nine properties of powder in single instrument, (B. Pitchumani)
10. Developed machine for separation of particles based on density and shape, (B. Pitchumani)
11. Developed cyclone to reduce erosion, (B. Pitchumani)
12. Developed software to estimate size distribution from flow measurement from packed bed, (B. Pitchumani)
13. Radioactive Particle Tracking, and Dual-Source Gamma Ray Tomography to monitor velocity distribution and holdup distribution, (Shantanu Roy)
14. Creation of a novel aqueous two phase extraction process for purification of biotech therapeutics, (Anurag S. Rathore)
15. Creation of a novel single step process for purification of biotech therapeutics, (Anurag S. Rathore)
16. CFD modeling of a helical coil heat exchanger to aid in scale up from lab to manufacturing scale for Ranbaxy laboratories, (Anurag S. Rathore)
17. Creation of a high throughput process development (HTPD) protocol for development of biotech processes, (Anurag S. Rathore)
18. Proposed a novel approach for using multivariate data analysis (MVDA) for evaluating comparability of biotech processes and products, (Anurag S. Rathore)
19. Developed a process analytical technology (PAT) based control scheme for a process chromatography column for Biocon Ltd, (Anurag S. Rathore)
20. Creation of manufacturing process for Granulocyte Colony Stimulating Factor (GCSF), a biotech therapeutic – in negotiation with Gennova Pharmaceuticals for licensing, (Anurag S. Rathore)
21. Development of miniaturized voidage probes (probe hardware and data processing algorithms) for measurement of local gas volume fraction, bubble size and rise velocity measurements, (Vivek Buwa)
22. Development of multichannel online conductivity measurement system with miniaturized probes for measurement of mixing time, (Vivek Buwa)
23. Development of multichannel measurement system using miniaturized pressure probes instantaneous local pressure fluctuations, (Vivek Buwa)
24. Development of CFD solvers to simulate two-phase flows based on open source code OpenFOAM, (Vivek Buwa)

4.6 Availability and access to student's workshops, "tinkering laboratories" so that they may pursue their own ideas.

- Design Laboratory
- Undergraduate Laboratory
- The CFI Plant Facility

4.7 Number of Students/teams who have competed in national/international competitions and outcome.

Student/Teams in National Competition: 16
Student/Teams in International Competition: 1

Outcome:

1. Special Mention in Gandhi Young Innovation Award, *"Natural Fiber Bamboo Composites Development",* 2013, (Advisor: Sanat Mohanty)
2. Manish Lonare, Ganesh Motkar, Best Paper Award, CHEMCON 2012, *"Liquid Crystalline Behavior of Folate Materials",* (Advisor: Sanat Mohanty)
3. Bhavika Gupta, Isha Rustagi, Best Paper Award, Tryst 2012, *"Chromonics Based Nanoparticles for drug delivery",* (Advisor: Sanat Mohanty)
4. Meenakshi Mazumdar Award for Best Paper presented at the Indian Chemical Engineering Congress CHEMCON-2013 in Category: Fluid Mechanics "*Investigations into Shear Induced Coalescence in Liquid-Liquid Dispersions*", (Advisor: Shantanu Roy)
5. Loveleen Sharma, Award for Best Paper presented at the Indian Chemical Engineering Congress CHEMCON-2013 in Category: Novel Reactors and Operating Strategies "*Effect of Geometric Parameters on the Performance of Coiled Passive Mixers in Laminar and Turbulent Flow Regime*", (Advisor: K. D. P. Nigam and Shantanu Roy)
6. Ankur Gupta, Award for Best Paper presented at the Annual Meeting of the Indian Institute of Chemical Engineers CHEMCON-2011, *"Modeling of flow in rectangular bubble columns using Euler-Euler CFD and Quadrature Method of Moments (QMOM): Experimental Validation"*, (Advisor: Shantanu Roy)
7. Kishore Kondamudi SRISTI (Society for Research and Initiatives for Sustainable Technologies and Institution) Gandhian Young Technological lnnovation Award (GYTl) 2013 under the category MLM (More from less for Many), *"Reactor & Catalyst development for oxygen evolving step in Sulfur Iodine cycle for Hydrogen production"* (Advisor: Sreedevi Upadhyayula).
8. Richa Singhal, National Award for Best M.Tech. thesis in Chemical Engineering, ISTE-IPCL 2010, *"Catalytic Cracking of Polyolefin",* (Advisor: Sreedevi Upadhyayula)
9. Kishore Kondamudi, Best Poster award on Science day (28/2/2013) *"Reactor & Catalyst development for oxygen evolving step in Sulfur Iodine cycle for Hydrogen production",* (Advisor: Sreedevi Upadhyayula)
10. P. Elavarasan, Kishore Kondamudi, Hindustan Platinum Award for Best Poster presentation in CATSYMP-19 held at NCL 2009,

"*Novel Sulfonic acid catalysts for alkylation of p-cresol with tert-butyl alcohol"*, (Advisor: Sreedevi Upadhyayula)

11. Pradeep Kumar Budde, Best industry relevant M.Tech project, awarded by FITT IITD, 2009, "*Synthesis, Characterization and Kinetic investigations of Methanol assisted methane conversion to gasoline over bifunctional zeolite based catalyst"* , (Advisor: Sreedevi Upadhyayula)
12. Patel Sanjay, Best Poster Award on Research paper entitled *"Simultaneous oxidative steam reforming of methanol and preferential oxidation of carbon monoxide over* $Cu/ZnO/CeO_2/Al_2O_3$ *and* Pt/Al_2O_3 *mixed catalysts"* presented at 5^{th} International conference on Fuel Cell Science, Engineering and Technology (FUELCELL2007), New York USA, 18-20 June, 2007. (Advisor: K. K. Pant)
13. Sanjay Patel :IIChE Award for the Year 2009: Dr A V Rama Rao Foundation's Best Ph.D. Thesis and Research Award in Chemical Engineering/Technology. "*Selective Hydrogen Production via Oxidative Steam reforming of methanol"* (Advisor: K. K. Pant)
14. Pravakar Mohanty, Shastri Research Fellowship, Graduate student Exchange Program Fellowship (GSEP), 2010 (Advisor: K. K. Pant)
15. Tarak Mondal, Shastri research fellowship, Graduate Student Exchange Program Fellowship (GSEP), 2013, (Advisor: K. K. Pant)
16. Sachchit Kumar Majhi, Shastri Research Fellowship, Graduate Student Exchange Program Fellowship (GSEP), 2010 , (Advisor: K. K. Pant)
17. Navdeep Kaur, Award for the second best paper presented at The International Conference in Advances in Applied Chemical Sciences and Innovative Materials, New Delhi, India, 2011, "*Equilibrium and Kinetic Behavior of Adsorption of Aleuritate Ion over Ion Exchange Resin*", (Advisor: A. K. Gupta, H. M. Chawla, V. K. Srivastava and Shantanu Roy)

Section 5

R & D ENVIRONMENT

Executive Summary: R & D Environment

The Department of Chemical Engineering has built a strong leadership in the following areas of chemical engineering research: (i) Energy and environment pertaining to low carbon technology and reduction in carbon footprint, (ii) Green processing and products, (iii) Process intensification and multiphase reactor engineering, (iv) Advanced functional materials, (v) Molecular simulation strategies, (vi) Bioseparations and pharmaceutical products. Our constant mission has been to focus on fundamental understanding that enables building technology leading to innovation and to encourage UG/PG students in research and development through science-based engineering education. In the last decade, many new faculty members having specialization in core and emerging areas of Chemical Engineering have joined the Department as a result of which the level of research activity has increased significantly. The total departmental funding has almost tripled from about Rs. 2.5 crores in 2002 to Rs. 7 crores in 2013. The total student strength has also risen by more than two-fold from approximately 380 students in 2000 (75 x 4 UG + 20 x 2 M.Tech. + 40 Ph.D.) to 727 students in 2013 (123 x 4 UG + 50 Dual + 36 x 2 M.Tech. + 119 Ph.D.). Both these factors have put an enormous stress on the infrastructure available to the Department for teaching as well as on our ability to take up new projects and their effective implementation for research. Space consideration is likely to become a bigger constraint in the coming years as the scale of research grows even further and the faculty strength reaches 28 in near future and 38 in the long term. On average, the research space available for every postgraduate student is approx. 75 sq. ft. This is likely to reduce in the coming years as the scale of research grows further and the faculty strength reaches 28 in near future and 38 in the long term. In spite of this constraint, the Department remains fairly active in terms of research output. Each faculty on average gives 15 research seminars over five years and a Ph.D. candidate on average attends 1.5 national and 0.4 international conferences. Also, at least 25 Masters and Ph.D. theses are co-supervised by researchers outside the Department.

5.1 Number of post-doctoral scholars hired in the department and their durations of stay

(i) From India

1. Sapna Jain (2005-2008), sponsored by IARI
2. Rakesh Gupta (2006-2008), sponsored by Ministry of Fertilizer
3. Bina Singh (2006-09), sponsored by Ministry of Fertilizer
4. Monika Aggarwal (2007-2009), sponsored by Ministry of Fertilizer and CSIR
5. Bharti Patil (2010 - 2011), sponsored by MNRE RA
6. Dyuti Pandey (2011 - present), sponsored by UGC RA
7. Rahul Pal (2012 - present), sponsored by DST RA
8. Vivek Kumar (2012 – present), sponsored by Ministry of Rural Development
9. Pratap Bade (2010 - 2013), sponsored by DBT RA
10. Varsha Joshi (2011 - present), sponsored by IIT Delhi
11. Debika Basu (2013 – present), sponsored by CSIR RA
12. Merajul Islam (2013 – present), sponsored by CSIR RA

(ii) From abroad

1. Farqad Saeed from Jordon (Oct 2008 - May 2009), sponsored by Royal Soc. Sci. and Tech Jordon and TATA
2. Mamluk Moody from Newcastle University, UK (Sept - Nov 2009), sponsored by UKIERI
3. Senthil Kumar from Newcastle University, UK (Nov 2010 - Jan 2011), sponsored by UKIERI

5.2 Number of foreign students enrolled

	2013-2012	**2012-2011**	**2011-2010**	**2010-2009**	**2009-2008**
In Masters	-	1	1	1	-
In Ph.D.	2	1	1	-	1

5.3 Number of Indian and foreign faculty/researchers who have spent a sabbatical in the Department

1. Vishnu Pareek, Curtin Univ. (Sep. – Dec. 2008)
2. M.P. Dudukovic, Washington University in St. Louis (Jan. 2008)

5.4 Sabbatical taken by faculty and where spent

KDPN	Humboldt Research Fellow at MPI Magdeburg, TU Burnschwid, TU Dartmund and TU Berlin (Sep. 2012 - Jun. 2013)

	Visiting faculty, ECTM Strasburg (Jan. – Feb. 2008) Adjunct faculty, Concordia, Montreal (Mar. – Jun. 2008) Visiting faculty, RPI, USA (Jul. 2008) Visiting faculty, TU Berlin (Aug. - Sep. 2008) Visiting faculty, Univ. of Sydney (Oct. - Dec. 2008)
SB	EPSRC-DST collaborative project at Imperial College London, UK (Jun. – Jul. 2012) UKIERI Fellowship at Newcastle University, UK (May – Jul. 2011) Royal Society visiting Scientist at Newcastle University, UK (May – Jul. 2008)
KKP	Visiting Professor at Tuskegee Univ, USA (Jun. - Jul. 2013) Visiting Professor at Univ. of Saskatechwan (Jun. - Jul. 2011) Visiting Professor at Aston Univ. UK (Jun. 2010)
SR	Visiting faculty at Curtin University, Australia (Jun. - Jul. 2010)
VVB	Visiting faculty at Univ. of Erlangen Germany (Jun. - Jul. 2009 and Jul. 2011)
PC	Visiting scientist at Materials Science Centre, DSM, Netherlands (Jun. - Jul. 2012)

5.5 Number of education and research seminars given by the faculty

Faculty	(i) In Department	(ii) In Other Departments	(iii) At Other Institutions
SB	2 (educational)	2 (educational) + 3(research)	25 (research)
SM	1 (educational) + 1 (research)	3 (research)	4 (research)
KKP	3 (educational) + 2 (research)	4 (research)	40 (research)
VVB	2 (research)	0	13 (research)
SG	1 (educational) + 2 (research)	0	6 (research)
ASR		0	74 (research) + 38 (educational)
RK	1	0	0
JS	1 (research)	1 (research)	3 (research)
SR		0	42 (research)
MAS	8 (educational)	0	10 (research)
PC	1 (research)	0	1 (research)
AS	0	0	1 (research)
GG	2 (research) + 1 (educational)	0	2 (research), 1 (educational)
ANB	0	0	7 (research)
BPM	0	0	21 (educational)
SKP	2 (research)	0	5 (research)
SDU	1 (research)	0	3 (educational)

5.6 Number of faculty/researchers/scholars who have visited the Department for (i) giving seminars, (ii) spending at least a week in the Department

(i) For giving seminars

S.No.	Date	Speaker	Affiliation	Title of Seminar
1.	17.01.2008	Prof. M. P. Dudukovic	Washington University in St. Louis, USA	Reaction Engineering and Modern Technological Challenges
2.	21.01.2008	Ms. Harmeet Chhina	Ballard Power Systems, Canada	Proton Exchange Membrane (PEM) Fuel Cells
3.	26.02.2088	Dr. Subir Bhattacharjee	University of Alberta, Edmonton, Alberta, Canada	Application of Electrokinetics in Water Treatment
4.	29.01.2008	Mr. Andrew Sherwood	Micromeritics Instrument Corporation, USA	Instruments for Catalyst Characterization
5.	21.02.2008	Prof. Chien-Hsiang Chang	National Cheng Kung University, Taiwan	Mixed Monolayer behavior of Dipalmitoyl-phosphatidyl-choline with Plasma Proteins at Air/Liquid Interfaces
6.	25.02.2008	Dr. Santosh Gangwal	SKG Process Development USA	Gasification and Syngas Cleanup
7.	24.04.2008	Mr. Sanjay Salunkhe	Shell Technology India Pvt. Ltd. Bangalore	Chemical Safety and Environmental Management for Laboratories
8.	19.05.2008	Dr. Mano Ram Maurya	University of California, San Diego, USA	Modeling Calcium Dynamics in Macrophage Cells
9.	28.08.2008	Dr. Jasbir Juneja	Rensselaer Polytechnic Institute, USA	CVD Parylene as Pore Sealant for Porous Materials
10.	03.11.2008	Prof. Dr. Evangelos Tsotsas	Magdeburg University, Germany	Formulation of Particles by Drying Processes
11.	13.02.2009	Dr. Madhava Syamlal	National Energy Technology Laboratory, Morgantown, USA	A Brief Presentation of Ongoing Research on Gas-Solid Flow at NETL
12.	02.03.2009	Dr. A. S. Chaurasia	Imperial College, London	Developing Low Cost Cleaner Coal Technologies for Mitigating Global Climate Change
13.	05.03.2009	Prof. G.M. Evans	University of Newcastle, Australia	Hydrodynamics of Mineral Flotation Processes
14.	02.04.2009	Dr. Raghvendra Singh	Johns Hopkins Medicine, Baltimore, USA	An Integrated Reaction-Transport Model for DNA Surface Hybridization: Implications for DNA Microarrays

15.	09.04.2009	Dr. Parag Pawar	Johns Hopkins University, Baltimore, USA	Integrating Biology and Mathematics in Medical Applications Pertinent to Infection and Inflammation
16.	06.04.2009	Mr. Thierry Hannecart	Total Professeurs Associes (TPA), France	Introduction to the TPA Programme
17.	20.04.2009	Dr. Ajay Singh Panwar	University of Massachusetts, Amherst, USA	A Computational Approach to Design of Complex Macro-molecular Materials Systems
18.	01.09.2009	Dr. Navraj Hanspal	University of Manchester (UMIST), Manchester, UK	Combined Navier-Stokes / Darcy Flows – CFD Modeling and Engineering Applications
19.	23.09.2009	Dr. Gaurav Singh	Senior Engineer, INTEL Corporation	Interface Driven Phenomena at Nanoscale: Electrical Double Layer (EDL)
20.		Dr. Ujjal Ghosh	University of Melbourne, Australia	Application of Chemical Engineering Research in Environmental Remediation: a) Separation of Carbon Dioxide from Flue Gas by Chemical Absorption; b) Separation of Organics from Aqueous Solution by Membrane Pervaporation
21.	17.11.2009	Dr. Srinivas Palanki	University of South Alabama	Technology for the Hydrogen Economy
22.	03.12.2009	Mr. Sumit Sharma	Columbia University, USA	Structure and Stability of Proteins upon Adsorption to Hydrophobic Surfaces
23.	11.12.2009	Prof. Dr. Ulrich Ruede	University of Erlangen-Nuremberg, Germany	Simulation and Animation of Complex Flows on Supercomputers
24.	09.12.2009	Dr. M. K. Singh	Corus Research and Development The Netherlands	Design, Analysis and Optimization of Distributive Mixing
25.	27.01.2010	Dr. Divesh Bhatia	University of Houston, USA	Kinetic and Modeling Studies of Catalytic Monolith Reactors and Lean NOx Traps
26.	03.03.2010	Dr. Supreet Saini	University of Illinois at Urbana-Champaign, USA	Multi-Process Control and Coordinated Regulation of Flagella, Invasion, and Adhesion Gene Circuits in *Salmonella enterica*

27.	09.03.2010	Prof. Xiao-Dong Zhou	University of South Carolina, USA	Physics and Electrochemistry of Energy Systems: Examples of Solid Oxide Fuel Cells and Thermoelectrics.
28.	12.03.2010	Prof. Vibha Kalra	Drexel University, USA	Using External Fields to Control the Location of Nanoparticles in Block Co-polymers: Experiments and Simulations
29.	26.03.2010	Dr. Jyoti Phirani	University of Houston, USA	Methane Production from Hydrate Bearing Sediments
30.	29.03.2010	Dr. Amit Kumar	University of Delaware, USA	Sorption and Diffusion of Small Gas Molecules in Nanostructured Materials: A Computational Study
31.	21.04.2010	Dr. Dayadeep Monder	Queen's University, Canada	Multi-Scale Models for Sulfur Poisoning of Solid Oxide Fuel Cell Anodes
32.	11.08.2010	Dr. Shalini Gupta	Imperial College, UK	On-Chip Assembly of Novel Biosensors and Composite Functional Biomaterials from Colloidal Particles
33.	23.08.2010	Dr. Chandra Shekhar Sharma	Indian Institute of Technology, Kanpur	Carbon Microelectromechanical Systems (C-MEMS): Synthesis, Fabrication and Properties
34.	26.08.2010	Dr. S. Ramanathan	Indian Institute of Technology, Madras	Mechanistic Analysis of Electrochemical Impedance Spectra
35.	01.10.2010	Prof. Jean Paris	École Polytechnique de Montréal, Canada	Sustainability of Forest Biorefinery: Canadian Context
36.	04.01.2011	Prof. Prabir Daripa	Texas A&M University	Generalized Saffman-Taylor formula for Multi-layer Hele-Shaw and Porous Media Flows
37.	28.01.2011	Mr. Vikram Singh	Cornell University, USA	Particles in Simple Shear Flow: Shape Matters
38.	10.06.2011	Prof. Soumya K. Srivastava	Washington State University, Pullman, USA	DC Insulator Dielectrophoretic Blood Typing Based on Human Abo-Rh System
39.	16.06.2011	Dr. Raghvendra Gupta	University of Sydney, Australia	Gas-Liquid Flow in Micro-Channels
40.	15.09.2011	Prof. Vikas Berry	Kansas State University	Graphene: Properties, Phenomena and Applications of a 2D Network of Carbon Atoms
41.	21.09.2011	Dr. Ajay Chatterjee	Intel Corporation, USA	Innovation and Evolution in Semiconductor Electronics

				Manufacturing and Supply Chain
42.	13.10.2011	Dr. Prankul Middha	GexCon AS, Bergen, Norway	Use of CFD for explosion Safety Studies on Process Facilities
43.	30.01.2012	Prof. Sankaran Sundaresan	Princeton University, USA	Filtered Two-Fluid Models for Fluidized Gas-Particle Suspensions
44.	08.02.2012	Mark Denys	Tata Steel Limited, Jamshedpur	Innovation for Energy Efficiency in Iron and Steelmaking
45.	20.03.2012	Dr. Naveen Tiwari	Saint-Gobain Northborough, MA, USA	Role of Thermo-Capillary Stress in the Dynamics and Stability of Micro-Scale Coating Flows Over Locally Heated Surfaces
46.	03.04.2012	Prof. Anand Prakash	University of Western Ontario, Canada	Investigations in Bubble Column Equipped with Internals
47.	25.05.2012	Prof. Shripad T. Revankar	Pohang, South Korea; Purdue Univ. , USA	Transient Analysis of Chemical Process Plant Coupled to Nuclear Heat Source
48.	08.06.2012	Prof. Vijaya K. Rangari	Tuskegee University, Tuskegee, USA	Carbon Nanotubes and Their Applications in Polymer Composites
49.	27.09.2012	Prof. Graeme J. Jameson	University of Newcastle, Australia	New Directions in Bubble and Particle Technology
50.	07.12.2012	Dr. James McGregor	Univ. of Sheffield, UK	Re-assessing Structure-Activity Relationships in Heterogeneous Catalysis: The Role of the "Structural Environment"
51.	26.12.2012	Prof. Suresh K. Bhatia	Univ. of Queensland, Australia	(i) Atomistic Modelling of the Structure of Nanoporous Carbons (ii) Quantum Molecular Sieving of Hydrogen Isotopes
52.	29.01. 2013	Dr. Suvajyoti Guha	US-FDA, Silver Spring, MD, USA	Understanding bio-nanoparticle behavior through physical characterization
53.	30.01.2013	Dr. Saurav Datta	Argonne National Laboratory Chicago, USA	Membrane Technologies for Sustainable Products and Processes
54.	8.02.2013	Dr. Rafal Klajn	Weizmann Institute of Science, Israel	Dynamic Materials and Systems based on Photoresponsive Molecules and

				Superparamagnetic Nanoparticles
55.	13.02.2013	Prof. Eric Climent	Institute of Fluids Mechanics, Toulouse, France	Multi-scale Simulations of Dispersed Two-phase Flows
56.	22.02.2013	Prof. Matthew Tirrell	University of Chicago, USA	Protein Analogous Micelles: Versatile, Modular Nanoparticles
57.	21.02.2013	Dr. Srinath Madasu	Halliburton Energy Services, Houston, USA	CFD Modeling of Interfacial and Biological Flows using Numerical Methods
58.	13.03.2013	Dr. Amit Kumar Jha	University of California, Berkeley, USA	Synthesis and Characterization of Hyaluronic Acid-Based Hydrogel Systems for Tissue Regeneration and Drug Delivery
59.	28.03.2013	Dr. M. Ali Haider	University of Virginia, USA	Reaction Mechanisms and the Design of Heterogeneous Catalysts for Sustainable Energy
60.	18.04.2013	Prof. Aibing Yu	University of New South Wales, Australia	Simulation and Modeling of Particulate Systems
61.	1.05.2013	Dr. Ankur Gaur	MNNIT, Allahabad	
62.	3.05.2013	Dr. Swarup Y. Jejurkar	Indian Institute of Technology, Kanpur	Combustion as Power Source for Miniature Machines
63.	6.05.2013	Dr. Prabu V.	IIT Guwahati	Clean Coal Technologies based on Carbon Neutral Power Generation
64.	27.06.2013	Dr. Anil K. Mathur	UPSPCB, Agra	Biodegradation of Volatile Organic Compounds in Biofilters
65.	01.07.2013	Dr. Sushil Kumar	MNNIT, Allahabad	Reactive Extraction: An Intensifying Approach for the Recovery of Carboxylic Acids
66.	16.07.2013	Dr. Manojkumar Ramteke	IIT, Roorkee	Biomimetic Adaptations of Multi-objective Evolutionary Algorithms for the Optimization of Chemical Processes
67.	22.07.2013	Dr. Anantharaj Ramalingam	University of Malaya, Malaysia	Simultaneous Desulphurization and Denitrification of Diesel oil Using Ionic Liquids: Experiments and Predictions
68.	25.07.2013	Prof. Jean-Numa Gillet	JNU	*Ab initio* Models for Lipid Mixtures and Misfolded

				Proteins
69.	03.10.2013	Dr. Ganesh Paramasivan	Vikram Sarabhai Space Centre, Thiruvananthapuram	Synthesis of Plant-Wide Control Strategies Using Mixed Integer Optimization
70.	04.11.2013	Mr. Satyaki Ray	Occidental Oil and Gas Corporation Houston, Texas, USA	Fundamentals Of Petrophysics and Its Application to Reservoir Modeling and Simulation
71.	07.11.2013	Dr. Divesh Bhatia	Nalco Water India Ltd. Pune.	Modeling of Concentration Fronts and Pt Dispersion Effects in A Lean NOx Trap
72.	12.11.2013	Dr.-Ing. Philip Jaeger	Technische Universität Hamburg-Harburg, Germany	Interfacial Properties Under Reservoir Conditions
73.	19.11.2013	Prof. Anthony Kucernak	Imperial College, London, UK	Getting the Most Out of Platinum: New Electrode Designs to Maximize The Performance of Electrocatalysts For Fuel Cells
74.	03.12.2013	Prof. Ned Djilali	University of Victoria, Canada	Experimental Characterization, Reconstruction and Pore Scale Modelling of Fuel Cell Catalyst Layers
75.	20.12.2013	Dr. Pankaj Sinha	Intel Corporation, USA	Semiconductor Fabrication – Trends and Opportunities

(ii) For spending at least a week in the department

1. Vishnu Pareek, Curtin Univ. (Sept. – Dec. 2008)
2. M.P. Dudukovic, Washington University in St. Louis (Jan. 2008)
3. Hseuh Kan-Lin, National United Univ. Taiwan (Feb. 2012)
4. Tseng Chun-jen, National Central Univ., Taiwan (Feb. 2012)
5. Ching Chin-Hsiang, National Cheng Kung Univ., Taiwan (Feb. 2012)

5.7 Adequacy of research infrastructure

See Annexure 5.1

5.8 Adequacy of technical staff – existing numbers and competency areas; competency areas in which there is a shortage

Labs	Existing	Required
PA to Head	1	1
Front Office	2	3
Chemical Reaction Engineering & Process Control Lab	1	2
Mass and Heat Transfer Lab	2	4
Chem. Eng Instruments Lab	1	2
Design Lab	1	2
Library	1	1
PSL	1	2
PG Lab	0	2
Stores and Purchase	1	2
Workshop	1	2
Biomass lab	1	0
Central Lab	0	3
Total:	10(technical staff)+3(office staff)	26

5.9 Work space available for PG students, project staff, post-doctoral scholars

Purely Research Labs	PG Teaching Labs	Overlapping Research Labs with Teaching Labs
17022 sq. ft.	2304 sq. ft.	4336 sq. ft.

See Annexure 5.1 for more details.

5.10 Number of national conference/workshops/seminars attended by Ph.D. students

Total number: 135
Per student: 1.5 (Note: average Ph.D. students in the last five years is approx. 90)

5.11 Number of international conference/workshops/seminars attended by Ph.D. students

Total number: 40
Per student: 0.44 (Note: average Ph.D. students in the last five years is approx. 90)

5.12 Number of M.Tech. and B.Tech. students who have continued to Ph.D.

	M.Tech.	B.Tech.
(i) in same department	3	0
(ii) in other departments of IITD	0	0
(iii) in India	2	0
(iv) abroad	4	8

5.13 Number of projects with co-guide from industry

Industry	Number of Projects	IIT Delhi Faculty
BPCL, India	2	SDU (1), KKP (1)
European Biomass Research Institute (EBRI), Germany	1	KKP
Tata Steel, India	1	VVB
IOCL, India	1	VVB
DRDO, India	1	SR
Shell Hydrogen, India	1	SB
ISRO, India	1	SB
CFCT, India	1	SB
NPL, India	1	SB
NEERI, India	1	SM

5.14 Number of students who have spent time in industry as part of thesis/project work

No. of students	Industry	Duration of project (months)	IIT Delhi Faculty
1	Dupont, India	3	SB
1	ABB, India	2	SB
1	BPCL, India	6	SDU
1	Tata Steel, India	0.5	VVB
1	BARC, India	4	SR
	Thermax, India	4	
2	Biocon Ltd., India	36	ASR
1	BPCL, India	12	KKP
1	Saskatechwan, Canada	8	KKP
1	Saskatechwan, Canada	9	KKP

5.15 Self-assessment reports of the department/centers/schools (if any)

None

5.16 Placement of M.Tech. and Ph.D. graduates in technical careers

See Annexure 5.2

5.17 Interdisciplinary work

Faculty	(i) Joint thesis guidance by faculty across groups within a Department, or across Departments/Centers	(ii) Proposals submitted and funded: PI, Co-PI and their group/department affiliations
SB	Thesis title: Investigation of multidoped ceria as cathode material for low temperature solid oxide fuel cell Student: Rajalakshmi Chokalingam (Ph.D.) Other supervisors: Ashok Ganguly (Chem, IITD) Thesis title: Development of PEM fuel cell diagnostics Student: M. Shaneeth (Ph.D.) Other supervisors: Aravunathan (ISRO VSSC) Thesis title: Development of La-doped Strontium Titanate anode for SOFCs. Student: Yohannes (M.Tech.) Other supervisors: N. Tefera (Addis Ababa Univ.)	1. "Hydrogen generation….PEMWE" by UKIERI-DST and Shell Hydrogen. Shared between Prof. S. Basu (IITD) and Prof. K. Scott (Newcastle Univ. upon Tyne) (2008-2011) 2. "Non-silicon based technologies for nano fabrication and nano scale devices." (One out of eleven PIs from Chem, Phy, ChemE, MechE, CARE, EE, DBEB) by MCIT ; IITD (2010-2015) 3. "Solar energy based multifunctional device with integrated holographic, photovoltaic and photo-electro-chemical cells." By DST, Prof. S. Basu (PI) with four Co-PIs viz Prof. A.K Ganguly (Chem), Prof. BR Mehta (Phy), Prof. Sudipto Mukherjee (Mech), Prof. J. Joseph (Phy), (2011-2014) 4. "Mind the Gap-jumping the hurdles limiting polymer fuel cell performance and commercialization." by EPSRC, UK/DST, India Prof. S. Basu(IITD), Dr. Rajalakshmi (CFCT, ARCI), Dr. Ramaprabhu (IITM), Dr. A. Kucernak (Imperial College London), Dr. Dan Brett (UCL), Prof. Keith Scott (Newcastle Univ.), (2012-2015)
SG	Thesis title: Design and development of point-of-care bioassay for rapid endotoxin detection Student: Prasanta Kalita (Ph.D.) Other supervisors: SM (ChE, IITD) Thesis title: Rapid diagnosis of bacterial infections Student: Saurabh Singh (Ph.D.) Other supervisors: Ravi E. Krishnan (DBEB, IITD) and Vivekanand Perumal (SBS, IITD) Thesis title: TBD Student: Vikas Pandey (Ph.D.) Other supervisors: Ravi E. Krishnan (DBEB, IITD) Thesis title: A non-invasive approach to predict	1. "Rapid on-chip dielectrophoretic assembly of quantum dots into semiconducting nanowires" by DST Fast Track. Dr. S. Gupta (PI) and Dr. S. Sapra (Co-PI) (2010-2013) 2. "Direct detection of enteric fever in blood by evanescent wave optical illumination" by DBT. Dr. R. Elangovan (PI), Dr. S. Gupta and Dr. V. Perumal (Co-PIs) (2013-2016) 3. "Assembly and Phase Behaviour of Biocolloidal Mixtures under AC Electric Fields" by CSIR. Dr. S. Gupta (PI) and Dr. G. Goel (Co-PI) (2014-2017)

	blood glucose levels using human saliva Student: Sarul Malik (Ph.D.) Other supervisors: Sneh Anand (CBME, IITD)	
SR	Thesis title: Dust Explosion Modeling using Mechanistic and Phenomenological Approaches Student: Vimlesh Kumar Bind (Ph.D.) Other supervisors: Chitra Rajagopal (CFEES, DRDO) Thesis title: Modeling of Atmospheric Transport Processes over Indian Subcontinent Student: Deepesh Kumar Biswal (Ph.D.) Other supervisors: O. P. Sharma (CAS), KKP (ChE, IITD) Thesis title: Study of Multiphase Reactors with Electrical Capacitance/Resistance Tomography Student: Brajesh Kumar Singh (Ph.D.) Other supervisors: VVB (ChE, IITD) Thesis title: Hydrodynamics in In-Line Motionless Mixers Student: Loveleen Sharma (Ph.D.) Other supervisors: KDPN (ChE, IITD) Thesis title: Effect of Packing Structure on Hydrodynamics and Performance of Trickle Bed Reactors Student: Aakarsha Srivastava (Ph.D.) Other supervisors: KDPN (ChE, IITD) Thesis title: Simulation of Sub-cooled Nucleate Boiling with Constant Wall Heat Flux Student: Avinash Moharana (M. Tech.) Other supervisors: RK (ChE, IITD), A. K. Nayak (BARC, Mumbai)	High Impact Proposal Funding (IIT Delhi), "Technology Development for Synthetic Liquid Fuels through Process Intensification", April 2011, 5 years, 1 Crore (PI: Prof. A. N. Bhaskarwar, Co-PI: KKP, SDU, AS, VVB, SR) "Design and Development of a Unified Modelling System for Seamless Weather and Climate Predictions", Jan. 2011, 5 years, 4.59 Crore (PI: Prof. O. P. Sharma (CAS), Co-PI: HC Upadhyaya, Maithili Sharan, Girija Jayaraman (CAS), Subodh Kumar, Huzur Sharan (CS), K Sreenadh (Mathematics), PMV Subbarao, P Talukdar, B Premachandran (ME), BR Chahar (CE), KKP, SR (ChE)
KKP	Thesis title: Selective Hydroisomerisation of Hexadecane Student: Snehal Kumar Parmar (P.hD.) Other supervisors: Dr. Bharat Newalkar (BPCL) Thesis title: Development of ecofriendly preservatives for the treatment of Bamboo Student: Perminder Kaur (Ph.D.)	1. CHT with HPCL, Catalytic decomposition of methane, Dec. 2010, 2 years, 33 Lakhs (PI: Prof. James Gomes) 1. Indo-UK Science bridge project with Aston Univ. UK, Conversion of biomass to fuels, 2009, 5 years, 12 crores (PI: S.N Singh (AM), Co-PIs: P K Sen (AM), P. Vasudevan (RDAT), S N Naik (RDAT), R. Phillip

	Other supervisors: S.N. Naik and S. Satya (RDAT, IITD) Thesis title: Effect of heat treatment on Transfatty acids content in Indian food items Student: Vikas Kardam Other supervisors: S.N. Naik and S. Satya (RDAT, IITD) Thesis title: Catalytic oxidative and non oxidative steam reforming of Bio ethanol Student: Tarak Mondal (Ph.D.) Other supervisors: A. Dalai (Univ. of Saskatechwan, Canada)	(Aston Univ, UK) and A. Hornung (EBRI, UK))
ASR	-	1. DST, Creation of a Decoupled Input-Output Linearizing Controller for Bioprocess Applications, Dec. 2010, 2 years, 33 Lakhs (PI: Prof. James Gomes) 2. High Impact Proposal Funding (IIT Delhi), Production of High Value Therapeutic Proteins using Pichia System, April 2011, 5 years, 1 Crore (PI: Prof. Saroj Mishra, Co-PI: James Gomes, Vikram Sahai, Vinay Ribeiro) 3. ABB Global Industries and Services Limited, Monitoring and Optimization of Ultrafiltration, Microfiltration and Membrane Bioreactor Unit Operations, July 2011, 18 months, 10 Lakhs (Co-PI: Anupam Shukla) 4. DST-EPSRC UK-India Partnership Scheme, Creation of a Process Understanding of Chromatographic Performance Loss during Biotherapeutic Manufacture, Jan. 2014, 4 Crore (Co-PIs: Anupam Shukla and James Gomes (IITD) and Soumyo Mukherjee (IIT Bombay))
RK	Thesis title: Studies on liquid transport in woven fabrics Student: Saikat Sengupta (M.Tech.) Other supervisors: R. Rengasamy (TXT, IITD) Thesis title: Studies on liquid transport in wovens and non-wovens Student: Vijay S. Beli (M.Tech.)	1. DBT, Developing a ready automated diagnostic imaging method for distinguishing early dementia from normal ageing with prediction of conversion-prone individuals, 2012, 5 yrs., 80 Lakhs (PI: P. K. Roy, NBRC)

	Other supervisors: R. Rengasamy (TXT, IITD)	
SM	Thesis title: Enzymatic glycerolysis of fatty acids Student: Malaya Naik (Ph.D.) Other supervisors: S. Naik (CRDT, IITD) Thesis title: Process optimization of Indigo production Student: Lopa Patnaik (Ph.D.) Other supervisors: S. Naik (CRDT, IITD) and B. K. Sarangi (NEERI)	1. DST, Chromonics based nanoparticles in drug delivery, Sep. 2011, 3 yrs., 40 Lakhs (Co-PI: A. Mittal, SBS IITD) 2. NAIP, Bamboo as a green material for rural infrastructure, Jun 2008, 5 yrs., 4.8 crores (Co-PIs: S. Satya (CRDT), D. Sahani (IDDC), S. Bhalla (Civil) and S. Gupta (Civil), IITD) 3. MoRD, Bamboo in waste land plantation and use in livelihood generation, 2010, 5 yrs., 1.5 crores (PI: S. Satya (CRDT) IITD)
SDU	Thesis title: Refining and conversion of coal and biomass for obtaining nano organic fuels Student: Heena Dhawan (Ph.D.) Other supervisors: Prof. Durlub K. Sharma (CES, IITD) Thesis title: Studies of Polypropylene/ Nanofiber carbon composites Student: Ranjan Kumar Kamat (M.Tech.) Other supervisors: Prof. A.K. Ghosh (TXT, IITD)	

Appendix 5.1

Adequacy of Research Infrastructure in the Department of Chemical Engineering

1. Present space with the Department

The total area currently occupied by the department and its break-up under the main heads is presented in the Table below. A more detailed is given at the end of this document in Table 5.1.

Category	Presently Occupied Space (sq. ft.)
Faculty Rooms	4728
Research labs	17022
Common labs (includes cutouts); e.g. UG lab, Design lab, Computation labs, etc.	16608
Other (Office, Store etc.)	7286
Total	**45644**

Additional information: Until 1991, the department had approx. 32,000 sq. ft. of space. The last major increase came around 1992 when block-II was extended and 10,250 sq. ft. were added to the departmental space in four floors (basement + three). Since then, there have been no further big additions. The only small additions include (i) approx. 1,920 sq. ft. added in 2003-04 in the Pilot Plant building (block I B), (ii) 688 sq. ft. added in block-II for fuel cell research in 2005-06 and (iii) 1,014 sq. ft. of temporary space in TBIU and ~ 600 sq. ft. of open space in block III both added in 2012 for Dr. Sreedevi's experimental setup.

2. Key drivers for additional space required by the Department

The Department of Chemical Engineering has undergone several significant changes in the last decade. In the following points, we highlight some of the key drivers which impress upon the need for a substantial increase in the departmental space.

(i) Increase in faculty strength: Since 2004, the number of faculty who have joined the Department is significantly high at 12. In spite of this, the current faculty strength is still looming at 25 (including 3 emeritus professors) because there have also been 11 retirements in the same period. With no further retirements anticipated in the next 5-6 years, it is expected to reach the first stage sanctioned strength of 28 soon in the next 2-3 years, and the final sanctioned strength of 38 eventually.

(ii) Increase in student strength: The number of students has gone up significantly in the last two decades. From about 225 students in the Department (40 x 4 UG, 20 x 2 M.Tech., 25 Ph.D.)

in 1990 to approximately 380 in 2000 (75 x 4 UG, 20 x 2 M.Tech., 40 Ph.D.), it is now about 733 (123 x 4 UG & Dual + 36 x 2 M.Tech. + 119 Ph.D.) in 2012. This more than **threefold** increase has put an enormous stress on the infrastructure of the department. Every lab, be it teaching or research lab, is over-crowded and far from what may be considered desirable working conditions.

(iii) Increase in research activities: The level of research activity in the department too has significantly increased over the past decade. The total departmental funding has gone from about Rs. 2.5 crores in 2002 to Rs. 7 crores in 2013. This increase in funding in addition to the significant rise in the number of M.Tech. and Ph.D. students as stated above, has resulted in space becoming a key constraint in our ability to take up new projects as well as in implementing overall safety and proper working conditions in the existing laboratories. It is important to note that most Chemical Engineering-related activities involved physically large setups while others require separate space allocation to meet safety requirements. With many new faculty having specialization in new and emerging areas of Chemical Engineering, space consideration is likely to become even more relevant with the further increasing scale of research, especially as the faculty strength reaches 28 and later 38.

Financial Year	Institutional Funding (in lacs)		
	Planned/Equipment	Recurring	Total
2008-09	101.59	39.72	141.31
2009-10	163.8	36.4	200.2
2010-11	133.61	44.78	178.39
2011-12	131.0	51.0	182.0
2012-13	406.5	50.0	456.5

Total institutional funding received during last 5 years: 11.67 Crores

Financial Year	External Research Grants (in lacs)		
	IRD	FITT	Total
2008-09	326.94	71.37	398.31
2009-10	200.7	65.65	266.35
2010-11	220.89	80.79	301.68
2011-12	1034.25*	124.94	1159.19
2012-13	177.00	73.27	250.27

Total external funding received during last 5 years: 23.76 Crores

(iv) Vision of the Department:

- Build leadership in following areas of chemical engineering: Energy and Environment – low carbon technology and reduction in carbon foot print, Green Processing and Products, Process

Intensification and Multiphase reactor engineering, Advanced Functional Materials, Molecular simulation, Bio-separations and pharmaceutical products

- Focus on fundamental understanding to enable technology elements leading to innovation
- Partnerships/consortia with industry for technology development/joint IPR, Spin-offs
- Induction of UG/PG students in research and development at an early stage through science based engineering education

3. Projected space requirement and its justification

The projected space needs of the Department are presented in the table below, along with justification for the same.

Category	Presently occupied space (sq. ft.)	Projected future requirement (sq. ft.)	Justification
Faculty Rooms	4728	6720	Increase in faculty strength [a]
Research labs	17022	45000	Increase in faculty strength and number of students [b]
Common labs (includes cutouts) e.g. UG lab etc	16608	27500	Increase in number of students [c]
Other (Office, Store etc.)	7286	10350	Increase in number of students and faculty [d]
Total	**45644**	**89570**	

a. Assumes faculty strength has grown to 35 with each room of 192 sq. ft. (eq. to 16' x 12').

b. Assumes each faculty gets a 1,000 sq. ft of personal lab space. On an average the number of B. Tech., M.Tech. and Ph.D. students who are working with a faculty has gone up to 12-13 presently and will still be 10 or more if the faculty strength goes up to 35. In addition 5 labs, each of 2,000 sq. ft., will be created to support major research projects that departmental faculty bring in. These labs will be shared by multiple faculty working on the project and will be like floating space available to faculty as per requirement at a given time. Some of this, up to ~ 1,500 sq. ft., may be required on ground floor for heavy/tall equipment, compressor, etc.

c. The projection includes UG lab space (22,000 sq. ft), computational lab space (3,000 sq. ft), sophisticated equipments lab (2000 sq. ft) and server room (500 sq. ft). The UG lab space assumes a 2,000 sq. ft lab for each labs that the department currently teaches (7 labs) plus space for labs taught to students of DBEB (4 labs). This is to avoid the overcrowding that presently exists. A similar increase is proposed for the computational lab space to be able to teach courses that require computer use in the class.

d. Our estimate includes space for office + library (5,850 sq. ft.), store and inventory (2,500 sq. ft.) and workshop/glass blowing facility/utilities (2,000 sq. ft). The office space includes a seminar room of 1,800 sq. ft., a committee room of 800 sq. ft., head's office and other attached offices of 1,000 sq. ft., a library 1,500 sq. ft. and 3 meeting rooms of 250 sq. ft. each for smaller meetings and presentations.

4. Concluding Remarks

The projected space requirement of 89,750 sq. ft. is approximately 1.96 times of the present space with the department (46,144 sq. ft.). Though this seems a large increase, the space needs of the department have really outgrown the current allocation. In view of the large student numbers and the eventual faculty strength of 38, the projected requirement is reasonable.

Table 5.1 The breakup of the total area (in sq. ft.) occupied by the Department under different heads.

	Fac-R	Name	Fac-L	Name	Cm-Lab	Name	Other	Name	Cut-Out	
BLK-I										
B'ment							770	Compr		**770**
I Fl (GF)			768	SDU						**3504**
					2736	PG Lab				
II Fl	144	SDU-209								**480**
	144	VVB-210								
	192	SKG-211								
									1600	
III Fl					1152	CRE+IC				**4616**
			1024	SR						
							1600	CI Lab		
	144	GG-309								
	144	SKP-310								
	144	Vac-311								
	144	JS-312								
									960	
	144	SR-314								
	120	SG-315								
BLK-II										
B'ment					480	Tata-H				**7068**
			448	AKS						
			288	MAS						
					1216	PSL				
					608	HPC				
			760	PC+GG						
							480	WkShp		
							128	Store		
							100	Cyl-room		

	192	ASR	1024	ASR						
	192	RK	1152	RK+AKS						
I Fl (GF)							1280	Store-K		**7472**
					3632	UG-Lab				
	192	KKP	1024	KKP						
	192	KDPN	1152	KDPN						
II Fl	192	Vac-272								**6448**
	192	SM-273								
	192	AKS-274								
							1120	Sem-R		
							864	Off-Cplx		
							512	Com-R		
	96	Pantry								
	96	Vac								
	192	Vac								
	96	Vac								
	192	ANB-285								
	144	AS-286								
									1920	
			1024	AS+RM						
	192	RM-289								
	192	BPM-290								
			1152	JS+SG						
III Fl					1024	Des Lab				**5184**
									1280	
	144	PC								
	144	MAS								
	96	Vac								
	96	Vac								
							432	Dept-Lib		

			1024	ANB						
			1152	VVB+SB						
	192	AKG-385								
	192	SB-386								
			688	SB						
Blk-III										**1408**
			896	SM						
			512	SKP						
Blk-IB			1920	Pilot Pl - KDPN						**1920**
Blk-IA							1014	TBIU-SB		**1014**
										5760
	4728		**16008**		**10848**		**8300**		**5760**	**45644**

All figures in the above Table are in sq. ft.

Nomenclature:

Fac – R	Faculty room
Fac – L	Faculty Lab
Cm – Lab	Common/Teaching Lab
Compr	Compressor room
CRE+IC	Chemical Reaction Engineering + Instrumentation & Control Lab
CI Lab	Central Instrumentation Lab
Vac	Vacant faculty room at present
TATA-H Lab	TATA Honeywell Lab (Control)
PSL	Process Simulation (Computation) Lab
HPC	High Performance Computing Lab (Server room)
Wkshp	Workshop
Cyl-Room	Cylinder storage room
Sem-R	Seminar Room
Com-R	Committee room
Dept-Lib	Department Library
Des Lab	Design Lab
UG Lab	Undergraduate Lab
PG Lab	Postgraduate Lab

Appendix 5.2

Review of the Department Placement of M.Tech. and Ph.D. Graduates in Technical Careers (based on the data provided by the Training and Placement Cell in IITD)

Program Type	Program Name	No. of graduating students	Nature of job for first 2-3 years after graduation	Nature of job 5 yrs. after graduation	% of graduates in technical lines of work	% graduates starting in technical line who are now a manager or administrator
MS(R)		3 (2008-2009) 1 (2009 - 2010) 1 (2010 - 2011) 2 (2011 - 2012) 0 (2012 - 2013)	Ankeet Saggar (2008CHY7521) - **Dolcera Information Tech.**	Data unavailable	Data unavailable	Data unavailable
M.Tech	2 Yr	22 (2008-2009)				
		17 (2009 - 2010)	Richa Singhal (2008CHE2014) - **CSIR labs** MS Narayani A (2008CHE2020) - **L&T** Bhuwnesh Rawat (2008CHE2023) – **Larsen & Toubro Ltd.** **Ghosh Debraj, Paresh Ratan (**2008CHE2418) – **TCE Consulting Engineers Ltd.** Rohit Jain (2008CHE2429) – **Sumitomo Chemicals Co. Ltd.** Sri Chaitanya Ayyagari (2008CHE2436) – **L&T** Varun Kumar Vadlagatta (2008CHE2442) – **Oriental Carbon & Chemicals Ltd.** Pratap Chandra Das (2008CHE2447) – **De Core Sc. & Tech. Ltd.** Bhupesh Kumar Bishwakarma (2008CHE2449)			
		23 (2010 - 2011)	Chaitanya Sharma () - **cognizant**			
		18 (2011 - 2012)	Tarun Krishna Jindal (2010CHE2031) – **Sumitomo Chemicals Co.**			

			Ltd., Tokyo Rishabh Tripathi (2010CHE2308) – **BIOCON Ltd**. Ranjana Khanna (2010CHE2313) – **3M India Limited** Praveen Kumar Singh (2010CHE2314) – **Hindustan Petroleum Corp. Ltd. (HPCL)** Ranoo Pathak (2010CHE2316) – **UOP India Pvt. Ltd**. Amit Agarwal (2010CHE2319) – **Technip KT India (GET)** Rachit Tandon (2010CHE2350) - **Evalueserve**						
		10 (2012 - 2013)	Ravinder Gahlawat (2011CHE2176) – **Halliburton Technology India Pvt. Ltd.** Saba Firoze (2011CHE3485) – **Aditya Birla Science & Technology CO. Ltd.** Bibek Dash (2011CHE3489) – **Relaxo Footwear Ltd.** Kavita Ganesh (2011CHE3491) – **UOP India Pvt. Ltd.** Debashis Biswal (2011CHE3509) – **Tata Steel**						
Ph.D.			**Post-doc**	**Teaching and Academics**	**Research Labs**	**Corporate R&D**			
	Full-time (FT) + Part-time (PT)	5 (2008-2009)		H. Pramanik – **IIT BHU** Amit Gupta **–** **BIT Sindri**		Bala Murugan – **Unilever**			
		9 (2009 - 2010)		PVKK Verma – **Mississippi State Univ., USA**	Suresh Kumar – **DRDO**	S. Vaishali – **Cummins**			
		4 (2010 - 2011)	Swapna Rabha – **Institute of Safety Research (HZDR), Dresden Germany**	Rajesh K. Upadhyay – **IIT Guwahati**		Vikrant Sarin – **Aqua Tech,**			

						USA Navdeep Kaur - **Sabic**			
		7 (2011 - 2012)	Immanuel V. – **Weissman Institute, Israel** Debika Basu **– IIT Delhi**	Shyamal Roy – **Jadavpur Univ.** P.Elavarasan - **College of Engineering Annamalai**	Vimlesh K. Bind – **DRDO**				
		5 (2012 - 2013)	Pradeep K. sahu – **Univ. of British Columbia, Canada** C. Rajlakshmi **– IIT Delhi**	U.K.Arun Kumar – **Rajiv Gandhi Univ. of Knowledge Technologies (RGUKT)** V Ramsagar (2009CHZ8016) – **Asst. Prof., NIT Warangal** Sanjeev Yadav (2007CHZ8249) – **Asst. Prof., Shiv Nadar Univ.**					

Section 6

OUTREACH / EXTERNAL STAKEHOLDER ENGAGEMENT

Executive Summary: Outreach / External Stakeholder Engagement

The faculty members of the department play a very active role in engaging chemical industry through numerous research projects sponsored by industries. While diverse research areas cater to various industries, major impetus has been to engage industries in the thrust areas of Petroleum & Petrochemicals, Pharmaceutical and Healthcare Technology, Materials & Nanotechnology and Energy Technologies. In last five years, research projects worth more than Rs. 12 Crores have been implemented solely with the help of industries, both from public and private sectors. Many of the completed projects have resulted into successful transfer of technology to the sponsoring companies. The department also takes pride in several faculty members making significant professional contributions to the Nation through their membership on various government committees for formulating strategies, policies and regulatory laws. Further, some high impact research projects funded by Government of India have been undertaken mainly in the area of process development and intensification, biotechnology and fuel cell technology to make significant contribution towards national development goals. The research expertise is disseminated to external stakeholders through short-term QIP courses and workshops, in addition to developing courses for NPTEL. By holding period interactions with alumni, industry personnel, school children and general public (open house), the department is constantly engaging the all stakeholders with the ongoing activities towards development of technology, scientific knowledge as well as course curriculum.

6. Outreach / External stakeholder engagement

6.1 Educational:

a) Workshops/short term courses – topical research for disseminating research of IITD

1) One Day Indo-US Workshop on "Frontiers of Electrochemical Science and Technology: Powering our Future with Clean Energy Storage and Conversion" by Prof. S. Basu, 2013
2) Invited Lead Expert Speaker for IAEA/RCA Regional Meeting on "RTD-CFD for Radiotracer Applications in Multiphase Reactors" by Prof. S. Roy, August 2013
3) Workshop Chair, "Implementation of Quality by Design for Biopharmaceutical Products, GE Healthcare Workshop", Tokyo, Japan, October 2013 (Prof. A. S. Rathore)
4) Conference Chair, "BIRAC-CDSA Regulatory Meet: Demystifying Indian Regulations for Product Approvals", New Delhi, India, July, 2013 (Prof. A. S. Rathore)
5) Workshop Chair, "Concept 2 Commercialization, Clone 2 Clinic, Culture 2 Chromatography", GE Healthcare Workshop, Mumbai, May 2013 (Prof. A. S. Rathore)
6) Workshop on "Fundamentals of Structure Property Analysis" by Dr. S. Mohanty, Dr. Shalini Gupta and Dr. Gaurav Goel, IIT Delhi, September 2012
7) Workshop Chair, "CCPIE/SFDA Training Program" by GE Healthcare, Shanghai China, July 2012 (Prof. A. S. Rathore)
8) Workshop Chair, "Quality by Design", GE Healthcare Workshop, Basel, Switzerland, June 2012 (Prof. A. S. Rathore)
9) Short term course on "Process Intensification" at ITESM Campus, Monterrey, Mexico, 4^{th}- 6^{th} June 2012 (Prof. K D P Nigam)
10) Workshop Chair, "Quality by Design", GE Healthcare Workshop, Mumbai, India, February, 2012 (Prof. A. S. Rathore)
11) "10^{th} Indo-German Winter Academy" by Dr. V. V. Buwa, December 2011
12) Workshop Chair, "QbD Process Development and Validation" by GE Healthcare, Shanghai China, November 2011 (Prof. A. S. Rathore)
13) IAEA/RCA Regional Training Course on "Radioactive Particle Tracking Technique for Investigating Process Hydrodynamics" by Prof. S. Roy, October 2011 (Organized jointly with BARC, Mumbai)
14) Short training course on "Radioactive Particle Tracking Techniques for Investigating Process Hydrodynamics" by Prof. S. Roy, October 2011

15) QIP Course on “Advances in Waste Water Treatment” by Prof. A. K. Saroha, October 2011
16) Workshop Chair, “Quality by Design for Biopharmaceuticals: Concepts and Implementation”, PDA Training and Research Institute Course Series, Washington DC, USA, September, 2011 (Prof. A. S. Rathore)
17) Invited Lead Expert Speaker for "Development of RPT Techniques for Multiphase Flows in Industry" by Prof. S. Roy at Malaysian Nuclear Agency (Nuklear Malaysia), Kajang, Malaysia, March 2011
18) Indo-US workshop on “Emerging Issues in Energy and Environment Security: Challenges and Research Opportunities” by Prof. S. Basu and Prof. S. Roy (Sponsored by IUSSTF, NSF, DST, MNRE, IITD), December 2010
19) Workshop Chair, “Quality by Design”, GE Healthcare Workshop, Mumbai, India, June, 2010 (Prof. A. S. Rathore)
20) “Modeling and Simulation of Multiphase Flow Systems” by Dr. V. V. Buwa, 2010
21) QIP Course on “Recent Advances in Multiphase Reactors” by Prof. A. K. Saroha, May 2010
22) FITT Course on "Multiphase Reactor Engineering for the Process Industry", by Prof. S. Roy, December 2009
23) Five-day Seminar on “Simulation and Modeling in Process Industry (Refineries and Petrochemicals focus)”, Organized jointly by Loveraj Kumar Memorial Trust, IIChE (NRC), PETROFED, IIT Delhi and Honeywell Automation India Ltd., under the aegis of FITT, IIT Delhi, (25 participants) by Dr. Munawar Shaik & Prof. S. Basu, June 2009.
24) Two-day Workshop on “Scheduling of Batch and Continuous Process Operations”, for ABB Global Industries & Services Ltd., Bangalore, under the aegis of FITT, IIT Delhi, (10 participants) by Dr. Munawar Shaik, September 2009.
25) Workshop Chair, “Process Validation for Biopharmaceuticals”, PDA Training and Research Institute Course Series, San Diego, USA, February, 2009 (Prof. A. S. Rathore)
26) DST-SERC School on “Tomography and Velocity Imaging in Multiphase Reactors”, July 2008 by Prof. S. Roy

b) Workshops/short term courses – educational methods (teaching, learning resources, pedagogy) – NIL

c) Learning, research material on website –

1) GPU based Molecular Dynamics software MD Darshan developed by Dr. Sanat Mohanty and students is available as an open source software on github (since 2012).

d) Science and technology for public information – Research papers published in national and international journals. Demonstration of completed projects during "Open House" – open for general public visitors – held once every year in April.

e) Courses taught to students of other IITs/NITs/Other institutions –

IIT Delhi-Addis Ababa University (Ethiopia) Post Graduate Program in Chemical Engineering, 2009-12. Following courses were taught:

1) Advanced Transport Phenomena
2) Chemical Engineering Mathematics
3) Chemical Reaction Engineering
4) Environmental Engineering and Process Safety
5) Petroleum Refining Engineering
6) Design of Separation Processes
7) Polymer Science and Engineering
8) Advanced Chemical Engineering Thermodynamics
9) Process Engineering
10) Membrane Science and Engineering
11) Process Dynamics and Control
12) Food Engineering

f) Courses taught via NKN – NIL

g) Courses developed for NPTEL:

1) Transport Phenomena by Prof. S. K. Gupta
2) Fuel Cell Technology by Prof. S. Basu and Prof. Anil Verma
3) Membrane Science & Engineering by Prof. S. K. Gupta
4) Mass Transfer by Prof. A. N. Bhaskarwar
5) Heterogeneous Catalysis and Catalytic Processes by Prof. K. K. Pant
6) Petroleum Refinery Engineering by Prof. K. K. Pant and Prof. Deepak Kunzru
7) Mechanical Unit Operation (Web and Video Course) by Prof. B. Pitchumani

h) Books, monographs, study material made available outside IITD

1) "Three Phase Slurry Reactors" by V. V. Buwa, S. Roy and V. V. Ranade in "Multiphase Catalytic Reactors: Theory, Design, Manufacturing and Applications", Editors: Zeynep Ilsen Önsan and Ahmet Kerim Avci, John Wiley, 2013.
2) "Process Validation in Manufacturing of Biopharmaceuticals", 3rd Edition, Edited by A. S. Rathore and G. Sofer, Taylor and Francis, 2012
3) "Ceria based electro-ceramic composite materials for solid oxide fuel cell application" (Ch 10), by Basu, S., Chokalingam, R., In Advanced Organic-Inorganic Composites: Materials, Device and Allied Applications, Ed. Inamuddin Siddiqui, Nova Science Publications Inc., N.Y. 2011
4) "Biomass Conversion to Energy" by M. Pande and A. N. Bhaskarwar in "Biomass Conversion – The Interface of Biotechnology, Chemistry and Material Science", Edited by C. Baskar, S. Baskar, and R. Dhillon, Springer, 2011
5) "Planning a Scientific Career in Industry: Strategies for Graduates and Academics", by Sanat Mohanty and Ranjana Ghosh, John Wiley & Sons, 2010 (published by Dr. S. Mohanty before joining IITD)
6) "Quality by Design for Biopharmaceuticals: Perspectives and Case Studies", Ed. by A. S. Rathore and R. Mhatre, Wiley Interscience, New Jersey, 2009
7) "Short-term Scheduling, Resource Constrained: Unified Modeling Frameworks" by M.A. Shaik and C.A. Floudas, in "Encyclopedia of Optimization" (2nd ed.), Editors: C.A. Floudas and P.M. Pardalos, Springer-Verlag, Netherlands, 2009, 3547-3560.
8) "Short-term Scheduling of Continuous Processes" by M.A. Shaik and C.A. Floudas, in "Encyclopedia of Optimization" (2nd ed.), Editors: C.A. Floudas and P.M. Pardalos, Springer-Verlag, Netherlands, 2009, 3533-3547.
9) "Multiscale Simulation Methods for Nanomaterials" by R. Ross and S. Mohanty, John Wiley & Sons, 2008 (published by Dr. S. Mohanty before joining IITD)
10) "Short-term Scheduling of Batch and Continuous Processes (Chapter 6)" by M.A. Shaik and C.A. Floudas, in "Supply Chain Optimization" Vol 4: Part II, Editors: L. G. Papageorgiou, M. C. Georgiadis, Wiley-VCH Verlag, Germany, 2007, 173 – 217.
11) "Recent Trends in Fuel Cell Science and Technology", Springer Ed. By S. Basu, 2007
12) "Elements of Biopharmaceutical Production Series", Ed. By A. S. Rathore, Advanstar Communications, New York, 2007.

i) **Experiments developed and made available to other institutions** – Various specialized lab equipment (like spray dryer, fuel cell test station, dip-coater) have been used by students from several institutions like IITG, IITGN, Allahabad University, New Castle University (UK), ICT Mumbai, Curtin University (Australia), etc.

j) **Seminars live/via NKN, web to other institutions in India/abroad** –

1) Invited lecture on "Alkylation over large pore molecular sieve catalysts" at Gayatri Vidya Parishad College of Engineering, Department of Chemical Engineering, Visakhapatnam, December 23, 2009 by Sreedevi Upadhyayula.
2) Invited lecture on "Heterogeneous Catalysis" at Thapar Institute of Technology, Patiala, June, 2011 by Sreedevi Upadhyayula.

k) **Reach out to schools, NCERT, KVs, etc** – Visit of school children arranged during "Open House" held once every year in month of April.

l) **Mentoring of other institutions, e.g. new IITs, NITs, universities** –

1) Member of academic interaction council of UPES Dehradun, 2008-2013 (Prof. K. K. Pant)
2) Member of curriculum review committee , MNIT Bhopal (Prof. K. K. Pant)
3) Member of Research advisory committee at NIT, Jalandhar, 2011-till date (Prof. K. K. Pant)
4) Had been member of curriculum review committee, MNIT Jaipur 2011-12 (Prof. K. K. Pant)
5) Member, Board of Governors, Bharat Institute of Technology Meerut, UPT Lucknow, Since 2008-till date (Prof. K. D. P. Nigam)
6) Member Research Advisory Committee of UPT, Lucknow, Since 2010-till date (Prof. K. D. P. Nigam)
7) Adjunct Professor, Department of Mechanical Engineering, Concordia University, Montreal, 2009-2012 (Prof. K. D. P. Nigam)

6.2 Industry collaboration

a) **No. of students (PhD/Masters) directly linked to industry funded projects** – 37 PhD/MTech students (29 PhD and 11 MTech):

1) 2 PhD students of Dr. Sreedevi Upadhyayula - Mr. B. Pradeep Kumar (SHELL STI, Bangalore) Mr. Kishore Kondamudi (ONGC Energy Centre), One MTech (Budde Pradeep Kumar, SHELL STI)

2) 5 PhD students of Prof. A. S. Rathore (Dr. Reddy's Lab, Ranbaxy Lab, GE healthcare)
3) 6 PhD students and 10 MTech students of Prof. S. Roy (Shell STI, Corning Inc. (USA), Thermax Ltd., Total (France) (jointly with Prof. KDP Nigam), DuPont (USA), General Motors ISL, MEMC Electronic Materials (USA))
4) 2 PhD students of Dr. Anupam Shukla (Immanuel V. and Pradeep K. Sow for ONGC Energy Centre)
5) 9 (PhD/MTech) students of Prof. K. K. Pant
6) 2 Ph.D. students of Prof. K. D. P. Nigam (R. N. Maiti, EIL 2008; Raminder Walia IICT, Hyderabad, 2009)
7) 3 (Ph.D.) student of Prof. S. Basu (Shaneeth 2012, ISRO; Varagunapandiyan 2008, Shell Hydrogen, Harikrishnan 2012, Intelligent Energy (EPSRC))

b) No. of industry staff/engineers who have taken a regular course(s) for entire semester- While unregistered persons (including industry staff) are not allowed to take regular courses, there have been many industry personnel registered as part-time students (both PhD and MTech) who have taken the courses. In last five years, there were 20 part-time PhD students and 2 part-time MTech students who have completed the course requirement.

c) Technology transfer to companies, entrepreneurs, local and other govt. agencies, NGOs

1) Ranbaxy Laboratories, CFD modeling of a helical coil heat exchanger to aid in scale up from lab to manufacturing scale, 2013 (Prof. A. S. Rathore)
2) BHEL, Tirchurapalli, CFD analysis to estimate eccentric location of vortex finder in cyclone to reduce pressure drop of cyclone for CFBC combustor, 2013 (Prof. B. Pitchumani)
3) Associated Soapstone, Udaipur, Carried out image processing to estimate the size distribution of jaw crusher product, 2013 (Prof. B. Pitchumani)
4) ABB Global Industries & Services Ltd., Bangalore, Proposed optimal water network synthesis, 2012-13 (Dr. Munawar Shaik)
5) Ranbaxy Laboratories, Creation of manufacturing process for Granulocyte Colony Stimulating Factor (GCSF) a biotech therapeutic – in negotiation with Ranbaxy Laboratories for licensing, 2011-12 (Prof. A. S. Rathore)
6) GE Healthcare, Creation of a high throughput process development (HTPD) protocol for development of biotech processes, 2011-12 (Prof. A. S. Rathore)

7) Dr. Reddy's Lab, Proposed a novel approach for using multivariate data analysis (MVDA) for evaluating comparability of biotech processes and products, 2011-12 (Prof. A. S. Rathore)
8) Dr. Reddy's Lab, Proposed an optimal refolding method for a biotech therapeutic – Granulocyte Colony Stimulating Factor (GCSF), 2011-12 (Prof. A. S. Rathore)
9) Thermax Limited, Studied hydrodynamics in rotary bioreactor with recommendations for performance improvement, 2011 (Prof. S. Roy)
10) Corning Incorporated, USA, Developed modeling suite for Fischer-Tropsch reactions in monolithic reactors, 2010 (Prof. S. Roy)
11) Engineers India Limited, Developed CFD model of hydrodynamics of slurry bubble column reactor, 2010 (Prof. S. Roy)
12) ABB Global Industries & Services Ltd., Bangalore, Proposed batch digester scheduling in pulp industry, 2010 (Dr. Munawar Shaik)
13) Corning Incorporated, USA, Developed theoretical model for catalyst impregnation of monolithic substrates, 2009 (Prof. S. Roy)
14) MEMC Electronic Materials, USA, Built reactor model for CVD process, 2009 (Prof. S. Roy)
15) HPCL R & D, Bangalore, Study on catalytic decomposition of methane for hydrogen generation, 2010-2013 (Prof. K. K. Pant)
16) Ministry of Defense, DRDO, Proposed reactor design and configuration for hydrogen generation for steam reforming of bioethanol, 2010-2013 (Prof. K. K. Pant)
17) Kalishwari Metal Powders, Sivakasi, Estimation of sphericity (flakiness) of aluminum powder particles, 2009 (Prof. B. Pitchmani)
18) Aurobindo Pharamaceuticals, Hyderabad, Development of various powder characteristics with single instrument, 2008 (Prof. B. Pitchmani)
19) Asian Paint Limited, Mumbai, Characterization of powders used in paint used by simple instrument, 2008 (Prof. B. Pitchumani)
20) BHEL, Tiruchipalli, Carried out DEM studies for estimation of feed point for pneumatic conveying venture nozzle, 2008 (Prof. B. Pitchumani)
21) Fresenius Kabi, Developed process to determine CMC of polysorbate 80 in human plasma (Prof. Rajesh Khanna)
22) Air Products and Chemicals, USA, Developed validated model for flow patterns in corrugated structured packings, 2008 (Prof. S. Roy)

d) Continuing education/courses for industry –

1) Short course "Risk Management in Pharmaceutical Development", by Prof. A. S. Rathore for Ranbaxy Limited, India, June, 2013
2) Short course "Quality by Design for Biopharmaceuticals: Challenges and Solutions", by Prof. Anurag S. Rathore for Dr. Reddy Laboratories, India, March, 2012.
3) Short course "Quality by Design based Process Development", by Prof. A. S. Rathore for Sartorius Stedim, Goettingen, Germany, May, 2011.
4) Short course "An introductory course on Chemical Engineering for Food Processing Industry" for employees of Pepsico India Holdings Pvt. Ltd., Gurgaon, by Dr. S. K. Pattanayek, Prof. S. K. Gupta and Prof. A. N. Bhaskarwar, 2010-11
5) Short course delivered at Tata Steel R&D Centre, Jamshedpur by Dr. V. V. Buwa, 2010
6) Implications of Quality by Design for a Biopharmaceutical Vendor, Short Course by Prof. A. S. Rathore for GE Healthcare, Uppsala, Sweden, December, 2009.
7) Lecture series for IOCL, Panipat personnel on "HDPE and LDPE production Technologies" by Dr. Sreedevi Upadhyayula, August 2009
8) Roadmap for Implementation of Quality by Design for Biopharmaceuticals, Short Course by Prof. A. S. Rathore for Intas Biopharmaceuticals Limited, Ahmedabad, July, 2009.
9) Two-day Workshop - "Scheduling of Batch and Continuous Process Operations", for ABB Global Industries & Services Ltd., Bangalore, under the aegis of FITT, IIT Delhi, Sep 10-11, 2009. (10 participants) by Dr. Munawar Shaik (Programme Coordinator & Speaker).
10) Short course – "Unit operations in pharmaceutical production", Ranbaxy, Chandigargh by Prof. B. Pitchumani, 2011
11) Short course – "Evaluation of centrifuge and milling process", Aurobindo Pharmaceuticals, Hyderabad by Prof. B.Pitchumani, 2011
12) Short course – "Importance of powder characterization in pharmaceutical process", Dr. Reddy's Laboratories by Prof. B. Pitchumani, 2012
13) Short course – "Design of large silo for reliable flow of coal and ash", BHEL, Tiruchirapalli by Prof. B. Pitchumani, 2012
14) Short course – "Effective variables for energy efficient operation of hammer mill", Associated Soapstone, Udaipur by Prof. B. Pitchumani, 2013
15) Short course – "Energy saving preheater cyclones, Sangi Cement" by Prof. B. Pitchumani, 2010

e) Faculty secondment to industry – NIL

f) Research projects undertaken with industry as partner – Projects worth Rs. 11.7 Crores.

1) ONGC Energy Centre, Mechanistic Studies on the Catalytic Decomposition of Sulfuric Acid in the I-S cycle for Hydrogen Production, 9 months starting from 25th Feb 2013. Rs. 17.47632 lacs (Dr. Sreedevi Upadhyayula).
2) Total S. A., France, Catalyst Loading and its Impact on the Performance of Trickle Bed Reactors, Rs. 17.22 Lacs, Nov. 2012 - Oct. 2013 (ongoing in 2013) (Prof. K. D. P. Nigam and Prof. S. Roy)
3) Corning Incorporated (USA), Analysis of Two-Phase Flow through Fine Channels of Porous Substrates, Rs. 82.84 Lacs, May 2006 - Dec. 2012 (ongoing in 2013) (Prof. S. Roy)
4) HPCL R & D, Bangalore, Catalytic decomposition of methane for hydrogen and Carbon Nano tube: 2010-2013, Rs. 51 lacs (Prof. K. K. Pant)
5) Pall Europe, Optimization of Chromatography Process Steps for purification of monoclonal antibody based therapeutics, 2013, Rs. 40 Lakhs (Prof. A. S. Rathore)
6) HPCL and Centre for High Energy, "Catalytic Decomposition of Methane to Hydrogen and Carbon Nano Fiber", 2013, Rs. 51 lacs (Prof. K. K. Pant)
7) ONGC Energy Centre, Modeling of membrane electrolysis cell for Bunsen reaction and electro-electro dialysis unit for concentration of HI_x solution, 9 Months start date: February 2013, 10.86 lacs (Dr. Anupam Shukla)
8) Loreal India Pvt. Ltd. "Investigation of Foam Formation Kinetics, Stability and Characterization", 2013, Rs. 1.1 lacs (Dr. Shalini Gupta)
9) ABB Global Industries and Services Ltd, Monitoring and Optimization of Ultrafiltration, Microfiltration and Membrane Bioreactor Unit Operations, 2011-13, Rs. 10 lacs (Prof. A. S. Rathore)
10) Dr. Reddy's Laboratories, Aggregation of monoclonal antibody based therapeutics – effect of processing and storage, 2013, Rs. 20 lacs (Prof. A. S. Rathore)
11) Dr. Reddy's Laboratories, Implementation of Quality by Design (QbD) for production of Bio similar Products, 2011-13, Rs. 20 lacs (Prof. A. S. Rathore)
12) Dr. Reddy's Laboratories, Process Development and Optimization Studies for Therapeutic Biotech Products, 2011-12, Rs. 28 lacs (Prof. A. S. Rathore)
13) Uniforge Pvt. Ltd. Analysis and Design of Solid Lubricants", Rs. 1.25 lacs (Dr. S. Mohanty)
14) Continental Carbon Ltd., Process optimization for reduction in ppm level impurities in carbon production, Rs. 1.5 lacs (Dr. S. Mohanty)

15) Biocon Ltd, Development and Commercialization of Biotech Therapeutic Products, 2011-13, Rs. 10 lacs (Prof. A. S. Rathore)
16) Waters Corporation, USA, Analytical Characterization of Biotech Therapeutics, 2012-13, Rs. 16 lacs (Prof. A. S. Rathore)
17) ABB Global Industries & Services Ltd., Bangalore, Optimal Water Network Synthesis, 2012-13, Rs. 11.236 lacs (Dr. Munawar Shaik)
18) ONGC Energy Centre, Studies on Catalytical Decomposition of Sulfuric Acid in the IS Cycle for Hydrogen Production, 2008-12 (ended 11th Oct. 2012), Rs. 98.844 lacs (Dr. Sreedevi Upadhyayula and Prof. A. N. Bhaskarwar)
19) Methanol assisted Methane to Gasoline on Bi-functional Zeolite Based Catalysts. (completed), Shell Technology India Pvt. Ltd., 3 years, 2008-11, Rs. 26.045 lakhs (Dr. Sreedevi Upadhyayula).
20) Ansys Inc, CFD Simulations for Analyzing Effects of Stent Design on Cerebral Aneurysm, 2011, Rs. 0.7 lacs (Prof. A. S. Rathore)
21) S. S. Gas Labs (India) Pvt. Ltd., New Delhi, Flow sheet Simulation and Optimization for CO_2 Production Process, 2011, Rs. 2.68 lacs (Dr. Munawar Shaik)
22) ONGC, Studies on Bunsen Reactor for Production of H_2SO_4 and HI using Membrane Electrolysis and Concentration of HI_x using Electro dialysis, 2011, Rs. 102.33 lacs
23) ABB Global Industries and Services Ltd, Development of process model for electro dialysis (ED) powered by renewable energy (i.e PhotoVoltaic (PV) power), One year, start date: December 2011, 10 Lacs (Dr. Anupam Shukla)
24) ISRO, Electro catalyst for PEM water electrolyzer, 2011, Rs. 22.5 lacs
25) Thermax Limited, Investigation of Hydrodynamics in Rotary Fluidized Bed Bio-Reactor, Rs. 3.15 Lacs, Oct. 2010 - Mar. 2011 (Prof. S. Roy)
26) Shell Technologies, Studies on Droplet Coalescence and Re-dispersion in Liquid-Liquid Dispersions Rs. 68.87 Lacs Oct. 2008 - Sept. 2011 (Prof. S. Roy)
27) Sartorius Stedim, Germany, Fundamental Studies and Industrial Applications in Membrane Adsorbers, 2010, Rs. 37 lacs (Prof. A. S. Rathore)
28) Pall India, Use of Bio-Separation Technologies in PAT and QbD based Process, 2010, Rs. 8 lacs (Prof. A. S. Rathore)
29) ABB Global Industries & Services Ltd., Bangalore, Batch Digester Scheduling in Pulp Industry, 2010, Rs. 5.73 lacs (Dr. Munawar Shaik)
30) Engineers India Limited, Development of Computational Fluid Dynamic (CFD) Model of Hydrodynamics of Slurry Bubble Column Reactor, Rs. 5.50 Lacs Dec. 2009 - Sept. 2010 (Prof. S. Roy)
31) Scope of Fuel Cell Tech in India, Rs 5.5 Lacs 2009-2010 (Prof. S. Basu)

32) Thermax Limited, Radioactive Particle Tracking (RPT) in a Bio-reactor Pilot Plant, Rs. 0.86 Lacs Dec. 2009 - May 2010 (Prof. S. Roy)
33) MEMC Electronic Materials (USA), Reactor Modeling of CVD Process, Rs. 10.05 Lacs, Oct. 2008 - May. 2009 (Prof. S. Roy)
34) MEMC Electronic Materials (USA), Study of Epitaxial Silicon Wafers, Rs. 8.12 Lacs, Apr. 2007 - Mar. 2008 (Prof. S. Roy)
35) BPCL, Development of catalyst for selective hydroisomerisation of lube oils (under Petrotech fellowship), 2010-13 (Prof. K. K. Pant)
36) Asian Paints, Characterization of powders to design reliable flow of silo, 2010 (Prof. B. Pitchumani)
37) Asian Paints, Ultrafine grinding in high energy mill to reduce the consumption of pigments in paint, 2011 (Prof. B. Pitchumani)
38) Sun Ark Metal Co., Sivakasi, Alternate use of aluminum powder, 2012 (Prof. B. Pitchumani)
39) BHEL, Tiruchirapalli, Design of reliable flow of silo for coal storage, 2012 (Prof. B. Pitchumani)
40) PDIL, Noida, "Spent Catalyst Reused/Disposal", in collaboration with Department of Fertilizer, Ministry of Chemicals and Fertilizers, Rs. 2 Crore, 2006-2011 (Prof. K. D. P. Nigam and Prof. K. K. Pant)
41) BHEL Hyderabad, Hydrodynamics of Coal, Ash and Mixtures in Fluidized Beds of relevance to IGCC, Rs. 29.09 Lacs, June 2013 - Feb. 2015 (Prof. S. Roy)
42) EIL and IOC (R & D), "Scale up and Design of Trickle Bed Reactors-Phase III", funded by Ministry of Petroleum and Natural Gas, Rs. 1.35 Crores, 2006 to September 2011 (Prof. K. D. P. Nigam)

g) Laboratories, equipment, etc. provided by industry for use in UG/PG teaching laboratories and student projects –

1) Fourier Transform Infrared Spectrometer(PG lab) by ONGC Energy Centre
2) High Pressure fixed bed reactor set-up (PG lab) by SHELL STI, Bangalore.
3) Attrition Mill and fine silica grinding media by Associated Soapstone Ltd., Udaipur.
4) Nikon Trinocular Microscope (ECLIPSE 55i) attached with a Nikon CCD camera, by Shell STI, Bangalore.
5) Liquid distribution measurement apparatus, by Corning Inc, USA.
6) Fluid bed reactor system by HPCL
7) Gas Chromatography by HPCL
8) Catalyst preparation system by HPCL

9) High pressure BTRS System (up gradation)
10) GCMS by Ministry of Fertilizers
11) TGA Unit

h) Seminars/workshops held with industry by the department

1) "Round Table Discussion Meeting on Challenges in Applications of CFD in Oil and Gas, Energy and Process Industries", 2013 by Dr. V. V. Buwa
2) BIRAC-CDSA Regulatory Meet: Demystifying Indian Regulations for Product Approvals, Five Day Course held at IIT Delhi, New Delhi, India, July, 2013 by Prof. A. S. Rathore
3) Technical Conference organized: "A Meet on Industrial Problems related to Surface and Interfacial Science" on 5th April 2012 by Dr. S. K. Pattanayek

6.3 Professional

a) Service as Board, Senate, selection committee member at other IITs, NITs and universities –

1) Member of Selection Committee for Faculty Selection at several IITs, NITs (Prof. S. K. Gupta, Prof. K. D. P. Nigam, Prof. S. Basu, Prof. A. K. Gupta, Prof. K. K. Pant, Prof. R. Mohan, Prof. B. Pitchumani, Prof. Rajesh Khanna)
2) SERC / SAC member of CSIR, MNRE (Prof. S. Basu)
3) Chairman, IIChE NRC (Prof. S. Basu)
4) RA/SRF selection committee member of CSIR, MNRE (Prof. S. Basu)
5) Member, Selection Committee, Bio Processing Unit, Department of Biotechnology, Government of India, 2013 (Prof. A. S. Rathore)
6) Vice Chancellor UP Technical University nominee on the BOG for BIT Meerut, UPT Lucknow, 2008-Till date (Prof. K. D. P. Nigam)
7) Member, Selection Committee, Fullbright-Nehru Postdoctoral Fellowships, United States-India Educational Foundation, 2010 (Prof. A. S. Rathore)
8) Member of Academic interaction council for Univ. of Petroleum and Energy Studies, Dehradun, 2008-2012 (Prof. K. K. Pant)
9) Member of Board of Studies, MNIT, Jaipur (Prof. K. K. Pant)
10) Member of Curriculum Review Committee, NIT Jaipur, 2010-12 (Prof. K. K. Pant)
11) Member of Board of Studies (PG), NIT, Jalandhar (Prof. K. K. Pant)
12) Member of Research Advisory committee, NIT Jalandhar, 2011-date (Prof. K. K. Pant)
13) Member of Board of Studies, NIT, Bhopal (Prof. K. K. Pant)

14) Member of Selection Committee for Faculty Selection at MNIT Allahabad, UPES Dehradun, Punjab Technical Univ. Chandigarh, ISM Dhanbad, ITM Gwalior and many other Private Engineering colleges (Prof. K. K. Pant)
15) Member of Selection Committee for Faculty Selection, Shiv Nadar University (Prof. Rajesh Khanna)
16) Member of Selection Committee for Faculty Selection, Punjab University (Prof. B. Pitchumani)
17) Member of Selection Committee for Faculty Selection, AMU, Aligarh (Prof. B. Pitchumani)
18) Member Research Committee UPT, Lucknow (Prof. K D P Nigam)

b) Service as PhD thesis examiner at other institutions (nos) – Several faculty members have served as PhD thesis examiner at: National educational institutes – IIT Bombay, IIT Madras, IIT Kanpur, IIT Roorkee, ICT Mumbai, NIT Jalandhar, NIT Bhopal, NIT Surat, NIT Tiruchirapalli, BITS Pilani, ISM Dhanbad, Anna University, Madras University, Kerala University, SVNIT Surat, Dharmsinh Desai University Nadiad, RGPTU Bhopal, PTU Chandigarh, Ujjain Engg College, IP University Delhi, Indian Association for Culmination of Science (Dept of Materials Science); and International institutions - Malaya university (Malaysia) and Pretoria University (South Africa).

c) Service as technical expert on committees – MHRC, DST, CSIR, DRDO, Pan-IIT initiatives, other ministries, state and local governments -

1) Member of Innovation council for the Fertilizer sector, Ministry of Chemical and Fertilizers, Govt. of India, 2010-2020 (Prof. K. D. P. Nigam)
2) Expert Member, DST-TIFAC Committee on "Process Intensification" 2013 (Prof. K. K. Pant & Prof. S. Roy)
3) Member on various committees of DST, AICTE, UGC, 1997-present (Prof. S. K. Gupta)
4) Chairman, Committee for Advising the DCGI on Regulation of Biotech Products (r-DNA product), Ministry of Health and Family Welfare, Government of India, 2013, (Prof. A. Rathore)
5) Expert for Technology Development Board (TDB), Department of Science and Technology (DST), Govt. of India, for assessing business feasibility, progress and commercialization of incubated and start-up companies, 2012 (Prof. S. Roy)
6) Member, Scientific Advisory Committee (SAC), apex body of the Ministry of Petroleum and Natural Gas, Govt. of India for approving and review of technology development projects of major energy companies in India, 2010 (Prof. S. Roy)

7) Member, BIRAC Technical Expert Committee for Translational Facilities, Biotechnology Industry Research Assistance Council, Department of Biotechnology, 2012 (Prof. A. S. Rathore)
8) Expert Member, Biotechnology Ignition Grant (BIG) from Department of Biotechnology, IIT Delhi, 2012 (Prof. A. S. Rathore)
9) Member of Scientific Body, Indian Pharmacopeia Commission, Ministry of Health and Family Welfare, 2012 (Prof. A. Rathore)
10) Expert Member of DST-TIFAC Apex Committee for the study on "Indian Chemical Industry – Technology Imperatives & Business Opportunities", 2010
11) Expert Member, Naval Materials Research Laboratory, DRDO at Ambernath (Prof. S. Basu)
12) Expert Member, CSIR (Prof. S. Basu)
13) Expert Member, Science and Engineering Research Council (SERC) (Prof. S. Basu)
14) Expert Member, Ministry of New and Renewable Energy (MNRE) (Prof. S. Basu)
15) Member of Research Advisory Committee of National sugar Institute, Kanpur, Ministry of Civil Supplies, Government of India, 2003 onwards (Prof. K. D. P. Nigam)
16) Member of screening committee of Petroleum conservation Research Association (PCRA), 2002-till date (Prof. K. D. P. Nigam)
17) Member of Research Advisory Committee, Fertilizer Association of India, 2001-till date (Prof. K. D. P. Nigam)
18) Member, State Level Environment Impact Assessment, SEIA, Delhi Government, 2010 [Environmental clearances to all industrial and construction projects in Delhi NCT] (Prof. S. K. Gupta)
19) Member, Consent Management Committee (under orange category), Delhi Pollution Control Committee, Govt. of Delhi NCT, 2007-present [Managing consents to all polluting industries in Delhi] (Prof. S. K. Gupta)
20) Member, Consent Management of Municipal Solid Waste, Delhi Pollution Control Committee, Govt. of Delhi NCT, 2007-present [Managing consents to MSW treatment, Power Projects and water treatment plants in Delhi] (Prof. S. K. Gupta)
21) Member, committee on evaluation of project proposals, PCRA, Ministry of Petroleum and Natural Gas, 2007-2009 (Prof. S. K. Gupta)
22) Member, Scientific Advisory Committee, Bio Processing Unit, Department of Biotechnology (Prof. A. Rathore)
23) Member, Scientific Body, Indian Pharmacopeia Commission, Ministry of Health and Family Welfare, Government of India (Prof. A. Rathore)

24) Member, Engineering Advisory Committee, apex body of the Ministry of Industries Govt. of India for environmental clearance for approving and review projects of major industries in India, 2008 (Prof. B. Pitchumani)
25) Member of Selection Committee, Min. of Environment (Prof. B. Pitchumani)
26) Member of Selection Committee, Central Pollution Control Board (Prof. B. Pitchumani)
27) Consultant for Coordinated Research Project (CRP) for Radioactive Particle Tracking (RPT) techniques by International Atomic Energy Agency (IAEA), Vienna, Austria, 2007 (Prof. S. Roy)
28) Mentor and auditor to different Institutions for NPIU, MHRD, GOI (Prof. K. D. P. Nigam)

d) Technical expert on policy, regulatory, laws, standards committees

1) Member, Expert committee of Government of India for drafting the National Auto Fuel Vision & Policy: 2025 (mandated to develop norms and road-map for BS-V and BS-VI automotive fuel standards in the country), 2013 (Prof. S. Roy)
2) Chairman, Committee for Advising the DCGI on Regulation of Biotech Products (r-DNA product), Ministry of Health and Family Welfare, Government of India, 2013, (Prof. A. S. Rathore)
3) Member, Task Force to Frame Guidelines for Submission of Dossiers or Proposals for Regulation of Biotech Products (r-DNA products), Ministry of Health and Family Welfare, 2012 (Prof. A. S. Rathore)
4) Member of committee on "Formulating Strategy for Managing National Hazardous Waste", MOEF, GOI, 2009 [Strategy document submitted to GOI for implementation] (Prof. S. K. Gupta)
5) Member of committee on "Formulation of Hazardous Waste Management Handling and Trans Boundary Movement", MOEF, GOI, 2008 [New rules have been notified and implemented throughout India] (Prof. S. K. Gupta)
6) Member of Sieves Committee of ISI of Indian Bureau of Standards (Prof. B. P. Mani)

e) Member of Board/Advisory Board of public and private corporations –

1) Advisory Board, Dr. Reddy's Lab, 2012 (Prof. A. S. Rathore)
2) Member Board of Directors for Engineers India Limited, July 2010 - July 2013 (Prof. K. D. P. Nigam)
3) Member, Research Advisory Council, Engineers India Limited, 2012-till date (Prof. K. D. P. Nigam)

4) Member, Board of Directors, NFL (Prof. K. D. P. Nigam)
5) Member, Research Advisory Committee of FAI (Prof. K. D. P. Nigam)
6) Member, Accreditation Board, European Process Intensification Centre, The Netherlands during 2011 (Prof. K. D. P. Nigam)
7) Scientific Advisory Board, Pall Life Sciences, USA (Prof. A. S. Rathore)

f) Positions (e.g. Director, Vice Chancellor, etc) held by faculty on lien – NIL

6.4 Contributions to national development goals

a) Projects undertaken and their outcome –

1) "Technology Development for Trickle Bed Reactors" in association with EIL & IOC, sponsored by MP&NG, GOI. Based on joint project from 1997 to 2011 the First Hydrocracker was commissioned by EIL at Bongaigaon Refinery in December 2011 (Prof K. D. P. Nigam)
2) "Technology Development for Synthetic Liquid Fuels through Process Intensification", Industrial Research & Development Project under IRD, IIT Delhi (Prof. A. N. Bhaskarwar, Dr. Sreedevi Upadhyayula). Sponsored by Ministry for Human Resource and Development (MHRD). Duration: 5 years starting November 2010, Rs. 1 Crore
3) "Production of High Value Therapeutic Proteins using Pichia System", Industrial Research & Development Project under IRD, IIT Delhi (Prof. A. S. Rathore with Prof. Saroj Mishra- DBEB, Prof. James Gomes – SBS). Sponsored by Ministry for Human Resource and Development (MHRD). Duration: 5 years starting November 2010, Rs. 1 crore.

b) Policy inputs – implications, visible impact on society

1) Member, Task Force to Frame Guidelines for Submission of Dossiers or Proposals for Regulation of Biotech Products (r-DNA products), Ministry of Health and Family Welfare, 2012 (Prof. A. S. Rathore) – resulted in the issuance of the Biosimilar Guideline for assessment of all biosimilar products
2) Member, Scientific Body, Indian Pharmacopeia Commission, Ministry of Health and Family Welfare, Government of India (Prof. A. S. Rathore) resulted in issuance of 10 monographs for biotech therapeutics

c) Entrepreneurship development

1) *EnNatura Technology Ventures Pvt. Ltd.* (Prof. A. N. Bhaskarwar)
   EnNatura is a clean materials company developing specialty chemicals from renewable sources. The company designs polymers that reduce hydrocarbon consumption and deliver high performance and environmentally-friendly attributes when applied in specialty chemicals. (http://www.ennatura.com)

2) *Simplyfeye Softwares Ltd.* (Prof. A. S. Rathore)
   Simplyfeye enables biologics and biopharmaceutical companies to better manage and understand bioprocess data with the help of its data management products and solutions. The company develops solutions that aim for cutting down the unproductive time and effort spent on putting together relevant data needed for analysis. (http://www.simplyfeye.com)

3) *Inkilab Technologies Pvt. Ltd.* (Dr. S. Mohanty)
   Inkilab Technologies is focused on diagnostics and decision support solutions for manufacturing of high value products and reductions of defects integrated on to manufacturing lines and enabling continuous improvement processes. (www.inkilabtechnologies.com)

6.5 Alumni engagement

a) Regular interactions/engagement with alumni and outcomes – Formal and informal interactions with alumni take place periodically (at least once in a year).

b) Contributions from alumni – Alumni serve as useful contact points with industries and have been helping with the Training & Placement activities. Alumni also provide feedback for the curriculum review.

6.6 Recognitions and Awards

a) Awards to faculty –

1) Prof. K. D. P. Nigam – Senior Humboldt Research Award (Humboldt Laureate Award), Germany, 2013
2) *Industrial Engineering Chemistry & Research* published a Festschrift issue 51(4), 1437-2178, 2012, in recognition of research contributions made by Prof K. D. P. Nigam to Chemical Engineering, 2012

3) Dr. Sreedevi Upadhyayula – Er. B. N. Chatterjee Mineral Engineering Science (MESA) Award, 2013
4) Prof. B. Pitchumani - Life time achievement award for contribution to "Powder and Bulk Solids Handling". The award was given by German powder forum at International congress on powder and bulk solids handling at Ahmedabad, 2013
5) Prof. S. Basu - 1st prize publication in peer reviewed international journal, Journal publication award by Indian Society for Electro Analytical Chemistry (ISEAC), 2012
6) Prof. S. Basu – Prof. R. D. Desai 80th Birthday Commemoration Medal and Prize, Indian Chemical Society, 2012
7) Dr. Jayati Sarkar – IIChE Young Engineer Amar Dye-Chem Award for Excellence in Research and Development, 2012
8) Dr. Gaurav Goel – TOTAL Young Faculty Award, 2012
9) Prof. S. K. Gupta – "Excellence in Teaching Award" by IIT Delhi, 2012
10) Dr. V. V. Buwa – "Excellence in Teaching Award" by IIT Delhi, 2012
11) Dr. P. Chokshi – "Excellence in Teaching Award for Young Faculty" by IIT Delhi, 2012
12) Dr. Munawar Shaik – IEI Young Engineers Award (below 35 years category) in Chemical Engineering for year 2011-12 from The Institution of Engineers (India), 2011.
13) Prof. S. Basu - Prof. Bal Krishna Memorial lecture - International Year of Chemistry, 48th Convention of Chemists, Indian Chemical Society, Dec 4, 2011, Allahabad University
14) Dr. Shalini Gupta – DPCC Young Faculty Incentive Fellowship, 2011
15) Prof. S. Basu - Distinguished Alumni Award, Dept of Chemical Engineering, Calcutta University, 2010
16) Prof. S. Basu - FITT award for best M.Tech./Ph.D. thesis 2010; Rs 40,000/- prize money shared with student A. Awasthi
17) Prof. S. basu - Distinguished Alumni Award, Department of Chemical Engineering, Calcutta University, 2010
18) A. V. Ramarao Award for the best thesis supervised, IIChE, 2010 (Prof. K. K. Pant)
19) Dr. Anupam Shukla - Best Industry related Ph. D. thesis supervision, FITT, IIT Delhi, 2009
20) Dr. Munawar Shaik – Young Scientist Award (below 32 years category) in Engineering Sciences for year 2008-09 from Indian Science Congress Association (ISCA), 2009

21) Dr. V. V. Buwa – Young Engineer Award, Indian National Academy of Engineering, 2008
22) Prof. S. Basu - Visiting Fellow, Royal Soc., UK, Univ. of Newcastle upon Tyne, UK, 2008
23) Dr. Anupam Shukla – Kusuma Outstanding Young Faculty Fellowship, 2008
24) Dr. Vivek Buwa – Kusuma Outstanding Young Faculty Fellowship, 2008
25) Dr. Munawar Shaik– Kusuma Outstanding Young Faculty Fellowship, 2008
26) Dr. Jayati Sarkar – Kusuma Outstanding Young Faculty Fellowship, 2008

Awards shared with students

1) Venkat Krishna Kishore, a graduate student in Dr. Sreedevi Upadhyayula's group, won the Gandhian Young Technological Innovation (GYTI) Award 2013 for his work on reactor and catalyst development for oxygen evolving step in sulfur-iodine cycle for hydrogen production, 2013.
2) Dr. Vivek Kumar, a post-doctoral fellow in Dr. Sanat Mohanty's group, received a certificate of appreciation at the Gandhian Young Technological Innovation (GYTI) Award 2013 for his work on high performance bamboo epoxy composites, 2013.
3) Venkat Krishna Kishore, a graduate student in Dr. Sreedevi Upadhyayula's group, won 1st prize in poster competition in the Science day event at IIT Delhi, 2013.
4) Ankur Gupta, Best paper award at CHEMCON 2011, shared with Prof. S. Roy.
5) A. Awasthi, FITT award for best M.Tech./Ph.D. thesis 2010; Prize money shared with Prof. S. Basu.
6) Suresh Kumar, FITT award for the best industry-related Ph.D. thesis, 2009; (supervisors: Prof. A. K. Gupta & Dr. Anupam Shukla)

b) Fellows of academies, INAE, etc –

1) Prof. S. Basu – Fellow of Indian Chemical Society, 2012
2) Prof. S. Basu – Fellow of Institute of Engineers, 2011

Section 7

GOVERNANCE

Executive Summary: Governance

Governance of the Department of Chemical Engineering at IIT Delhi is characterized by its efficient and transparent decision making. As is evident from the detailed submission, the various administrative committees that we have are functional and meet frequently and that the decision making is taken place at these meetings. The Department has been proactive in performing the due diligence and taking a stand on key issues whether it is about communicating the space requirements to the Institute or amending our approach for selection of graduate students. An example that best illustrates our ability to be proactive is that of hiring new faculty. About five years ago, the department was facing a severe crunch of faculty and a bunch of faculty retirements were looming in the horizon. The teaching load was increasing and faculty dissatisfaction was high. Over the last few years, the department formed a search committee for seeking new applicants as well as actively processes the incoming applications, talk to the candidates over Skype and drive the individual applications to their eventual goal in an efficient manner. As a result, we have been able to add 7 faculties in the last 5 years. While we are still not where we wish to be in terms of faculty strength, we have come a long way and are now more confident of reaching the optimal strength in the near future.

The Department has also performed very well with respect to generating sponsored research funds. Our external funding has gone from 3.9 Crores in 2008 to 11.6 Crores in 2012. The number of graduate students has also steadily grown from about 80 in 2008 to > 100 today.

7.1 Governance

(a) Organization structure – their autonomy/terms of reference

The department is composed of the following employees:

- Faculty members (25).
- Administrative/technical staff (3).

The head of the Department (HOD), who is chosen by rotation among senior professors, is ultimately responsible for all administrative departmental matters. The department has several committees that assist the head in managing the various aspects of the department. Each of the committees has varying degrees of independence. These include:

i. Department Faculty Board (DFB)

- It comprises of all full-time faculty members & Joint Faculty of the Department, except those appointed under Sponsored Research Projects and Visiting Faculty. The Chairman of the Faculty Board may invite the Visiting Faculty to attend the Board meetings as Special Invitees.
- The Head of Department is the ex-officio Chairman of the DFB.
- One of the members of the DFB nominated by the DFB acts as its convener. His/Her tenure shall be at the discretion of the DFB.
- The DFB is required to meet as and when necessary but at least twice in a semester with 50% of its members in station forming the quorum. It normally meets at least once a month.
- The duties & responsibilities of the DFB are overall policy formulation, co-ordination and review of all activities of the Department in addition to the matters which are referred to it by the Head of the Department/Dean(s)/Dy. Director(s)/Director.
- Minutes of the meeting of the DFB are recorded and circulated to the members & confirmed in the subsequent meeting.

ii. Professorial Committee (COP)

- COP comprises of all Professors and Scientific/Design staff of the equivalent rank.
- The Head of the Department is Ex-officio Chairman of the COP.
- The COP is required to meet as and when necessary but at least twice in a semester with 50% of its members in station forming the quorum. It normally meets at least once a month.
- Apart from matters which may be referred to it by the Director, Dy. Directors,

Deans and Head of Department, the COP will assist the Head of Department in execution of the policies/programmes formulated by the authorities of the Institute and DFB of the Department such as recommending the areas and levels for faculty advertisement, short listing of application for faculty positions, secondment of faculty to any outside Organisation, grant of leave (long & medium) to faculty, visiting faculty appointments, budget allocation, space/resource allocation, preparation of plan document and other proposals for future developmental activities of the Department.

- Minutes of the meetings of COP are circulated to all the members of the Committee. Minutes of all meetings of the COP (except on confidential matter) are kept in a file for reference by the faculty of the Department.

iii. Department Research Committee (DRC)

- The DRC monitors and advises on Post Graduate and Research Programs of the Department.
- The DRC consists of a minimum of seven members including Chairperson but not exceeding 1/3rd of the sanctioned faculty strength of the Department. At least four members are Professors.
- Chairperson of the Committee is nominated by the Department Faculty Board. Normally he/she is a Professor. In case of any difficulty in unanimously nominating a Chairperson, due to one reason or other, the same is decided by the Dean, Academics.
- If the Head of Department is not the Chairperson of the DRC, he/she is necessarily a member of the DRC.
- Department's representatives to the Board of Post Graduate Studies (BAP) is a member of the DRC.
- Post Graduate Programme Coordinators are also members of the DRC.
- The DFB nominates the Committee members. As far as possible while nominating the members, the DFB ensures that various prominent research areas of the Department are represented.
- The names of the proposed DRC members are sent to the BAP by the Head of Department for approval.
- The tenure of the Chairperson as well as members of the DRC is at a minimum one year.
- In case any member resigns or leaves the Institute for a period longer than three months, a new member is nominated in his/her place by the DFB in consultation with the Dean, Academics.

- Any faculty member registered for a Ph.D. degree is not a member of the DRC.

iv. Standing Review Committee

- The Standing Review Committee is constituted by the Director to make a review of the academic activities (Teaching, Research & Development etc.) of the Department and to advice on its future academic activities.
- The committee comprises of Head of the Department and experts from outside, including those from Industry/educational/research institutions and user organizations.
- The membership of the Committee is chosen to cover as many areas of the Department as possible.
- The Committee reviews the activities (Teaching, Research and Development) of the Department every alternate year.
- The composition & strength of the committee is at the discretion of the Director.

(b) Planning documents developed by the department

i. A Vision document was recently prepared by the department and communicated to the Institute administration.
ii. A document on Space Requirement was also prepared recently and forwarded to the relevant Institute authorities.

(c) Records of discussions within the department – internal documents (meeting minutes, position papers, discussion papers, concept papers, etc.)

- Most committees have minutes that are published and circulated amongst the committee members.
- In certain cases (such as DRC) the minutes are also sent to the relevant Institute authorities.

(d) Physical resources – percentage utilization for UG PG core and elective teaching separately, UG and PG student projects, Ph.D. Student research. Projections for future.

- At this time, on average faculty spends 20% of their time teaching core courses, 20% on teaching elective courses, 10% on laboratory or similar courses, 20% on administrative matters, 10% on UG/PG project guidance and 20% on PhD research guidance.

- In future, as we continue to improve faculty strength, we hope to reduce the faculty load from teaching and administration and increase the focus on PhD research guidance. One possible outcome could be - 10% on teaching core courses, 10% on teaching elective courses, 10% on laboratory or similar courses, 10% on administrative matters, 10% on UG/PG project guidance and 50% on PhD research guidance.
- With increased faculty strength we also hope to be more liberal in allowing faculty to take sabbaticals or no-teaching semesters.

(e) Financial resources – (i) funds provided to the department, (ii) processes of distribution, (iii) funding for focus areas, (iv) funding for UG and PG core teaching laboratories. Outcomes of funds utilization. Changes in funding pattern and funds utilization, and effects on departmental strategy.

- Funds are provided to the department under several different budget heads. These include NPN05 and PLN03. For 2012-13, the value of the NPN05 fund was 53 lacs.
- The budget for consumables (NPN05) is distributed equitably amongst the faculty. If certain faculty members do not use their allocated budgets, those funds are given to others who may need more than the designated share. For the budget of non-consumables (PLN03), the HOD calls a DFB meeting and requests all faculty to submit their requests for the year. The requests are collected and the end result is communicated to Planning. Once the funds are received from Planning, the HOD through DFB discussion decides which equipments are to be purchased.
- Funding requests from faculty for repairs of offices and laboratories are routinely made from the faculty to the Planning Unit via HOD.
- Funding requests for UG/PG lab upgradation are made by the respective faculty lab in-charges together with the HOD as per lab requirements.
- At present, we feel that the support we receive from the Institute meets our expectations.
- In future, the department would like to be in a place where majority of the funding comes through sponsored research projects from government agencies and industry. We are already moving towards this situation. In 2012 alone, the total funding that the department faculty received via major sponsored research projects was 21.88 crores while the total funding received from the Institute from 2008 to 2012 was 8.36 crores.

(f) Delegation of decision making within department/centre. List the processes and structures for financial and academic management, and the methodology for their review.

- As mentioned above, the department takes a team-based approach towards decision making. The various teams listed above and in section 7.2 are responsible for the assigned areas and do most of the legwork. Final approval of the matter may happen in the respective committee or a higher level committee or by the HOD depending on the nature of the matter.

7.2 Department management and operations

(a) Organization structure - mandates, flexibility, etc. (Sept. 2012 onwards)

Head of the Department	Prof. Suddhasatwa Basu
Department Mentor	Prof. A.K. Gupta
Secretary, Professorial Committee	Prof. Ratan Mohan
Secretary, DUGC	Prof. K.K. Pant
Secretary, DFB	Prof. A.K. Saroha
Secretary, DRC	Prof. Anurag S. Rathore
In-charge, Time Table & Exam Schedule	Dr. Anupam Shukla
Chairman, Dept. Curriculum Review Committee	Prof. S.K. Gupta
Convener, Dept. Curriculum Review Committee	Prof. S. Roy
Chairman, Faculty Search Committee (FSC)	Prof. Rajesh Khanna
Convener, Faculty Search Committee	Prof. S. Roy
In-Charge, Dept. Library/ACL	Prof. K. K. Pant
In Charge, Dept. Seminars	Prof. S. Roy
In Charge, Office Management/Imprest	Prof.. A.K. Saroha
Member, BUGS	Dr. Gaurav Goal
Member, BPGS	Dr. Shalini Gupta
Coordinator, T&P	Prof. Anurag Singh Rathore, Dr G. Goel, Dr. S. Pattanayek (To help)
Coordinator, Ph.D.	Dr. Vivek Buwa
Coordinator, M.Tech. Dual	Dr. Jayati Sarkar
Coordinator, M.Tech 2 yr.	Dr. S. Pattanayek
Coordinator, B.Tech.	Dr. Munawar Shaik
Coordinator, CHES	Dr. S. Mohanty
Coordinator, Class Committee Meetings/ Election of Convener and CRs	Dr. Sreedevi U.
Coordinator, TA Duty (M.Tech 2yr/Dual)	Dr. Paresh Chokshi / Dr.Anupam Shukla
Coordinator Dept. Website	HOD / Dr. Shalini Gupta
Coordinator, Publication Reports, Dept. Flyers	Dr. V.V. Buwa

Coordinator UG Lab FPM Experiments FM Experiments HT/Thermo Experiments MT, Experiments	Dr. Sreedevi/Prof. B.P. Mani Dr. S.K. Pattanayek Dr. V.V. Vuwa Prof. Rajesh Khanna Dr. Sreedevi U.
Coordinator, Design Lab (DL)	Dr. Shalini Gupta
Coordinator, Process Control (PC)	Dr. Munawar Shaik
Coordinator, ChemicaI Reaction Engg. (CRE)	Prof K K Pant
Coordinator, PSL	Dr. G. Goel, Dr. P. Chokshi
Faculty Search Committee	Prof. Rajesh Khanna — Chairman Dr. Shalini Gupta — Member Dr. Gaurav GoeI — Member Prof. Anurag Singh Rathore — Member Dr. V.V. Buwa Member Dr. S. Mohanty — Member Prof. S. Roy — Convener
Curriculum Review Committee (UG/PG)	Prof. S K. Gupta — Chairman Prof A K Gupta — (Chairman, CRC) Prof. Anurag Singh Rathore — Member Dr. G. Goel— Member Dr. Shalini Gupta — Member Dr. Anupam Shukla— Member Prof. S. Roy — Convener
Dept. Research Committee (DRC)	Prof. S Basu — Chairman Prof. S.K. Gupta — (Chairman. CRC) Prof. Ratan Mohan — Member Prof. K. K. Pant — Member (Sec. DUGC. CRE Inch.) Dr. V. V. Buwa — Member (Coord. Ph.D.) Prof. S. Roy — Member (Corv. CRC. Previous DRC Sec.) Dr. M.A. Shaik — Member (Coord. BTP, PC Inch.) Dr. Sudip Pattanayek — Member (Coord. MTP) Dr. Jayati Sarkar — Member (Coord. Dual) Dr. Sreedevi U. — Member (UG Lab Inch.) Dr. Shailni Gupta — Member (Member, BPGS. DL Inch) Prof.. Anurag Singh Rathore -.Secretary

Dept. Undergraduate Committee (DUGC)	Prof. S. Basu — Chairman Dr. Jayati Sarkar.{Coord. MTP (Dual)} Dr. M.A Shaik (Coord. BTP) Dr. Anupam Shukla (Inch. Time Table) Dr. Sreedevi U. (Coord. UG Lab) Dr. Gaurav Goel (Member. BUGS) Prof. Anurag Singh Rathore (Previous Sec.. DUGC) Prof. A. K. Gupta (Member) Prof . K. K. Pant (Sec. DUGC)

Flexibility: A faculty can go on sabbatical in which case his/her work is shared by otherfaculty.

(b) Processes for curriculum planning.

- A departmental committee is made to look into the affair.
- An institute-level curriculum development workshop is held where the departmental committee puts across their ideas/needs.
- The required changes are then discussed in senate and minimum/maximum credits required are allotted for core courses, departmental and program electives.
- The departmental faculty board is then informed by the departmental committee about the requirements.
- Subgroups in the department are made based on expertise to develop different parts of the course.
- The reformed course structure gets approved by senate before implementation.

(c) Processes and methods for teaching resources management.

The faculties manage their own course files. They also use institute's online academic management and infrastructure SLA system for giving grades/marks, marking attendance, to get student feedback and get linked to sakai to share teaching resources with students.

(d) Guest faculty, affiliation for teaching core, elective UG & PG courses.

There is seldom any guest faculty who is invited to take courses. Guests in their specified field of specialization are, however, often called for giving seminars, invited talks and to evaluate MTP and PhD theses.

(e) Faculty short-listing criteria.

Minimum qualifications and Experience prescribed in the Advertisement	Criteria used for short listing
PROF./ASSOC. PROF./ASSTT. PROF.: A Ph. D. with first class or equivalent grade at the preceding degree in an appropriate branch /discipline with a very good academic record throughout. **PROFESSOR:** Minimum 10 Years Teaching/ Research/ Industrial experience of which at least 4 years should be at the level of Associate Professor in IITs. IISc Bangalore. IIMs, NITIE Mumbai and IISERs or at an equivalent level in any such other Indian or foreign institution/institutions of comparable standards. **ASSOCIATE PROFESSOR:** Minimum 6 years Teaching /Research/Industrial experience of which at least 3 years should be at the level of Assistant Prof. or equivalent. **ASSISTANT PROFESSOR:** At least three years Teaching/Research/Industrial experience excluding however, the experience gained while pursuing Ph.D. **NOTE:** Fresh Ph.D.s or candidates having less experience can also apply However, they will normally be considered for Assistant Professor on contract in the Pay Band-3. (such selected candidates will be eligible to be considered for a regular /tenured position once they obtain three years experience)	As per criteria enclosed.

Short-listing criteria used by department

It is certified that:
(a) the above has the concurrence of the short-listing committee of the department,
(b) none of the applicants who fulfills the short-listing criteria has been rejected.
(c) further, the short-listing criteria used to arrive at the above short-listing is the institute-level short-listing criteria, suitably enhanced with additional criteria for this particular department

Institute-level short-listing criteria:

Minimum Short-listing Criteria for an Assistant Professor:

- Ph.D. with three years experience (excluding the experience gained while pursuing Ph.D.), and
- lst class or equivalent grade in all degrees in respective discipline, with a consistently good academic record, and
- Potential for very good teaching,

- Maximum age is 35 years (to be relaxed by 5 years in case of person with physical disability. SC and ST), and
- At least 4 publications/ refereed conference/journal papers (of which at least 2 should be in reputed journals).

Minimum Short-listing Criteria for an Associate Professor:

- Ph.D. with 6 years experience (excluding the experience gained while pursuing Ph.D.) of which at least 3 years should be as Assistant Professor or equivalent and
- 1st class or equivalent grade in all degrees in respective discipline, with a consistently good academic record.
- Should have demonstrated capability for good teaching.
- At least 10 publications/refereed conference/journal papers (of which at least 4 should be in reputed journals), and
- Should have guided at least one Ph.D. student, possibly jointly with another faculty/researcher, (This criteria is relaxed in 2012 selection) and
- Completed at least one sponsored R&D or consulting project as a PI..or completed two sponsored R&D or consulting project as a co-PI.

Minimum Short-listing Criteria for a Professor:

- Ph.D. with 10 years experience (excluding the experience gained while pursuing Ph.D.) of which either.
- At least 4 years should be as Associate Professor or equivalent, or
- At least 8 years should be as Assistant Professor or equivalent (in case of Institutions where the post of Associate Professor or equivalent does not exist), and
- First class or equivalent grade in all degrees in respective discipline, with a consistently good academic record,
- Should have demonstrated excellence in teaching.
- At least 20 publications (of which at least 8 should be in reputed journals), and
- Should have guided independently at least one Ph.D. student, or have guided at least two Ph.D. students jointly with other faculty/researchers, and
- Completed: One sponsored R&D or consulting project as a PI, and One more sponsored R&D or consulting project as a PI, or two sponsored R&D or consulting projects as a co-PI.

Note:In case of exceptionally outstanding candidates on some fronts, criteria in some other front(s) may be relaxed and justified by the Short-listing Committee.

(f) How collectiveness of the faculty has enhanced academic output and enhanced quality, etc.

The faculties according to their areas of specialization are clubbed in different groups as shown in the table below and there are several occasions where people have joint projects/papers inside the groups and outside as well. Inter-departmental discussions, joint projects are also there. Also through MTP project evaluation and Ph.D. SRC committee formation, the group members interact and help to enhance the quality of research going on in the department. In section 3 (research) part of the document more information on number of collaborative projects, papers written together in the last 5 years can be found

Energy/Fuel cells/Catalysis	ANB, SB, KKP,SDU,AS,MAH
Complex fluids/ Rheology/ Molecular scale modeling &Simulations	SKP, RK, JS, ANB, PC, GG
Advanced materials/membranes	AS, SKP, SM, SKG, BPM
Multi phase flow / reactors, process Engineering/optimization	KDPN, RM, SR. VVB, MAS, JP
Environment/Waste management	AKS, ANB, AKG
Biosciences/Pharmaceuticals/Drug delivery	ASR, SM, SG, GG, SKP

(g) Nature, quantum and quality of support from of secretarial staff, stores and inventory management, purchases, ambience, etc.

There are several staff members who help the department. Some of the posts and the implicit nature of work involved are as mentioned below:

1. Secretary to HOD
2. Jr. superintendant,
3. ChE front office,
4. Attendant, ChE front office
5. Library incharge,
6. Store superintendant,
7. Biomass lab incharge,
8. Biomass lab attendant,
9. Reaction Engineering and & Process Control lab incharge,
10. Design lab incharge,
11. UG Lab incharge,
12. UG Lab attendant,
13. Workshop incharge,

14. Workshop attendant,
15. Senior lab assistant, PG lab,
16. Jr. mechanic, PSL

7.3 Faculty

(a) Faculty profile and a critique of the same.

At present the Department has 22 regular faculty members and 3 Emeritus Professors. There is a mix of 9 Professors, 6 Associate Professors and 7 Assistant Professors in the regular members. The expertise of the faculty can be broadly classified into four areas viz., (i) Energy and environment, (ii) Process engineering, modeling and optimization, (iii) Complex fluids and materials and (iv) Biopharmaceuticals and fine chemicals. As can be seen from the relevant sections of the present document, faculty members actively engage into fundamental as well as applied research. Despite the rich diversity in faculty profiles, highlighted in the following section, there still remain some gaps in terms of skills especially in the area of process control.

(b) Diversity in faculty profile by: (i) gender, (ii) category, (iii) region, (iv) Ph.D. in-situation, (v) post-doctoral institutions worked in, (vi) organizations/industry worked in and (vii) employment prior to joining the department.

- Gender: 21 males and 4 females
- Category: 24 general and 1 reserved
- Region: 9 central, 5 north, 3 south, 4 east, 4 west
- Ph.D. Institution: 16 from IIT/IISC and 9 from US
- Post-doctoral institute: 17 Abroad
- Industrial experience: 7
- Prior employment: 5 in academics, 7 in industry

(c) Procedure for faculty searches

There are three routes by which the Department tries to search and attract new faculty.

- Department aggressively seeks young and fresh Ph.D.s around the world through its faculty members and their contacts.
- Interested candidates contact the HOD or any other faculty member directly. Such enquires are cultivated swiftly by the HOD and FSC with the help of other faculty members.
- Through regular and rolling Advertisements.

Faculty members try to highlight the Department and its activities at all available forums. The Department also maintains a highly visible and informative website to attract the prospective faculty aspirants. The procedure to select a faculty member through all the routes remains the same

Procedure

As per the Statutes of the institute, all faculty posts at the Institute are normally filled through advertisement. However, the BOG has the power to decide, on the recommendations of the Director, that a particular post be filled by invitation or by promotion from amongst the members of the staff of the Institute. In all these cases, appointments are made by the BOG on the recommendations of the Selection Committee constituted for the purpose. In the case of appointments to reserved posts, the relevant reservation rules apply. The advertisement is drafted to include the following:

- Designation of the post sought to be filled.
- Area in which recruitment is contemplated.
- Pay scale attached to the post and allowances.
- Minimum qualifications expected of the candidates.
- Additional/desirable qualifications, if any.
- Previous experience required, with the type of experience, duration etc.
- Prescribed age.
- Relaxation of age, qualifications and experience if any.
- Mode of collecting forms of application from the Institute by the intending candidates.
- Last date for receiving requests for application forms from intending candidates.
- Last date for the receipt at the Institute, of filled and completed applications from candidates.

When any post is reserved for candidates belonging to the Scheduled Castes/Scheduled Tribes/OBC, this fact is specifically mentioned in the advertisement. Candidates in the service of Government or Quasi-Government or Govt. aided Institutions including Universities, are expected to send their applications through proper channel or furnish a certificate from the employer that they have no objection to their applications being considered. The advertisement is released in such a way that all the regions of the country are covered. A panel of such newspapers is approved by the Director from time to time. In special cases, the Director may decide that additional coverage be provided by advertising the posts abroad and/or in scientific journals. The Institute also has rolling advertisement for the post of Assistant Professor in its various academic Departments/Centres. Prospective candidates can apply any time throughout the year. Based on the need of the department/Centre concerned, efforts are made to take a decision at the earliest.

The processing of applications is done in accordance with Statutes of the institute. Applications received in the Establishment (E-1) Section by the due date prescribed, are registered in a register kept for the purpose and entered in the ACSS System. All the applications received are then forwarded to the Head of the Department for his preliminary scrutiny and advice to the Chairman Selection Committee regarding the candidates who are shortlisted and could be invited for test/interview by the Selection Committee for the post. The applications undergo the shortlisting criteria check. The shortlisted applications are forwarded to Faculty Search Committee (FSC) of the Department. The FSC is a mix of Faculty members who represent the spectrum of available Chemical Engineering fields in the Department. The FSC critically evaluates the application with respect to the publications/patents/technology development and alignment with the departments requirement. The recommendations of FSC are conveyed to Professorial Committee (COP) of the Department which then takes a decision on further progress of the applications. Shortlisted candidates are then invited for interaction with the Department. This is preferably in the form of a one-day visit to the Department. FSC coordinates this visit by arranging many one-to-one meetings with the current faculty members and a seminar by the candidate. The seminar is attended by the faculty members. Each member is asked to provide a feed-back about the candidate's suitability for selection to the HOD. Based on these inputs and experience of the one-to-one meetings, FSC prepares a recommendation for the COP. The COP thoroughly deliberates on each application and arrives at a recommendation which is conveyed to the Head of Department. The HOD gets the applications discussed by the COP before sending his advice to the Chairman Selection Committee.

In case of Professor, the selection committee consists of

- Director (Chairman).
- One Visitor's nominee (member).
- Two nominees of the Board, one being an expert but other than a member of the Board (members).
- One expert nominated by the Senate other than being a member of the Senate (member).

In case of Assistant and Associate Professors, the selection committee consists of

- Director (Chairman).
- Two nominees of the Board, one being an expert but other than a member of the Board (members).
- One expert nominated by the Senate other than being a member of the Senate (member).
- Head of the Department (member).
- The Institute may have one member of the Board and one expert from the approved list against two nominees of the Board on the Selection Committees or both the experts as nominees of the Board from the approved list in case local member of the Board is not available. The nominees of the Board are approved by BOG from time to time, normally

for a period of two years. SC/ST/OBC representative will also be included as a member of the Selection Committee if the post is reserved for SC/ST/OBC etc.

The meeting of the Selection Committee is fixed by the Chairman of the Committee. A copy of the advertisement and particulars of all the candidates called for interview are forwarded to each member of the Selection Committee. The Selection Committee interviews the candidates called therefore. It considers the credentials of all the persons who have applied and also considers names if any suggested by members or otherwise brought to its notice. The Selection Committee thereafter makes its recommendations, the names of selected candidates being arranged in the order of merit. The Selection Committee also suggests the starting salary in the grade in each case. The Chairman, BOG looks at the recommendations of the selection committee and takes the final decision. Offers of appointment are issued on approval of the Chairman, BOG. The offer of appointment indicates the salary offered, the rates of allowances, the duration of the appointment and other terms and conditions of service as applicable from time to time, and prescribes the date by which acceptance of offer is to be communicated by the candidate. A candidate who is offered an appointment in the Institute should join within three months, if in India; and within six months, if abroad, from the date of the offer. However, Director may extend the joining time on request, up to six months from candidates in India; and one year for candidates abroad. The candidate is directed to get himself examined for physical fitness by the prescribed Medical authority. On production of a satisfactory certificate of physical fitness, the offer of appointment becomes operative.

(d) Result of faculty searches- area-wise (as in Annexure IV), number of applicants, shortlisted and offered a position, their educational qualifications & experience

There has always been a good response to faculty advertisements and rolling advertisements. All shortlisted candidates satisfy the shortlisting criteria (given in section 7.2). Advertisement wise responses are listed here. Response with respect to post applied for is listed first followed by those of with respect to area. Many applicants as well as currently serving faculty members would fall into multiple areas.

Advt.	Post	Applied	Shortlisted	Offered
2013*	Assistant Professor	27	5	1
1/2012	Professor	5	3	3
1/2012	Associate Professor	7	2	2
1/2012	Assistant Professor	0	0	0
3/2010	Professor	4	3	3
3/2010	Associate Professor	6	2	2

3/2010	Assistant Professor	0	0	0
1/2010	Professor	4	0	0
1/2010	Associate Professor	19	3	2
1/2010	Assistant Professor	73	5	5

* : Special drive for OBC/SC/ST

Advt. Area: Energy and Environment

2013*	Assistant Professor	9	0	0
1/2012	Professor	1	1	1
1/2012	Associate Professor	2	0	0
1/2012	Assistant Professor	0	0	0
3/2010	Professor	2	1	1
3/2010	Associate Professor	1	1	1
3/2010	Assistant Professor	0	0	0
1/2010	Professor	0	0	0
1/2010	Associate Professor	8	1	1
1/2010	Assistant Professor	22	2	2

* Special drive for OBC/SC/ST

Advt. Area: Process Engineering, Modelling and Optimiation

2013*	Assistant Professor	12	1	1
1/2012	Professor	3	1	1
1/2012	Associate Professor	4	1	1
1/2012	Assistant Professor	0	0	0
3/2010	Professor	4	3	3
3/2010	Associate Professor	3	2	2
3/2010	Assistant Professor	0	0	0
1/2010	Professor	2	0	0
1/2010	Associate Professor	12	3	3
1/2010	Assistant Professor	27	1	1

* Special drive for OBC/SC/ST

Advt. Area: Complex Fluids and materials

2013*	Assistant Professor	8	0	0
1/2012	Professor	3	2	1
1/2012	Associate Professor	3	1	1
1/2012	Assistant Professor	0	0	0
3/2010	Professor	2	2	2
3/2010	Associate Professor	3	1	1
3/2010	Assistant Professor	0	0	0
1/2010	Professor	2	0	0
1/2010	Associate Professor	6	2	2
1/2010	Assistant Professor	28	3	3

* Special drive for OBC/SC/ST

Advt.	Area: Biopharmaceuticals and Fine Chemicals			
2013*	Assistant Professor	3	0	1
1/2012	Professor	3	1	1
1/2012	Associate Professor	0	0	0
1/2012	Assistant Professor	0	0	0
3/2010	Professor	1	0	0
3/2010	Associate Professor	0	0	0
3/2010	Assistant Professor	4	0	0
1/2010	Professor	0	0	0
1/2010	Associate Professor	4	1	1
1/2010	Assistant Professor	14	3	3

* Special drive for OBC/SC/ST

(e) Success in recruitment (data for last 5 years), and offers that the person had from other IITs/IISc/TIFR.

In the last five years we have been able to attract 2 new Associate Professors and 6 new Assistant Professors. Most of them had offers from multiple IITS. In addition some of existing faculty members also got promoted to higher level.

(f) Faculty lost to other institutions post selection.

Two, namely Dr. Supreet Saini joined IIT Gandhinagar and Dr. Ravikant Pathak joined IIT Kanpur.

(g) Faculty time utilization – in class, in meetings, project management, Ph.D. guidance, Masters project guidance, UG project guidance.

At this time, on average faculty spends 20% of their time teaching core courses, 20% on teaching elective courses, 10% on laboratory or similar courses, 20% on administrative matters, 10% on UG/PG project guidance and 20% on PhD research guidance. In future, as we continue to improve faculty strength, we hope to reduce the faculty load from teaching and administration and increase the focus on PhD research guidance. One possible outcome could be - 10% on teaching core courses, 10% on teaching elective courses, 10% on laboratory or similar courses, 10% on administrative matters, 10% on UG/PG project guidance and 50% on PhD research guidance. With increased faculty strength we also hope to be more liberal in allowing faculty to take sabbaticals or no-teaching semesters.

(h) Level of harmony among department faculty.

At a professional level there is a very high degree of cooperation among faculty members. This ranges from sharing research scholars, laboratory space in groups of two, courses and tutorials to working on joint projects and publications. Most of the activities of the departments are run through identified groups of faculty members who work harmoniously. There is a coffee-club where faculty members meet to have informal discussions over a cup of coffee/tea.

At a personal level, the faculty members are very close to each other and occasions such as marriages are celebrated with great common joy and gaity. It is not uncommon for faculty members to share their happiness by inviting other members for get-togethers from time to time. Many Faculty members continue with the departmental bonds by opting for their post-retirement homes in common housing societies.

7.4 Students

(a) Criteria for short-listing and selecting students for admission to Master's and Ph.D. programmes in the past 5 years.

M.Tech

YEAR	DIRECT (Regular)					INTERVIEW (Regular)			INTERVIEW (Part Time)
2009 (May)			OBC	GEN	PH /SC /ST	OBC	GEN	PH /SC /ST	For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 1 year experience (as on August 1, 2009) will be required of all part-time candidates, as required by Institute regulations
	BE/ BTECH /DUAL	% Marks	75	75	70	60	60	55	
		CGPA	8.5	8.5	7.5	6.75	6.75	6.25	
		GATE	488	525	427	460	465	400	
	Or IIT BTech without GATE score	CGPA				8	8	8	
YEAR	DIRECT (Regular)					INTERVIEW (Regular)			INTERVIEW (Part Time)
2010 (May)			OBC	GEN	PH /SC /ST	OBC	GEN	PH /SC /ST	For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 1 year experience (as on August 1, 2010) will be required of all part-time candidates, as required by Institute regulations.
	BE/BTECH /DUAL	% Marks	75	75	70	60	60	55	
		CGPA	8.5	8.5	7.5	6.75	6.75	6.25	
		GATE	559	638	529	483	509	350	
	Or IIT BTech without GATE score	CGPA				8	8	8	

M.Tech

<table>
<tr><td>YEAR</td><td colspan="5">DIRECT (Regular)</td><td colspan="3">INTERVIEW (Regular)</td><td>INTERVIEW (Part Time)</td></tr>
<tr><td rowspan="6">2011</td><td></td><td></td><td>OBC</td><td>GEN</td><td>PH /SC /ST</td><td>OBC</td><td>GEN</td><td>PH /SC /ST</td><td rowspan="6">For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 1 year experience (as on August 1, 2011) will be required of all part-time candidates, as required by Institute regulations. NOC should be provided from the employer</td></tr>
<tr><td rowspan="4">BE/ BTECH /DUAL</td><td>% Marks</td><td>75</td><td>75</td><td>70</td><td>60</td><td>60</td><td>55</td></tr>
<tr><td>CGPA</td><td>8.5</td><td>8.5</td><td>7.5</td><td>6.75</td><td>6.75</td><td>6.25</td></tr>
<tr><td rowspan="2">GATE</td><td rowspan="2">552</td><td rowspan="2">615</td><td rowspan="2">500</td><td rowspan="2">480</td><td rowspan="2">496</td><td>403 (SC)</td></tr>
<tr><td>344 (ST)</td></tr>
<tr><td>Or IIT BTech without GATE score</td><td>CGPA</td><td></td><td></td><td></td><td>8</td><td>8</td><td>8</td></tr>
<tr><td>YEAR</td><td colspan="5">DIRECT (Regular)</td><td colspan="3">INTERVIEW (Regular)</td><td>INTERVIEW (Part Time)</td></tr>
<tr><td rowspan="7">2012</td><td rowspan="6">BE/ BTECH /DUAL</td><td></td><td>OBC</td><td>GEN</td><td>PH /SC /ST</td><td>OBC</td><td>GEN</td><td>PH/SC/ST</td><td rowspan="7">For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 1 year experience (as on August 1, 2012) will be required of all part-time candidates, as required by Institute regulations. NOC should be provided from the employer</td></tr>
<tr><td>% Marks</td><td></td><td></td><td></td><td>65</td><td>65</td><td>60</td></tr>
<tr><td>CGPA</td><td></td><td></td><td></td><td>7.5</td><td>7.5</td><td>6.75</td></tr>
<tr><td rowspan="2">GATE</td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2"></td><td rowspan="2">415</td><td rowspan="2">468</td><td>359 (SC/ PH)</td></tr>
<tr><td>309 (ST)</td></tr>
<tr><td>Or IIT BTech without GATE score</td><td>CGPA</td><td></td><td></td><td></td><td>8</td><td>8</td><td>8</td></tr>
</table>

M.Tech

YEAR	DIRECT (Regular)					INTERVIEW (Regular)			INTERVIEW (Part Time)
2013	BE/ BTECH/ DUAL		OBC	GEN	PH /SC /ST	OBC	GEN	PH /SC /ST	Same rules hold good as for regular Interview candidates, only GATE score is not required. 1 yrs and NOC/sponsorship certificate from the employer during interview; employee of PSU, Govt Dep. or R&D or Private Industries (approved by faculty boards) located within 50 KMs radius of IITD will be considered.
		% Marks	75	75	70	70	70	65	
		CGPA	8.5	8.5	7.5	7.5	7.5	7.5	
		GATE	500	525	450	450	400	400	
	Or IIT BTech without GATE score	CGPA	8	8	8	8	8	8	

MSR

YEAR	INTERVIEW (Regular)					INTERVIEW (Part Time)
2008 (May)			OBC	GEN	PH /SC /ST	No specific criteria mentioned
	BTECH /BE	% Marks	60	67	55	
		CGPA	6.1	7.0	6.0	
		GATE	315	350	300	
YEAR	INTERVIEW (Regular)					INTERVIEW (Part Time)
2008 (Dec)			OBC	GEN	PH /SC /ST	No specific criteria mentioned
	BTECH /BE	% Marks	60	63	55	
		CGPA	6.75	7.2	6.25	
		GATE	315	350	300	

MSR

YEAR	INTERVIEW (Regular)					INTERVIEW (Part Time)
2009 (Dec)			OBC	GEN	PH /SC /ST	For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 1 year experience (as on Jan 1, 2010) will be required of all part-time candidates, as required by Institute regulations.
	MSC	% Marks	60	60	55	
		CGPA	6.75	6.75	6.25	
		GATE	460	465	400	
	BTECH / BE	% Marks	60	60	55	
		CGPA	6.75	6.75	6.25	
		GATE	460	465	400	
	IIT BTech without GATE score	CGPA	8	8	8	

YEAR	INTERVIEW (Regular)					INTERVIEW (Part Time)
2010 (May)			OBC	GEN	PH /SC /ST	For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 1 year experience (as on August 1, 2010) will be required of all part-time candidates, as required by Institute regulations.
	BTECH / BE	% Marks	60	60	55	
		CGPA	6.75	6.75	6.25	
		GATE	387	463	340	
	IIT BTech without GATE score	CGPA	8	8	8	

MSR

<table>
<tr><td>YEAR</td><td colspan="5">INTERVIEW (Regular)</td><td>INTERVIEW (Part Time)</td></tr>
<tr><td rowspan="5">2010 (Dec)</td><td></td><td></td><td>OBC</td><td>GEN</td><td>PH /SC /ST</td><td rowspan="5">For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 1 year experience (as on December 1, 2010) will be required of all part-time candidates, as required by Institute regulations.</td></tr>
<tr><td rowspan="3">BTECH / BE</td><td>% Marks</td><td>60</td><td>60</td><td>55</td></tr>
<tr><td>CGPA</td><td>6.75</td><td>6.75</td><td>6.25</td></tr>
<tr><td>GATE</td><td>300</td><td>300</td><td>200</td></tr>
<tr><td>IIT BTech without GATE score</td><td>CGPA</td><td>8</td><td>8</td><td>8</td></tr>
<tr><td>YEAR</td><td colspan="5">INTERVIEW (Regular)</td><td>INTERVIEW (Part Time)</td></tr>
<tr><td rowspan="5">2011 (May)</td><td></td><td></td><td>OBC</td><td>GEN</td><td>PH /SC /ST</td><td rowspan="5">For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 1 year experience (as on August 1, 2011) will be required of all part-time candidates, as required by Institute regulations.</td></tr>
<tr><td rowspan="3">BTECH / BE</td><td>% Marks</td><td>60</td><td>60</td><td>55</td></tr>
<tr><td>CGPA</td><td>6.75</td><td>6.75</td><td>6.25</td></tr>
<tr><td>GATE</td><td>412</td><td>460</td><td>395</td></tr>
<tr><td>IIT BTech without GATE score</td><td>CGPA</td><td>8</td><td>8</td><td>8</td></tr>
<tr><td>YEAR</td><td colspan="5">INTERVIEW (Regular)</td><td>INTERVIEW (Part Time)</td></tr>
<tr><td rowspan="5">2011 (Dec)</td><td></td><td></td><td>OBC</td><td>GEN</td><td>PH /SC /ST</td><td rowspan="5">For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 1 year experience (as on January 1, 2012) will be required of all part-time candidates, as required by Institute regulations.</td></tr>
<tr><td rowspan="3">BTECH / BE</td><td>% Marks</td><td>60</td><td>60</td><td>55</td></tr>
<tr><td>CGPA</td><td>6.75</td><td>6.75</td><td>6.25</td></tr>
<tr><td>GATE</td><td>412</td><td>460</td><td>395</td></tr>
<tr><td>IIT BTech without GATE score</td><td>CGPA</td><td>8</td><td>8</td><td>8</td></tr>
</table>

MSR

<table>
<tr><td>YEAR</td><td colspan="5">INTERVIEW (Regular)</td><td>INTERVIEW (Part Time)</td></tr>
<tr><td rowspan="5">2012 (May)</td><td></td><td></td><td>OBC</td><td>GEN</td><td>PH /SC /ST</td><td rowspan="5">For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 1 year experience (as on August 1, 2012) will be required of all part-time candidates, as required by Institute regulations.NOC should be provided from employer.</td></tr>
<tr><td rowspan="3">BTECH / BE</td><td>% Marks</td><td>65</td><td>65</td><td>60</td></tr>
<tr><td>CGPA</td><td>7.5</td><td>7.5</td><td>6.75</td></tr>
<tr><td>GATE</td><td>400</td><td>450</td><td>350 (SC /PH) 300 (ST)</td></tr>
<tr><td>IIT BTech without GATE score</td><td>CGPA</td><td>8</td><td>8</td><td>8</td></tr>
<tr><td>YEAR</td><td colspan="5">INTERVIEW (Regular)</td><td>INTERVIEW (Part Time)</td></tr>
<tr><td rowspan="5">2012 (Dec)</td><td></td><td></td><td>OBC</td><td>GEN</td><td>PH /SC /ST</td><td rowspan="5">For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 1 year experience (as on January 1, 2013) will be required of all part-time candidates, as required by Institute regulations.</td></tr>
<tr><td rowspan="3">BTECH / BE /MSc</td><td>% Marks</td><td>65</td><td>65</td><td>60 (SC) 65 (ST /PH)</td></tr>
<tr><td>CGPA</td><td>7.5</td><td>7.5</td><td>6.75</td></tr>
<tr><td>GATE</td><td>400</td><td>450</td><td>350 (SC /PH) 300 (ST)</td></tr>
</table>

MSR

YEAR	Direct (Regular)							Interview (Regular)				
2013			OBC	GEN	PH	SC	ST	OBC	GEN	PH	SC	ST
	BE/ BTECH/ DUAL	% Marks	75	75	70	70	70	65	65	60	60	60
		CGPA	8.5	8.5	7.5	7.5	7.5	7.5	7.5	6.75	6.75	6.25
		GATE	500	525	450	450	400	400	450	300	300	285
	Or IIT BTech without GATE score	CGPA	8	8	8	8	8	8	8	8	8	8
	Part Time (Interview): Same rules for regular interview candidates, only GATE score is not required.1 yrs and NOC/sponsorship certificate from the employer during interview; employee of PSU, Govt. Dep. or R&D or Private Industries (approved by faculty boards) located within 50 KMs radius of IITD will be considered.											

Ph.D.

YEAR	INTERVIEW (Regular)					INTERVIEW (Part Time)
2008 (May)			OBC	GEN	PH/SC/ST	No specific criteria mentioned
	MTECH	% Marks	60	63	55	
		CGPA	6.75	7.2	6.25	
	MSC	% Marks	60	63	55	
		CGPA	6.75	7.25	6.25	
		GATE	300	430	200	
		(OR NET, CSIR, ,UGC)				
	BTECH	% Marks	70	75	60	
		CGPA	7.5	8.0	6.4	
		GATE	400	450	360	
	IIT BTech	% Marks	70	76	64	
		CGPA	8.0	8.25	7.25	
YEAR	INTERVIEW (Regular)					INTERVIEW (Part Time)
2008 (Dec)			OBC	GEN	PH/SC/ST	No specific criteria mentioned
	MTECH	% Marks	60	63	55	
		CGPA	6.75	7.2	6.25	
	MSC	% Marks	60	63	55	
		CGPA	6.75	7.2	6.25	
		GATE	300	430(OR NET, CSIR, ,UGC)	200	
	BTECH	% Marks	70	75	60	
		CGPA	7.5	8	6.75	
		GATE	400	450	360	
	IIT BTech	% Marks	70	75	63	
		CGPA	7.5	8	7.2	

Ph.D.

YEAR	INTERVIEW (Regular)					INTERVIEW (Part Time)
2009 (May) (Sep)			OBC	GEN	PH/SC/ST	For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 2 year experience (as on August 1, 2009) will be required of all part-time candidates, as required by Institute regulations.
	MTECH	% Marks	65	70	60	
		CGPA	7.25	7.5	6.75	
	MSC	% Marks	65	70	60	
		CGPA	7.25	7.5	6.75	
		GATE	400	450	300	
	BTECH	% Marks	75	80	65	
		CGPA	8	8.25	7.25	
		GATE	440	470	400	
	IIT BTech without GATE score	CGPA	8	8.25	8	
(Sep) only	M. Pharma	% Marks	55	60	50	
YEAR	INTERVIEW (Regular)					INTERVIEW (Part Time)
2009 (Dec)			OBC	GEN	PH/SC/ST	For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 2 year experience (as on Jan 1, 2010) will be required of all part-time candidates, as required by Institute regulations.
	MTECH	% Marks	65	70	60	
		CGPA	7.25	7.5	6.75	
	MSC	% Marks	65	70	60	
		CGPA	7.25	7.5	6.75	
		GATE	400	450	300	
	BTECH	% Marks	75	80	65	
		CGPA	8	8.25	7.25	
		GATE	440	470	400	
	IIT BTech without GATE score	CGPA	8	8.25	8	
	M. Pharma	% Marks	55	60	50	

Ph.D.

YEAR	INTERVIEW (Regular)					INTERVIEW (Part Time)
2010 (May)			OBC	GEN	PH/SC/ST	For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 2 year experience (as on May 1, 2010) will be required of all part-time candidates, as required by Institute regulations.
	MTECH	% Marks	65	70	60	
		CGPA	7.25	7.5	6.75	
	MSC	% Marks	65	70	60	
		CGPA	7.25	7.5	6.75	
		GATE	400	450	300	
	BTECH	% Marks	75	80	65	
		CGPA	8	8.25	7.25	
		GATE	440	470	400	
	IIT BTech without GATE score	CGPA	8	8.25	8	
	M. Pharma	% Marks	55	60	50	
YEAR	INTERVIEW (Regular)					INTERVIEW (Part Time)
2010 (Dec)			OBC	GEN	PH/SC/ST	For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 2 year experience (as on Dec 1, 2010) will be required of all part-time candidates, as required by Institute regulations.
	MTECH	% Marks	60	60	55	
		CGPA	6.75	6.75	6.25	
	MSC	% Marks	60	60	55	
		CGPA	6.75	6.75	6.25	
		GATE	300	300	200	
	BTECH	% Marks	70	70	65	
		CGPA	7.5	7.5	7	
		GATE	440	470	400	
	IIT BTech without GATE score	CGPA	8	8	8	
	M. Pharma	% Marks	60	60	55	

Ph.D.

YEAR	INTERVIEW (Regular)					INTERVIEW (Part Time)
2011 (May)			OBC	GEN	PH/SC/ST	For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 2 year experience (as on June 1, 2011) will be required of all part-time candidates, as required by Institute regulations.
	MTECH	% Marks	60	60	55	
		CGPA	6.75	6.75	6.25	
	MSC	% Marks	60	60	55	
		CGPA	6.75	6.75	6.25	
		GATE	300	300	200	
	BTECH	% Marks	70	70	65	
		CGPA	7.5	7.5	7	
		GATE	440	470	400	
	IIT BTech without GATE score	CGPA	8	8	7.5	
	M. Pharma	% Marks	60	60	55	
YEAR	INTERVIEW (Regular)					INTERVIEW (Part Time)
2011 (Dec)			OBC	GEN	PH/SC/ST	For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 2 year experience (as on December 1, 2011) will be required of all part-time candidates, as required by Institute regulations.
	MTECH	% Marks	60	60	55	
		CGPA	6.75	6.75	6.25	
	MSC	% Marks	60	60	55	
		CGPA	6.75	6.75	6.25	
		GATE	270	300	200	
	BTECH	% Marks	70	70	65	
		CGPA	7.5	7.5	7	
		GATE	440	470	400	
	IIT BTech without GATE score	CGPA	8	8	7.5	
	M. Pharma	% Marks	60	60	55	

Ph.D.

<table>
<tr><td>YEAR</td><td colspan="5">INTERVIEW (Regular)</td><td>INTERVIEW (Part Time)</td></tr>
<tr><td rowspan="11">2012 (May)</td><td></td><td></td><td>OBC</td><td>GEN</td><td>PH/SC/ST</td><td rowspan="11">For part-time candidates, same criteria as above are proposed except that requirement of national qualifying examination (like GATE) is waived. Minimum 2 year experience (as on May1, 2012) will be required of all part-time candidates, as required by Institute regulations.</td></tr>
<tr><td rowspan="2">MTECH</td><td>% Marks</td><td>60</td><td>60</td><td>55</td></tr>
<tr><td>CGPA</td><td>6.75</td><td>6.75</td><td>6.25</td></tr>
<tr><td rowspan="3">MSC</td><td>% Marks</td><td>60</td><td>60</td><td>55</td></tr>
<tr><td>CGPA</td><td>6.75</td><td>6.75</td><td>6.25</td></tr>
<tr><td>GATE</td><td>270</td><td>300</td><td>200</td></tr>
<tr><td rowspan="3">BTECH</td><td>% Marks</td><td>70</td><td>70</td><td>65</td></tr>
<tr><td>CGPA</td><td>7.5</td><td>7.5</td><td>7</td></tr>
<tr><td>GATE</td><td>440</td><td>470</td><td>400</td></tr>
<tr><td>IIT BTech without GATE score</td><td>CGPA</td><td>8</td><td>8</td><td>7.5</td></tr>
<tr><td>M. Pharma</td><td>% Marks</td><td>60</td><td>60</td><td>55</td></tr>
<tr><td>YEAR</td><td colspan="5">INTERVIEW (Regular)</td><td>INTERVIEW (Part Time)</td></tr>
<tr><td rowspan="11">2012 (Dec)</td><td></td><td></td><td>OBC</td><td>GEN</td><td>PH/SC/ST</td><td rowspan="11">Minimum 2 years experience (as on 1st January, 2013) will be required for all Part-time candidates, as required by the Institute. NOC should be provided from the employer.</td></tr>
<tr><td rowspan="2">MTECH/ME</td><td>% Marks</td><td>70</td><td>70</td><td>65</td></tr>
<tr><td>CGPA</td><td>7.5</td><td>7.5</td><td>7</td></tr>
<tr><td rowspan="3">MSC</td><td>% Marks</td><td>70</td><td>70</td><td>65</td></tr>
<tr><td>CGPA</td><td>7.5</td><td>7.5</td><td>7</td></tr>
<tr><td>GATE</td><td>330</td><td>330</td><td>200</td></tr>
<tr><td rowspan="3">BTECH/ BE</td><td>% Marks</td><td>70</td><td>70</td><td>65</td></tr>
<tr><td>CGPA</td><td>7.5</td><td>7.5</td><td>7</td></tr>
<tr><td>GATE</td><td>350</td><td>350</td><td>200</td></tr>
</table>

Ph.D.

YEAR	INTERVIEW (Regular)					INTERVIEW (Part Time)
2013 (May)			OBC	GEN	PH/SC/ST	
	MTECH/ ME	% Marks	70	70	65	
		CGPA	7.5	7.5	7	
	MSC	% Marks	65	65	60	
		CGPA	7	7	6.5	
		GATE	450	450	400	
	BTECH / BE	% Marks	70	70	65	
		CGPA	7.5	7.5	7	
		GATE	450	450	400	

(b) Facilities provided to students and their maintenance/management system.

A. Learning:
   1. Institute and departmental Library for referring books.
   2. Online resources like e-books, e-journals managed by central library

B. Research:
   1. Individual research laboratories of their own supervisors and that of other faculty members.
   2. PSL lab for computational purpose other than their own labs
   3. Special instruments laboratory ....(managed by ChE)
   4. Central instrumentation facilities

C. Staying: Hostel Facilities with internet access

(c) Mentoring seminars/sessions held for Ph.D. students for prospective facultycareers

The seminars delivered by prospective faculty candidates in front of all faculty members are open to all PhD students. In fact all seminars are open for Ph.D. students.

Section 8

BENCHMARKING

Executive Summary: Benchmarking

For benchmarking purposes we have chosen one good chemical engineering department from India (i.e. IIT Bombay) and one from abroad (i.e. Stanford University). The benchmarking is broadly done under three categories: curriculum, teaching and research based on several benchmarking parameters identified under these categories. The information from other institutes is collected from the data available in their websites and other sources from internet. The curriculum for UG, PG, and PhD programmes is more or less comparable in all the three institutes. The main difference is in the teaching and research environments. Generally, the student to teacher ratio is relatively higher in Indian Institutes (about 85) compared to abroad. The technical staff availability is limited (3 staff) at IIT Delhi. We are doing reasonably well in terms of sponsored research & consultancy projects. The total number of publications in the past 5 years is comparable across all the three departments (IITD: 648, IITB: 624, Stanford: 730). The number of publications per faculty per year is better for IITD compared to IITB, and both are lower compared to Stanford (IITD: 6.2, IITB: 3.2, Stanford: 11.2). However, there is a large difference in the average number of citations per department, where Stanford University has a bigger impact (IITD: 332, IITB: 290, Stanford: 4146). These conclusions are based on the limited data available from internet. We also tried contacting representatives from these two departments but did not receive any response. Our aim for next five years is to work towards making the Department of Chemical Engineering among the very best ranked Department of the Institute and among top two-three Chemical Engineering Departments of the country. It will also be our endeavor to consistently and substantially improve our position in Asia as well as in the global rankings of Chemical Engineering Departments.

For benchmarking purposes we have chosen one good institute from India, i.e. IIT Bombay, and one top institute from abroad, i.e. Stanford University, USA(QS rank 5). In the following three subsections we compare the performance of Department of Chemical Engineering, IIT Delhi against the other two departments from IIT Bombay and Stanford University. The benchmarking is broadly categorized into three parts based on comparison of (i) curriculum, (ii) teaching, and (ii) research. The comparison is done based on different parameters as listed out in the tables given under these three broad categories.

8.1. Benchmarking of Curriculum– for past 5 years

Benchmarking Parameters	**IIT Delhi**			**IIT Bombay**			**Stanford University (USA)**		
	UG	**PG**	**PhD**	**UG**	**PG**	**PhD**	**UG**	**PG**	**PhD**
Total credit requirement	180	60	6 for M. Tech and 20 for B. Tech. and M.Sc.	259/289	164	12 credits for M.Tech, 50 credits for B.Tech.	120-130	45	135 (including MS credits) of which min 45 in lecture coursework
Core credits	110	36	Adv Thermo, Adv TP Adv CRE	223/241	140	A.ChE background: TP, Thermo, Rxn Engg.,Maths Methods B. Others: Intro Chem.Engg.,Maths methods for biologists, Bio processing, Princ. Molec.Biology, Metabolism & Bioenergetics, Intro Bio-Maths, Maths Methods, Thermo, TP,	111-117	15	26

						Optimization, Multivar. Statistics			
Elective credits	70	24	-	36/48	24	-	13-19	30	19
Core credit as % of total credits	61.1	60	-	86.1/83.4	85	-	90	33.33	57.78
Comparison of core cores across institutions	See Curriculum section: 1.3 (c)	Adv. Thermo, Adv. TP, Adv. CRE, Proc. Engg.	Adv. Thermo, Adv. TP, Adv. CRE (either credit or audit)		Adv. TP, Math & Stat Methods, Adv. Rxn Engg., Adv. Thermo, Comp. Methods, Comm. Skills, Exper. Methods	-	Restricted choice of math courses, Quarterly system.	Any Four: Appl. Maths, Micro hydrodyn, Chem. Kin & RxnEngg., Molec. Thermo, Fund & appl. of Spectroscopy, Adv. BiochemEngg..	No info
No. of theory courses in core curriculum	24	4		27/30	7		30	4	
No. and nature of laboratories	8(4 from other departments, 3 credit Colloquium and industrial training compulsory)	0		11 (6 are from other departments two are design lab)	1		3 (teaching labs, total credits: 11)	0	

Thesis Requirements	One semester project (6 credits)+one semester optional(12 credits)	Two semester project (18 credits. In addition minor project of 4 credits)	Compulsory	NA/Elective	Two semester and summer (90 credits)	Compulsory	For honors degree	Optional (6 credits thesis of 6 credits course work)	Compulsory
Important differences with peers	Dual Degree offered additional 38 credits (one thesis of20 credits spread over twosemester. In addition a 4 credit project course)			Dual Degree offered additional 96 credits, 72 core credits, 72 credits project spread over two semesters)			1.Minor program, 2. Dual degree (named Coterrminal bachelor and master degree in ChemEngg.)		

8.2. Benchmarking of Teaching Environment (in past 5 years)

Benchmarking Parameters	**IIT Delhi**			**IIT Bombay**			**Stanford University (USA)**		
	UG	**PG**	**PhD**	**UG**	**PG**	**PhD**	**UG**	**PG**	**PhD**
Student-Teacher Ratio	83.25			No info			No info		
No. of Students graduated in each program	279	92	33	182	79	40	23(2009-2011)	19(2009-2011)	11(2009-2011)
Student-T.A Ratio	It depends on courses taken by students. Typically 24 students/TA			No info			No info		
No. of Skilled Staff	3			7			7		
Gross Lab Space (UG/PG teaching	11568 sqft	2304 sqft		No info			No info		

8.3. Benchmarking of Research (in past 5 years)

Benchmarking Parameters		IIT Delhi	IIT Bombay	Stanford University (USA)
No of Masters & Ph.D students supported	(i) by institute assistantship	35	Masters: 21 PhD: 47	No info
	(ii) on sponsored research projects /consultancies	31		
	(iii) other sources	25		
No. of Ph.D.s (per faculty)	(i) enrolled	4.45 (average)	2 (average)	No info
	(ii) graduated	1.25 (average)		
List of Research Areas		• Process Intensification/ Multiphase Reactor Engineering • Catalysis • Energy • Advanced materials • Process modeling & Optimization • Environment & Waste Management • Pharmaceutical Biotechnology • Complex Fluids/ Rheology • Process Intensification/ Multiphase Reactor Engineering	• Biological Systems Engineering • Energy & Environment • Interfacial Science and Engineering • Materials Engineering • Process Systems Engineering • Reactor Engineering • Transport Phenomena and Complex Fluids	• Bioengineering • Environment and Engineering • Information Technology • Nanoscience and Nanotechnology
Publications per faculty: average per year in past 5 years		6.17	3.2	11.23
Publications (journal & conference)	Total	648	624	730
	(i) Per Ph.D student	67.83		
	(ii)Per Masters student	10.23	No info	No info
	(iii) Per UG student	3.81		
Average citation per dept: total citations of all faculty since 2009 (for all papers) /no of faculty)		332.38 (from scopus)	290.15 (from scopus)	4146.4 (from scopus)

No of sponsored projects - with details per faculty	84 (all faculty members) Details already given in section 3.9	No info
No of industrial consultancies - with details per faculty	27 (all faculty members) Details already given in section 3.10	No info
No of large interdisciplinary projects	13 (all faculty members) Details already given in section 3.11	No info

Section 9

FEEDBACK SYSTEMS & RESULTS

Executive Summary: Feedback Systems & Results

The course feedback framework is an important mechanism in teaching at IIT Delhi and is set up to allow students to maintain anonymity while sharing their feedback about the course, the quality and clarity of presentation and knowledge of the instructor as well as the efficacy in support of learning. Feedback mechanisms are set up for all credited activities included lectures, labs and training processes. To help IIT Delhi and the faculty get most out of this feedback, multiple statistical correlation tools are available to allow study of the feedback by attendance, and performance by the students. Best teacher awards are presented every semester to faculty members on Institute foundation day based on this feedback on lecture courses.

In addition, feedback from the industries are also requested in all activities where they participate - including training and during recruitment. There is also a feedback from industry during the annual Alumni meet in the department, about the freshly recruited students in core sector industry.

On campus placement for UG, and Master's and PhD students were 100%, 97% and 100% averaged over the last 5 years.

9.1 & 9.2 System for feedback from UG & PG students and results

Teaching and Course evaluation for faculties:

The system for feedback of UG and PG students is the same. Students can turn in their feedback online. The faculty has to login at the following link: https://campus1.iitd.ac.in/hcmprod1/signon.html with their Kerberos ID and Password.

For navigation of teaching and course evaluation summary, please navigate to
"**Teaching and course evaluation→ feedback summary"**

Figure 9.1.1 Screenshot for faculty access of course feedback

The faculties can click on the search button to see all the courses and the course components taught by them. In addition to that they can filter these results based upon course type.
For each course component (lecture/tutorial/practical) there are three types of feedback summaries:

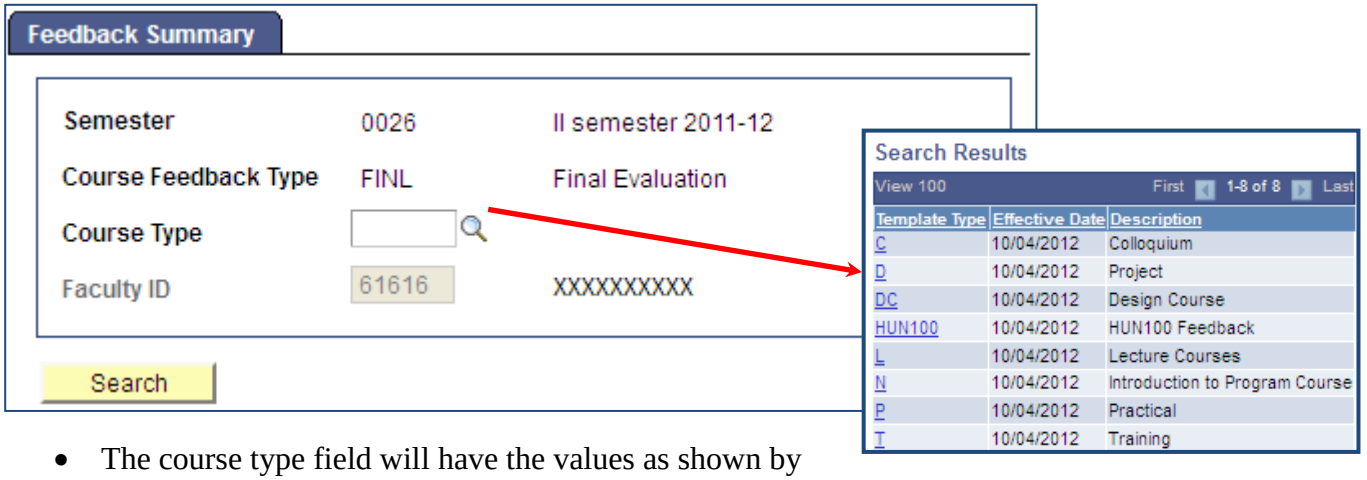
1. Feedback Summary (Based upon student enrollment).
2. Attendance Correlation Summary (Based upon student enrollment and consolidated student attendance entered in the system).
3. Grade Correlation Summary (Based upon student enrollment and the grades received by students in the system).

In addition to the faculty's own feedbacks, they can access the feedbacks that are declared as public. To access public feedbacks please navigate to
"**Teaching and course evaluation→ Public feedbacks"**
Note: Each summary opens in a new window, ***Please turn off your browser's pop up blocker in order to see the summary***. Please close the window after viewing the summary.

1. Feedback Summary

Navigation: Teaching and course evaluation → feedback summary

- The faculty will see the following page with his faculty ID and name.
- The faculty may select the course type to further filter.
- The faculty will click on the search button.



- The course type field will have the values as shown by the lookup.

Please note that if course type field is left blank then all the feedbacks of this faculty will be shown.

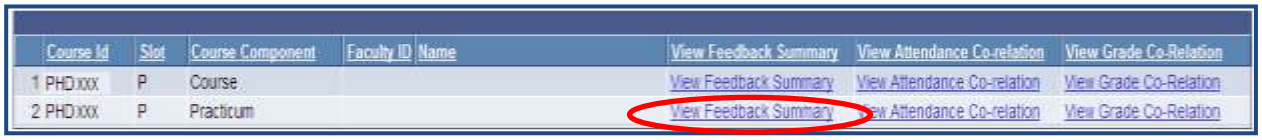


Figure 9.1.2 Options for faculty to access course feedback

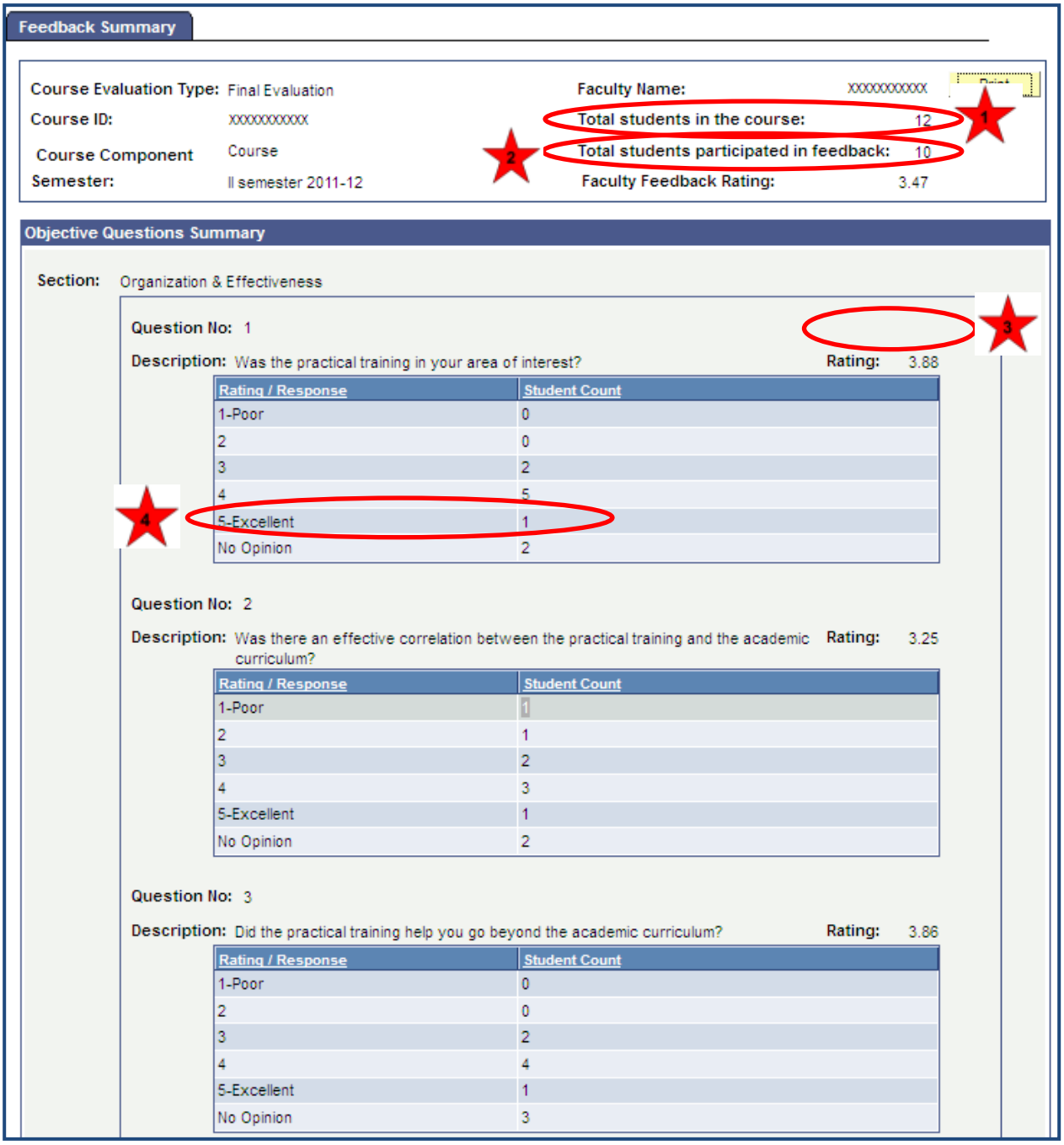
- The faculty can click the "view feedback summary" link if he wishes to view the feedback summary for a particular course and course component.

Feedback summary

Information shown to the faculty in feedback summary

1) The number of students participated in the feedback for this course component.
2) Faculty feedback rating
3) Individual question rating
4) Student count for a particular rating.
5) The subjective questions and their corresponding feedbacks given by the students (No rating).

Note: All these points are shown in the screenshot below with numbering.



Feedback Summary

Course Evaluation Type: Final Evaluation
Course ID: xxxxxxxxxx
Course Component: Course
Semester: II semester 2011-12

Faculty Name: xxxxxxxxxx
Total students in the course: 12
Total students participated in feedback: 10
Faculty Feedback Rating: 3.47

Objective Questions Summary

Section: Organization & Effectiveness

Question No: 1
Description: Was the practical training in your area of interest?
Rating: 3.88

Rating / Response	Student Count
1-Poor	0
2	0
3	2
4	5
5-Excellent	1
No Opinion	2

Question No: 2
Description: Was there an effective correlation between the practical training and the academic curriculum?
Rating: 3.25

Rating / Response	Student Count
1-Poor	1
2	1
3	2
4	3
5-Excellent	1
No Opinion	2

Question No: 3
Description: Did the practical training help you go beyond the academic curriculum?
Rating: 3.86

Rating / Response	Student Count
1-Poor	0
2	0
3	2
4	4
5-Excellent	1
No Opinion	3

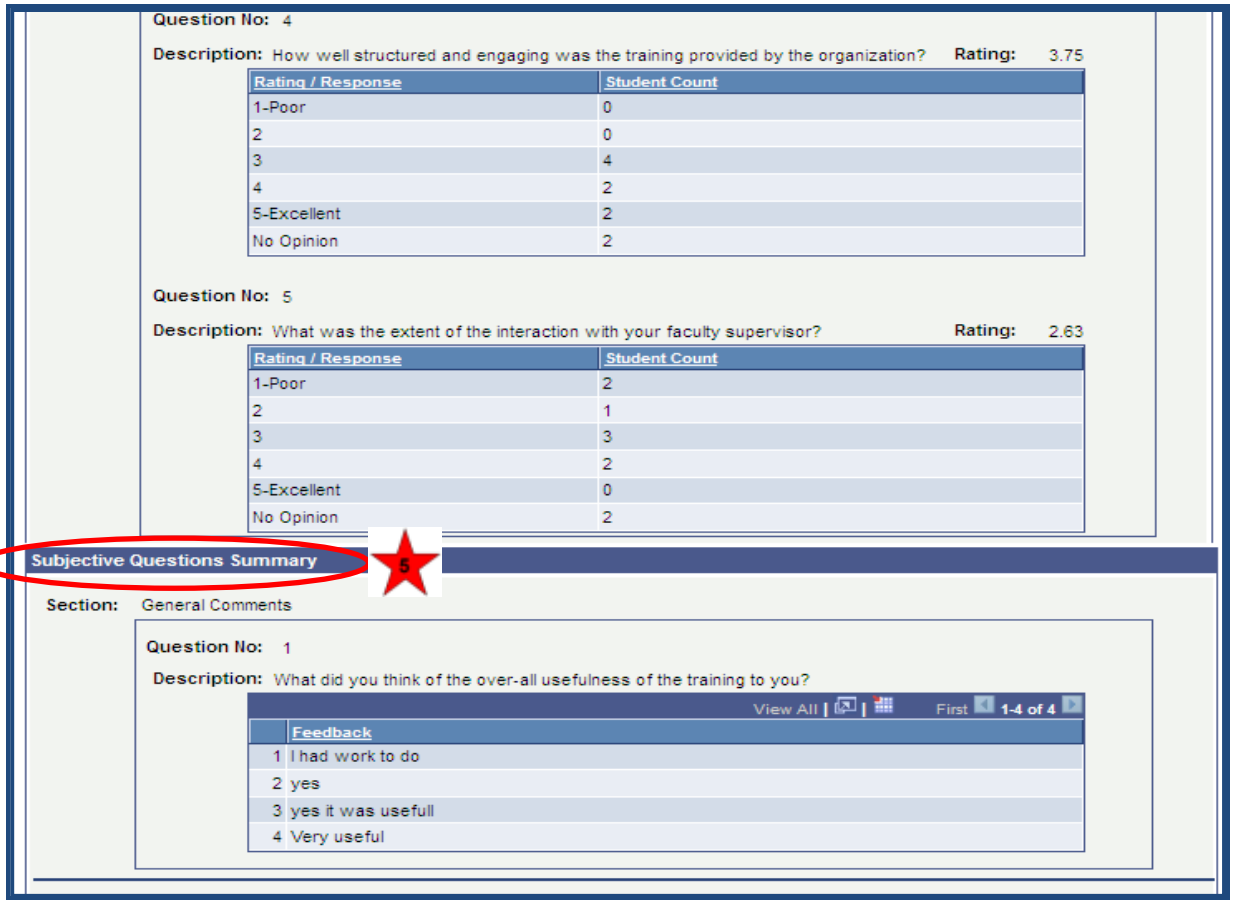


Figure 9.1.3 Screenshot feedback summary showing details of feedback for a hands-on training course

Faculty Section

- A faculty section will be shown in the feedback summary page if the faculty has setup specific question for feedback.

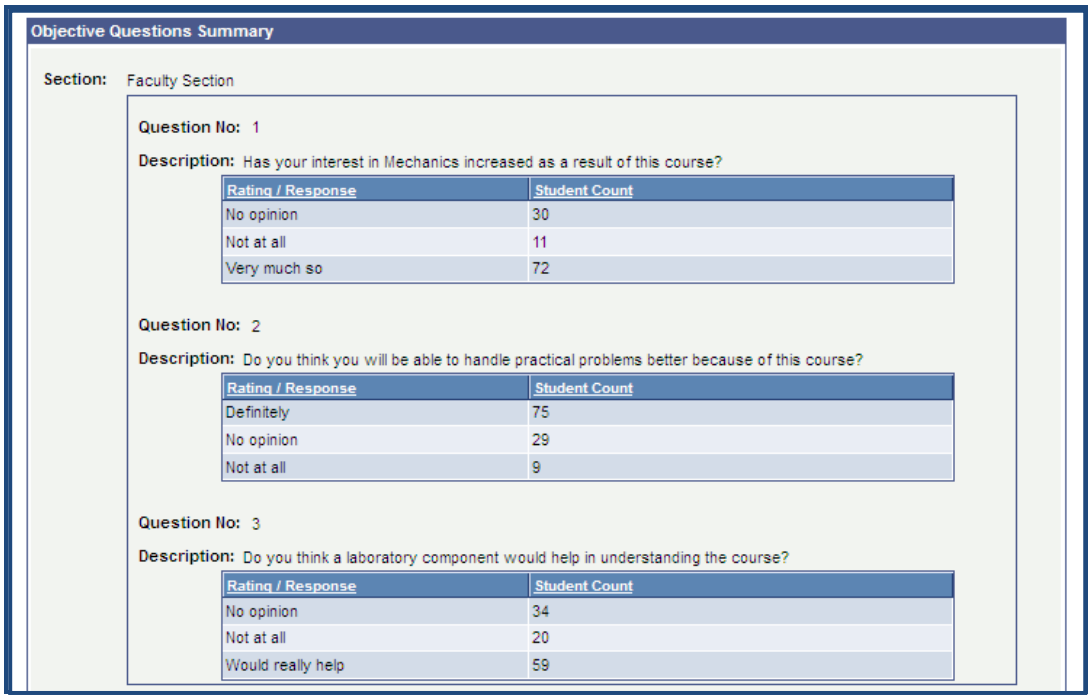


Figure 9.1.4 More details of feedback

Attendance correlation

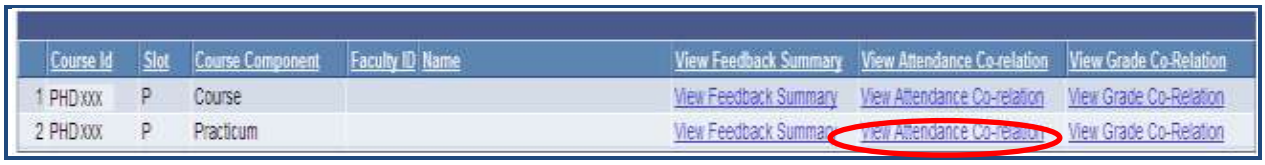
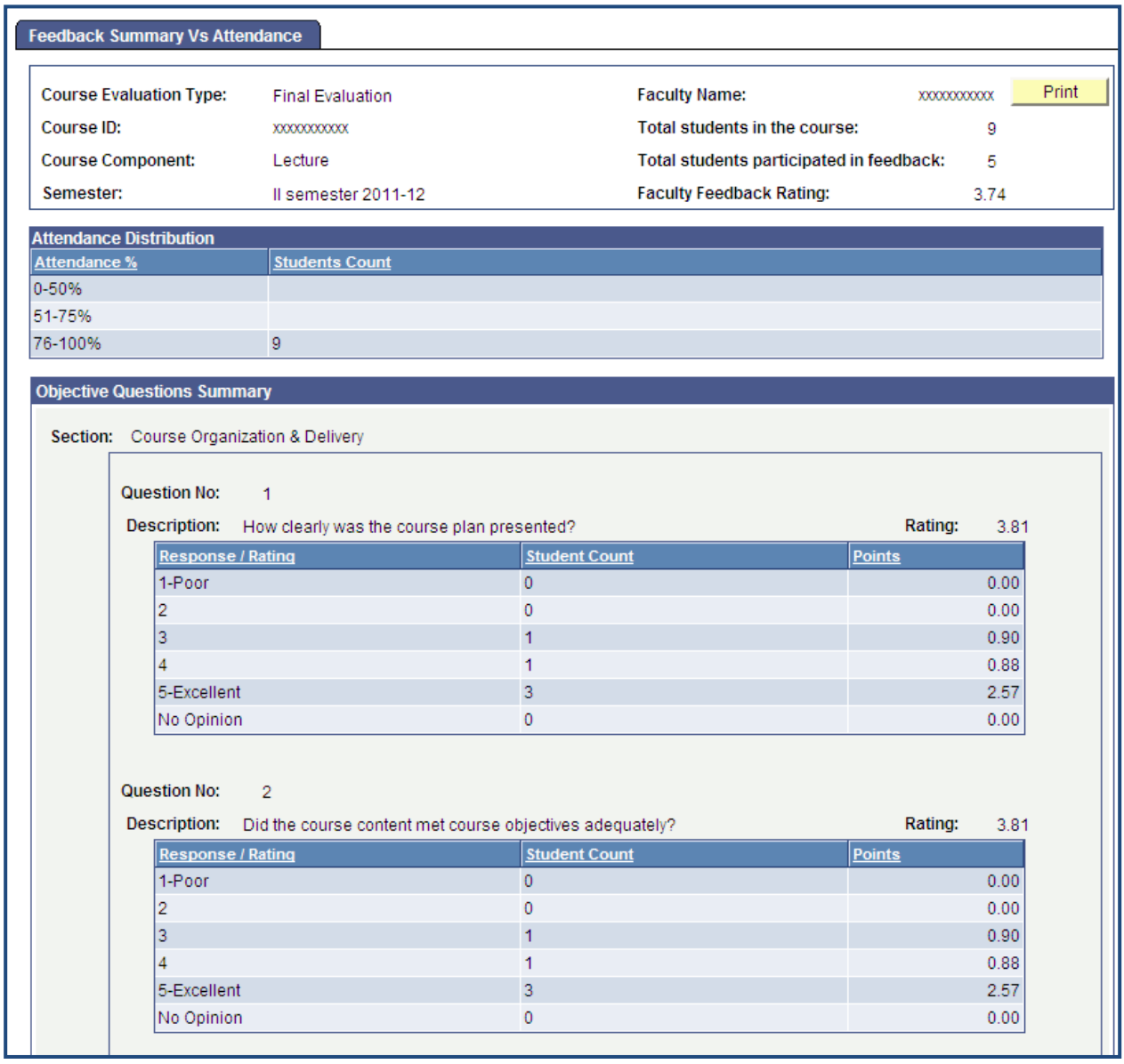


Figure 9.1.5 Feedback correlated to attendance of students

- The faculty can click the attendance correlation to view the relation between the attendance and feedback of the students.
- This relation will show the number of students in the categories: 0 to 50 %, 51-75%, 76-100% under Attendance distribution.
- This page will show the number of students participated in the feedback for the course component, Faculty feedback rating, Individual question rating and Student count for a particular rating.

- The rating will be calculated based upon a pre-decided formula. The attendance rating will be different from the feedback summary rating as the formula for this attendance rating will include the attendance percentage.



Feedback Summary Vs Attendance

Course Evaluation Type:	Final Evaluation	Faculty Name:	xxxxxxxxxx
Course ID:	xxxxxxxxxx	Total students in the course:	9
Course Component:	Lecture	Total students participated in feedback:	5
Semester:	II semester 2011-12	Faculty Feedback Rating:	3.74

Print

Attendance Distribution

Attendance %	Students Count
0-50%	
51-75%	
76-100%	9

Objective Questions Summary

Section: Course Organization & Delivery

Question No: 1

Description: How clearly was the course plan presented? Rating: 3.81

Response / Rating	Student Count	Points
1-Poor	0	0.00
2	0	0.00
3	1	0.90
4	1	0.88
5-Excellent	3	2.57
No Opinion	0	0.00

Question No: 2

Description: Did the course content met course objectives adequately? Rating: 3.81

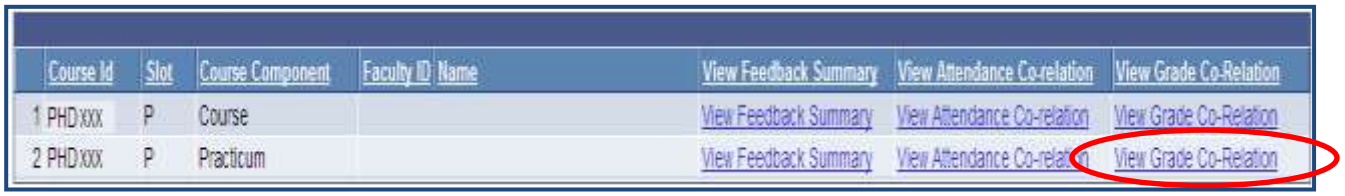
Response / Rating	Student Count	Points
1-Poor	0	0.00
2	0	0.00
3	1	0.90
4	1	0.88
5-Excellent	3	2.57
No Opinion	0	0.00

Figure 9.1.6 Example feedback from a lecture course

- The faculty can also view the subjective questions and their corresponding answers along with the faculty section (if any).

Grade Correlation summary

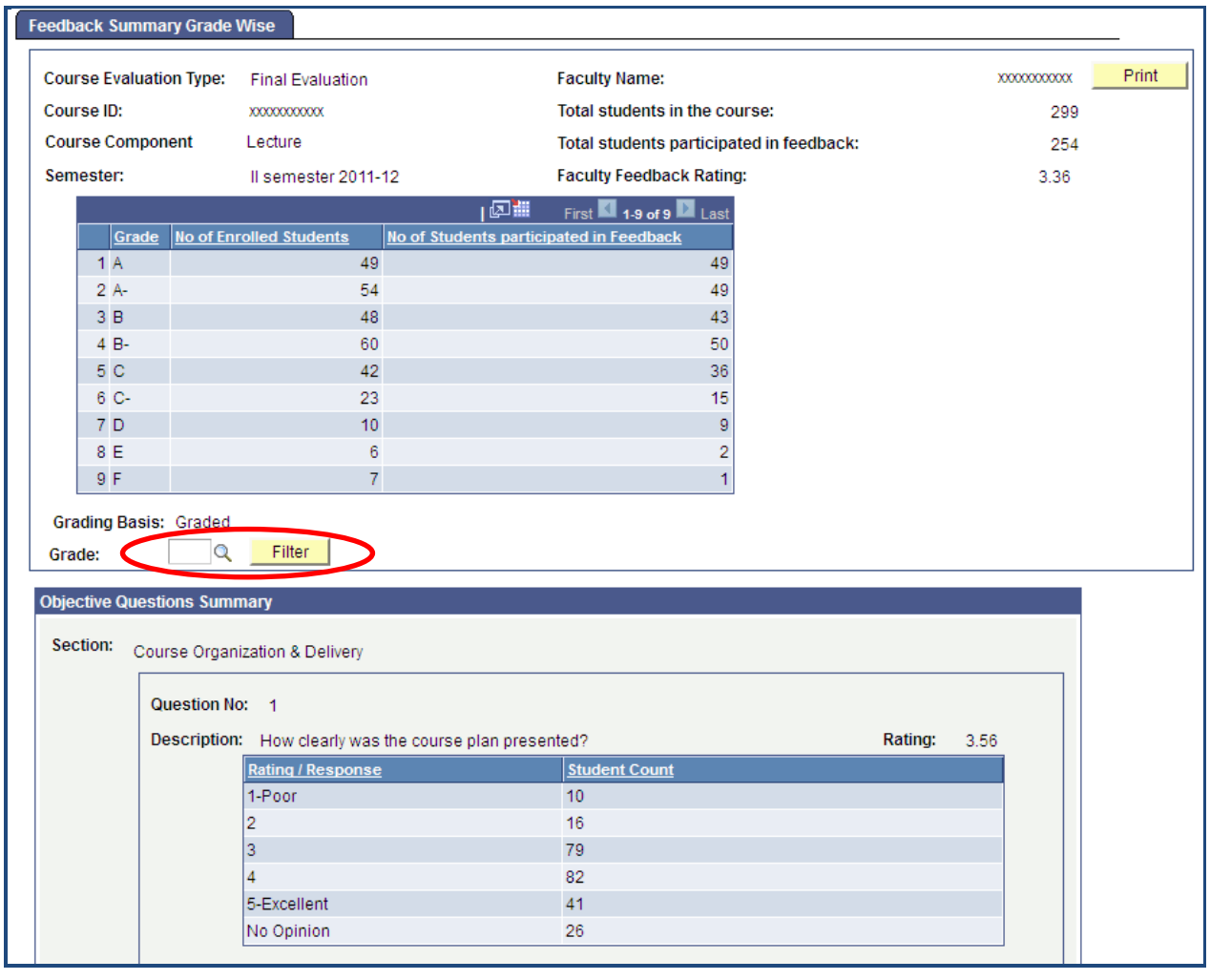
- The faculty will click the “View Grade Correlation” link.



	Course Id	Slot	Course Component	Faculty ID	Name	View Feedback Summary	View Attendance Co-relation	View Grade Co-Relation
1	PHDXXX	P	Course			View Feedback Summary	View Attendance Co-relation	View Grade Co-Relation
2	PHDXXX	P	Practicum			View Feedback Summary	View Attendance Co-relation	View Grade Co-Relation

Figure 9.1.7 Option to view feedback correlated to grades.

- The faculty can filter the feedback summary report according to the grades by clicking the filter button after entering the grade.



Feedback Summary Grade Wise

Course Evaluation Type: Final Evaluation
Faculty Name: xxxxxxxxxx
Print
Course ID: xxxxxxxxxx
Total students in the course: 299
Course Component Lecture
Total students participated in feedback: 254
Semester: II semester 2011-12
Faculty Feedback Rating: 3.36

First 1-9 of 9 Last

	Grade	No of Enrolled Students	No of Students participated in Feedback
1	A	49	49
2	A-	54	49
3	B	48	43
4	B-	60	50
5	C	42	36
6	C-	23	15
7	D	10	9
8	E	6	2
9	F	7	1

Grading Basis: Graded
Grade: Filter

Objective Questions Summary

Section: Course Organization & Delivery

Question No: 1
Description: How clearly was the course plan presented?
Rating: 3.56

Rating / Response	Student Count
1-Poor	10
2	16
3	79
4	82
5-Excellent	41
No Opinion	26

Figure 9.1.8 Illustration on assessing / filtering feedback by student grades.

- This will show the feedback summary for the grade entered by the faculty for example its C- in the screenshot.

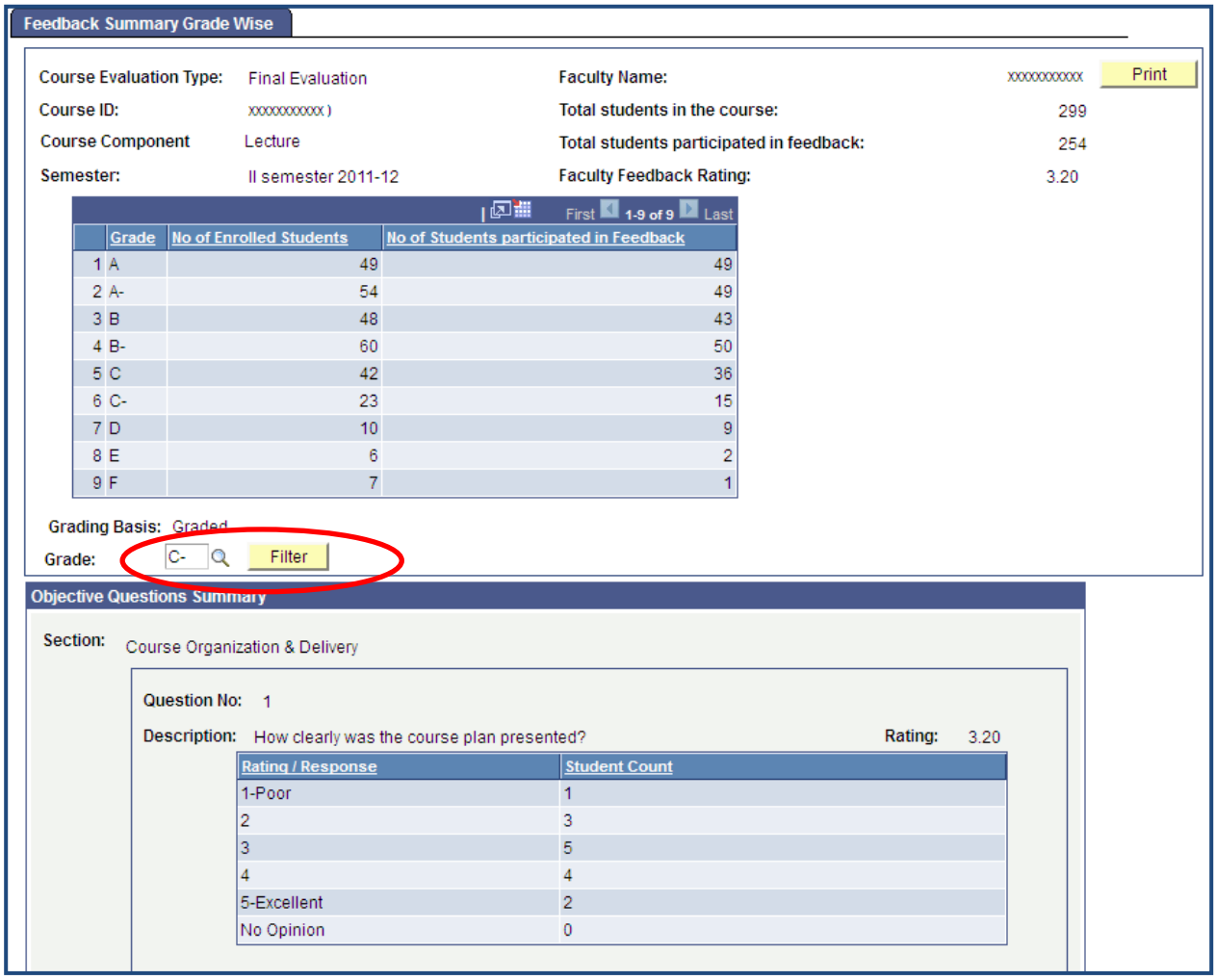


Figure 9.1.9 Illustration on assessing / filtering feedback by student grades.

2. Public feedbacks

Navigation: Teaching and course evaluation → Public feedbacks

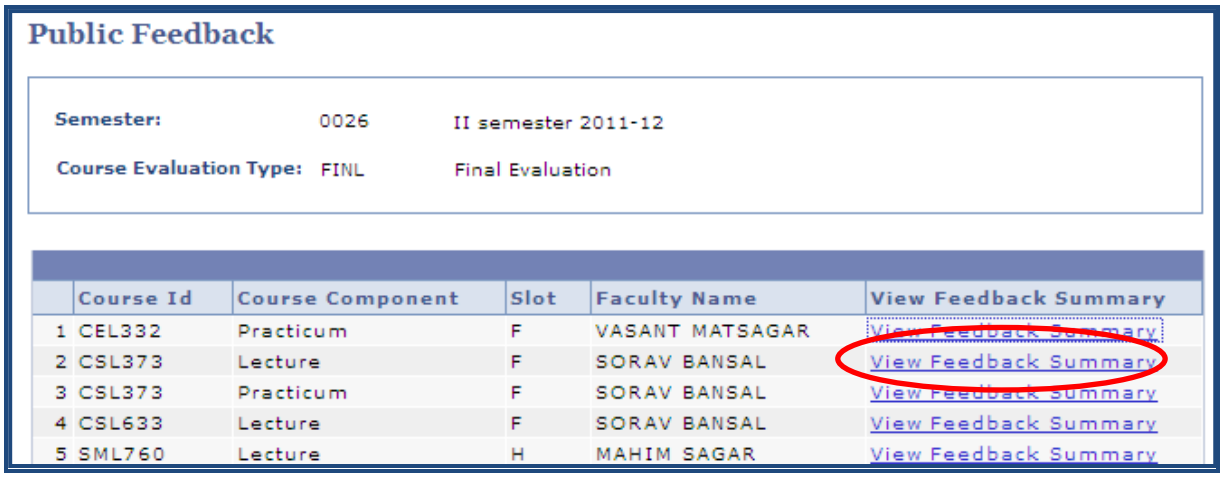
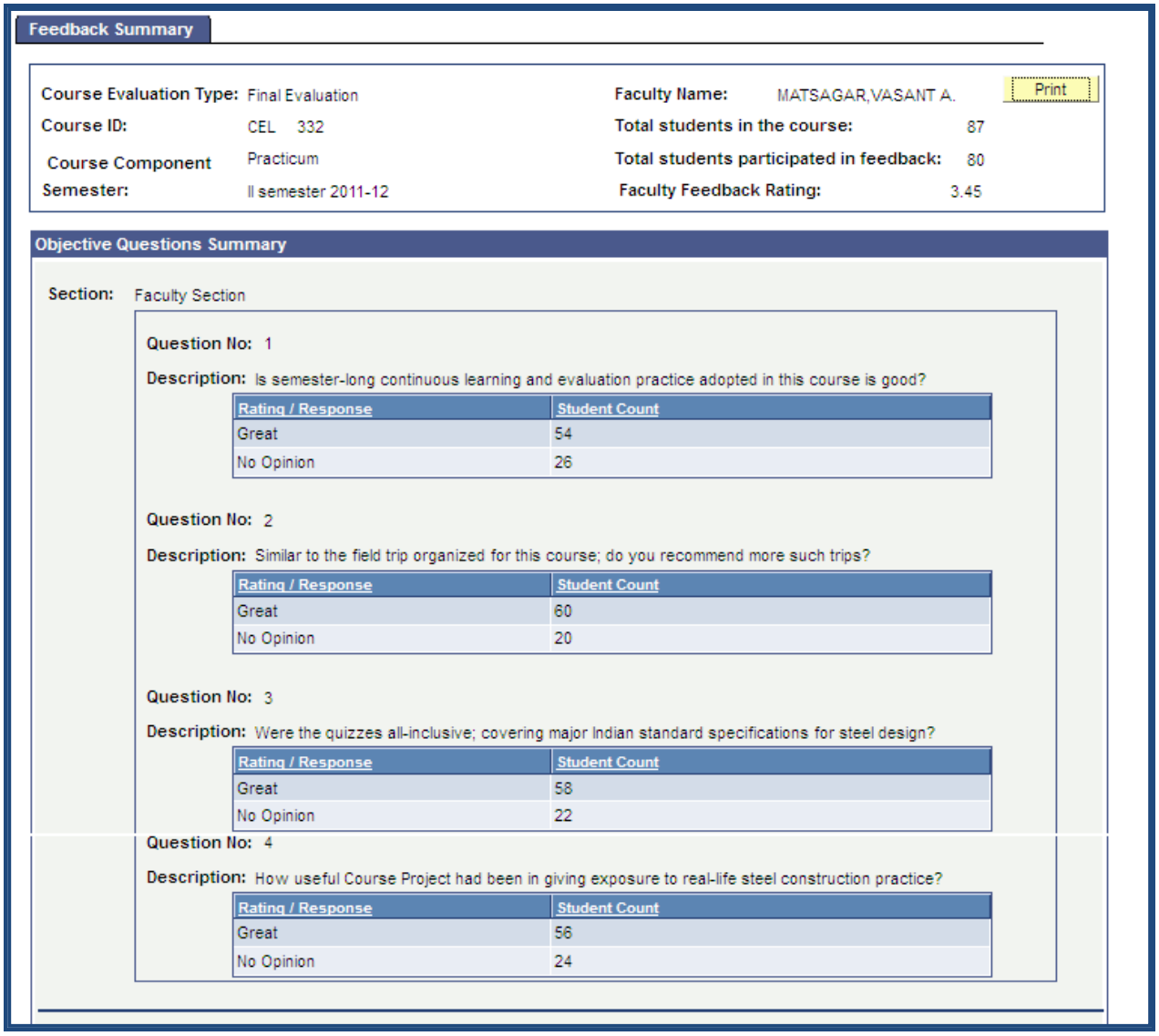


Figure 9.1.10 Accessing course feedback accessible to all.

- Everyone will have the access to this page.
- Feedbacks made public by the faculties will only be shown in this page.
- The user will click the link" View feedback summary" to view the feedback summary.



Feedback Summary

Print

Course Evaluation Type: Final Evaluation
Faculty Name: MATSAGAR,VASANT A.
Course ID: CEL 332
Total students in the course: 87
Course Component: Practicum
Total students participated in feedback: 80
Semester: II semester 2011-12
Faculty Feedback Rating: 3.45

Objective Questions Summary

Section: Faculty Section

Question No: 1

Description: Is semester-long continuous learning and evaluation practice adopted in this course is good?

Rating / Response	Student Count
Great	54
No Opinion	26

Question No: 2

Description: Similar to the field trip organized for this course; do you recommend more such trips?

Rating / Response	Student Count
Great	60
No Opinion	20

Question No: 3

Description: Were the quizzes all-inclusive; covering major Indian standard specifications for steel design?

Rating / Response	Student Count
Great	58
No Opinion	22

Question No: 4

Description: How useful Course Project had been in giving exposure to real-life steel construction practice?

Rating / Response	Student Count
Great	56
No Opinion	24

Figure 9.1.11 Illustration of publicly accessible courses.

9.**3 System for feedback from Recruiters** : (UG/PG)

On campus: T&P cell

Off campus: None

9.4 Mechanism of obtaining industry feedback & findings. Industry annually and informal feedback

9.5 Alumni feedback mechanism and its outcome: Have Alumni office – indirect feedback

9.6 Placement records: PhD (100%), MTech (95-98% in last 5 years), BTech (100%)

Section 10

VISION FOR NEXT 5-10 YEARS

Executive Summary: Vision Next 5-10 Years

IIT Delhi has been ranked number one engineering institute in India. In our endeavour to consistently improve our position in Asian as well as Global rankings of Chemical Engineering Departments and in view of the ever increasing number of students that are being admitted into the Department, with the value becoming close to being doubled over the last decade, the Department curriculum review aims to deliver the best possible mode of education to this large spectrum of students. Keeping in mind the increasing requirement of the nation for highly qualified and technically sound scientists, technologists, teaching faculty to cater the demands of indigenous technology development in public sector and private industries and also in government department (e.g. DAE, DRDO, CSIR, ISRO, etc), efforts are underway to increase the enrollment of Ph.D. students and offering post-doctoral positions at the department level as well as at the institute level. While this being done, significant efforts are needed to improve the quality of Ph.D. education and the Department of Chemical Engineering has taken many path-breaking steps in this direction. The department takes into account its benchmarking compared to global institutions and strives to increase the exposure of students to a global platform through mutual agreements with top ranked universities across the world through specific fellowship programs and double degree program. In addition the Department aims to augment the spirit of research by making state-of-the-art equipment available, and increasing focus on advanced research areas. The credit requirements for Doctoral research students have been increased to ensure a sound theoretical background in the area of one's research. The Department also strives to optimize the student-teacher ratio which is an ostensibly daunting task, and thorough learning being made available through softwares and online courseware on NPTEL, the student is made to experience a more hands-on mode of instructions so as to excite their interest in Chemical Engineering. New initiatives such as increasing research in Energy Technology, Advanced Materials, Biopharmaceutical Technology and increasing office and lab spaces, a consolidated curriculum with a highly interactive mode of teaching, despite a few shortcomings in space availability and infrastructure, will certainly go a long way in raising the research standards to globally appreciable levels and, on a more fundamental note, increased the love and interest of a student in the field of Chemical Engineering.

10.	Vision for next 5-10 years	
10.1	Goals and benchmarking for future in relation to (i) curricula, (ii) research, (iii) outreach, and (iv) processes for regular internal assessment.	**(i) UG curricula:** IIT Delhi has had a tradition spanning more than five decades of offering a rigorous undergraduate curriculum based on basic courses, engineering arts and sciences, core discipline courses, electives related to the chosen discipline, and open electives (electives from other disciplines as per the students' choice). The Department of Chemical Engineering has been part of this rigorous curriculum formulation and implementation from the early years of existence of IIT Delhi. In view of the heterogeneous and large population of UG students that are entering the Institute in recent times, it is an ever-increasing challenge to maintain student interest in the core curriculum. For a while, it had been felt in our Department as well as in the wider IIT Delhi community that this challenge needs to be addressed. Through curriculum revision exercise and with the norms set out by the Institute Senate as part of the UG Curriculum Review Committee Concept Paper, it has been decided to have a basic B. Tech. degree of 151 credits, which would include all the basic traditional elements of a core UG Chemical Engineering programme. We have changed the flavour of UG instruction in keeping with the latest developments in materials science, energy technology and biochemical engineering, and each core course has been modernized in content. The 151 credits will also have 12 elective credits and 10 open elective credits. In order to address the needs of a larger group of undergraduates that we teach today (around 125 compared to 75 about a decade ago), and also to address their varied aspirations and interests, the Department has evolved specialized elective courses in the following broad areas: (a) Energy and Environment; (b) Process Engineering, Modeling and Optimization; (c) Complex Fluids and Materials; (d) Biopharmaceuticals and Fine Chemicals. Students with high CGPA score and earned credits will be encouraged to take up courses in these areas and also do an extended project, and hence earn a Departmental Specialization in the chosen area, in addition to the basic B. Tech. degree. This specialization, we

		feel, will maintain and perhaps enhance the excitement in our young undergraduates towards the new and cutting-edge research in these areas and prepare those interested in a career in research, and also serve to address the growing and ever-changing needs of the job market. Indeed, as a Department we will need to be cognizant of challenges we might face in implementing this curriculum with a sharpened focus, and should not shy away for mid-course correction or enhancements, as required, over the next decade. Modernization of UG laboratories is an ongoing effort, and indeed this has to be brought into greater focus in coming years. Our students already work with faculty on projects relevant to the industry. However, at present most of that work gets done at IIT because the current load of courses prevents them to stay away from IIT for long. In the revised Curriculum, it will be relatively easy for students to pursue projects while actually working in the industry, for even as long as a semester, with active involvement of faculty in the project. Naturally, such an effort would involve commitment from our faculty as well as the industrial counterpart, and most importantly the student, and it will be a challenge to oversee the implementation of such a program. Finally the issue of benchmarking. As part of the exercise of preparation of this document, we went through an elaborate exercise wherein our Department curriculum was benchmarked against that of other selected institutions both within the country and abroad (see Annexure 3 section 1 Currculum). **(ii) Research:** In the last decade, industrial focus on high performance materials, energy and environmental technologies and biotechnology concerns have also resulted in greater research focus in these areas. Going forward, we see continued growth in these areas. There is growing focus on improved process intensification, micro reactor technology, advanced process control and greater efficiency in manufacturing. These concerns are reflected in development of newer programs in robust process integration, quality by design, and flexible process integration for manufacturing processes. There is a greater focus on environment and impact of chemical processing on environment. There is increased interest in upstream oil

		recovery and hence increased recovery of the "difficult to extract" reserved. There is greater focus on smart materials, materials developed from renewable energy resources (including through biorefining). There is interest in easier and more effective drug manufacturing processes as well as in more effective and cheaper healthcare diagnostics. In recognizing these needs, the department has proactively organized its research focus, hiring and advanced standing courses around these areas. Advanced standing programs in B.Tech have been developed on Energy & Environment, Process Integration, and Pharmaceutical & Specialty Materials. Close interaction with industry is also being forged through courses, joint research and consultancy. Greater interaction is by design to help students and faculty gain greater understanding of the needs of the industry. Major trends in the industries of interest to Chemical Engineering have influenced research and teaching of specialized topics in the curriculum. **(iii) Outreach:** Department is involved in development of courses under NPTEL and other web based e-learning portals. The courses are prepared for teachers and students of state and privately run engineering institutions and universities to build scientific and technical mind and spread entrepreneurship. Department would like to engage actively with professional institutes for a) skill set development for certain sector of industries, b) new product design and development jointly with industries. Many faculty members of IIT Delhi are executive committee members of IIChE and IIChE NRC and directly involved in several professional development activities. Further several faculty members actively take part in advising role in DPCC, CSIR and DST. Department already engaged in UG/PG exchange program with UBC, Vancouver, EPFL Lucerne, INSA Toulouse, INSA Leon, Ecole Polytechnique, Paris through mutual agreement and with German universities through DAAD fellowship. Every year Students and faculty take part in TOTAL summer schools. An effort will be made towards joint collaborative research with well known Institutes/Universities through double degree program in Masters and Ph.D. At present Department has strong interaction with several US and European Universities

		through exchange of Ph.D./M.Tech students under defined joint sponsored research program. Thus effort will be made in coming 5-10 years to make it much stronger through formally announced joint degree program. **(iv)Process for regular internal assessment**: Department does continuous evaluation of its program through Department Faculty Board and Department Research Committee discussion. Further several bodies of the institute such as Board of Academic Program, Senate are responsible to deliberate on various issues and, if require, make interim corrective measures. Time to time in house workshop within department and within institute would help us to make internal assessment more effective.
10.2	Vision of curricula and teaching-learning processes - UG, PG and Ph.D.; innovations proposed	As discussed earlier, the Department has undertaken PG curriculum review along with UG curriculum review, which is already completed. These Curricula have been modernized and made relevant to more contemporary needs of the industry and research, and indeed we have evolved four areas of specialization, namely: (a) Energy and Environment; (b) Process Engineering, Modeling and Optimization; (c) Complex Fluids and Materials; (d) Biopharmaceuticals and Fine Chemicals. For PG (Ph.D., M. Tech. and Dual degree B.Tech and M.Tech) students as well, the same area of specialization and courses contained therein would be offered. Over and above department felt that there is requirement of bridge courses for the students entering in two year M.Tech and Ph.D. program (pre Ph.D. course work). We have four bridge courses (TP, CRE, Thermo and Numerical Methods) bundled into two and apart from this student have to choose one of the advanced level courses Advanced Thermodynamics, Industrial Multiphase Reactors, Interfacial Behaviour and Transport of Biomolecules. Naturally, learning and teaching through formal courses and laboratories will continue. Enhancements in the learning process that we envision are the following: • We have a formal set of lectures offered by various academic and industry experts which PG students are mandated to attend. • With the availability of various open source modes of learning, such as NPTEL, different visualization and

		animation modules students shall be encouraged to consult such material as supplementary material to lectures and books. • With significant enhancement in research activity and availability of state-of-the-art equipment in the Department and Institute, students are to be provided live demonstrations of the same, and wherever possible, actual hands-on experience. This is important in sustaining student interest and enhancing their interest level in science and engineering. • Many of our courses already enable the learning and use of state-of-the-art softwares. This effort must continue and suitable enhancements included in the future. • In both the UG and most importantly the PG programmes, the new Curricula will offer the option of working in the industry as part of the major project (supervised by IIT faculty and co-supervised by industry person) for a time frame as long as a semester, so that the student actually invests time and effort to solve a problem of relevance to the industry (and also generate more industry interest in the process). This is likely to enhance the learning experience significantly. While IITs are widely acclaimed for their under-graduate teaching, in recent years, there has been a strong thrust to further improve the PG & research programs and this will continue to be our focus in next 5-10 years. Keeping in mind the increasing requirement of the nation for highly qualified and technically sound scientists, technologists, teaching faculty to cater the demands of indigenous technology development in public sector and private industries and also in government department (e.g. DAE, DRDO, CSIR, ISRO, etc), efforts are underway to increase the enrollment of Ph.D. students at the department level as well as at the institute level. Department has engaged several post-doctoral fellows in different labs through sponsored project positions. Institute has recently created 50 post-doc positions to augment research output. While this being done, significant efforts are needed to improve the quality of Ph.D. education and the Department of Chemical Engineering would like to take following steps in this direction: • Keeping in mind the heterogeneous educational

		background of students admitted to Ph.D. program in Chemical Engineering, the department is having intense deliberations on introducing additional course work to improve the educational background of incoming Ph.D. students. This will include specially designed bridge courses covering fundamentals of Chemical Engineering that will be offered specifically for PhD students and advanced courses for students will chemical engineering and non-chemical engineering background. • Increase in course credits requirements thus making PhD students to learn advanced and specialized courses relevant for their doctoral research. • In order to monitor the quality of research, the department will continue its emphasis on semester progress presentations and departmental seminars given by Ph.D. students • Encourage students to participate in national/international conferences, short courses/workshops and international research exchange programs. • Invite experts for industries, universities in India/abroad to expose them to international and industrial research. Organize special lecture to improve their writing/presentation skills
10.3	Areas identified for improvement in (i) curriculum, (ii) teaching-learning processes	(i) - Increase enthusiasm for applications / research in areas of chemical engineering - Increase focused learning opportunities in advanced areas of interest - Improve the basic understanding of students joining for post graduate program (ii) - Increase teacher - student ratio for increased interactions - Electives in areas of advanced studies - More exposure to use of concepts taught in the industry or in new research - Opportunities for lecture courses or project credits to interested students - Improve laboratory experiments and design projects

		methods of teaching Lab accessibility improvement
10.4	New areas for research and Masters programme, and industry participation in these	Department has currently the following broad areas of research: Catalysis (b) Energy (c) Advanced materials (d) Process Intensification/ Multiphase Reactor Engineering (e) Process modeling & Optimization (f) Complex Fluids/ Rheology (g) Pharmaceutical Biotechnology (h) Environment & Waste Management. In each of these areas, efforts are currently underway to consolidate our national and international presence through concerted efforts towards creating focussed groups and in some cases, inter-disciplinary and inter-departmental research centres. For instance, such a centre is being conceived in the broad area of pharmaceutical biotechnology, which will be involve several departments and schools in the Institute and have active industry involvement. In the area of energy, six faculty members are involved in an effort in coal-to-liquids (CTL) technology (and therein involving a focus towards coal gasification). Here too, industry participation is already in place through projects and efforts are underway to create a cluster of such projects. In the area of renewable energy (specifically hydrogen and fuel cells) and nanotechnology, faculty from the Department are involved in leadership roles in several efforts involving different departments. Such efforts will clearly be consolidated in coming years. In addition, in view of new and heavier oil reserves becoming relevant to the country and elsewhere, the Department may focus efforts at enhancing the research and course work relevant to the upstream oil sector. Already, there is considerable interest from companies in that area to collaborate with the Department. Also, with molecular modeling and the physics of complex fluids and materials becoming increasingly relevant and the Department developing strengths in that field, there is likelihood of greater consolidated efforts in that direction. It is conceivable that as and when appropriate, some of these areas may spin off organized M. Tech. programmes. A first step towards that is a list of relevant elective courses that are already being incorporated as part of the new Curriculum (see Appendix 1.1).
10.5	Projections for (i)	(i) The department has undertaken 85 sponsored research

	funded projects, (ii) journal publications.	projects worth 33.23 crores and 27 consultancy projects worth 2.03 cores in last 5 years. In next 5 years, the department is targeting an increase of 25% average growth in terms of external funding. (ii) In last 5 years, the department has published 397 peer reviewed international journal papers with an average of 3.3 papers per faculty per year and has presented 324 papers in peer reviewed international and national conferences with an average of 2.7 papers per faculty per year. With several faculty members recently recruited, the department is targeting an increase of 25% average growth in next 5 years e.g. an average of 4 international papers per faculty per year.
10.6	Projected graduation numbers - Ph.D., M.Tech. and B.Tech	PhD : 10 per year M.Tech+M.Tech Dual Degree : 40+50 per year B.Tech : 120 per year
10.7	Projected faculty profile, and areas for recruitment of faculty	i) Biotechnology and Health Care research ii) Energy Technology iii) Environmental Technology iv) Advance Material v) Advance Process control
10.8	Projections for future benchmarking (for comparison after 5 years) – institutions in India and abroad, and parameters for future comparison	IIT Delhi has been ranked number one engineering institute in India. Our aim for next five years is to work towards making the Department of Chemical Engineering among the very best ranked Department of the Institute and among top two-three Chemical Engineering Departments of the country. It will also be our endeavour to consistently and substantially improve our position in Asian as well as global rankings of Chemical Engineering Departments. The parameters for comparison would be curriculum, teaching, industry-academy interaction, research, publications, citations, sponsored & consultancy projects.
10.9	Infrastructure and governance - limiting factors that affect achievement of benchmarks and methods to overcome these	Limitations in infrastructure: While considerable improvement in infrastructure has occurred in the past decade, some key gaps remain. Most of these are across departments and need a solution at the Institute level. We need to have 24x7 electricity for critical equipment. It would also help to have centralized utilities (N_2, O_2, pressurized air, hot water, steam etc). Finally, space is also a constraint for the department. Most of these issues are expected to be addressed when we move to the new

		building in a few years time. Limitations in governance: Governance of the Department of Chemical Engineering at IIT Delhi is characterized by its efficient and transparent decision making involving every faculty members, staff and PG/UG students. As is evident from the detailed submission, the various administrative committees that we have are functional and meet frequently and that the decision making is taken place at these meetings. The Department has been proactive in performing the due diligence and taking a stand on key issues whether it is about communicating the space requirements to the Institute or amending our approach for selection of graduate students. Having said there is always scope for improvement specially stuff support of the department.
10.10	Working with other departments/centers and institutions in teaching and research	The department has a history of working with other departments and centers in teaching. We have been teaching students of the Department of Biotechnology and Biochemical Engineering and Department of Textile Technology as well as other disciplines on a variety of chemical engineering topics. We have also had faculty from School of Biological Sciences and Department of Applied Mechanics teach core courses of our department on topics as per instructor's expertise. The faculty of the department has been increasingly engaging in interdisciplinary research projects in collaboration with faculty of other departments (Chemistry, School of Biological Sciences, Physics, Biochemical Eng and Biotechnology, Civil Engineering, Atmospheric Sciences, Energy Studies, Polymer Science and Eng. and Rural Development Tech) within and outside IITD. As is shown in the Research section of the document, the faculty has been engaged in sixteen such major projects over the last 5 year duration. Overall, the department realizes the importance of interdisciplinary research and this combined by the recognition of the faculty expertise in certain research areas is likely to result in more opportunities of collaborative research in the future.
10.11	New initiatives that the department/centre will be undertake.	Research: a. Open centre of excellence – i. Energy Technology – development of low carbon fossil fuel based energy technology and renewable energy technology including bio-refining, ii. Bio-pharmaceutical technology

		b. Hire faculty members to achieve above goals with increasing industry based sponsored research funding in the above areas. c. Create labs space and engage dialogue with institute authority for acquiring new lab and office space. d. Development current central instrument lab in to state-of-the-art characterization lab through research grant and other sources. Teaching a. Consolidate newly introduced curriculum for UG/PG program in coming 5 years with required remedial step if necessary. b. Bring in interactive tools in all modes of teaching – theoretical/fundamental, design and experimental. c. Invoke self learning process in to the students Infrastructure/Facilities a. New labs and offices in the specialized area as mentioned in our Vision statement b. Better and updated equipment facilities through institute fund, FIST grant and sponsored research fund. c. Update UG lab experiments with the use of data acquisition system and advanced computer control.
10.12	Outreach goals and anticipated limitations in the attainment of these.	• Strengthen the industry-academics interactions - extend beyond research projects to teaching and curriculum development • Department expertise made available to develop research facilities in other institutions in India • Active role in national development projects • Develop a center of excellence driving research activities addressing certain key industries. • Advanced courses to be developed for NPTEL Limitations: none
10.13	Mechanisms for effective changes based on feedback received and development and implementation of corrective measures.	The Department looks forward to receiving constructive criticism of its performance in 5 years and feedback for improving our performance in the next five years and beyond. As per Senate statutes, the Departmental decisions are taken by the Head with the Committee of Professors (COP), Department Research Committee (DRC) and the Department Faculty Board

		(DFB) serving as the statutory bodies advising his/her office. In addition, several committees are formed by the Head for advice on other specific matters. Following this Review, a Plan-of-Action (PoA) will be developed with clearly listed tasks and implementation timelines, which the different statutory bodies and other advisory bodies for take up for timely implementation. Targets will be developed for achievement on various metrics (as recommended by the Review Committee) and we would have an yearly internal review to assess whether those targets have been met. In case we fail to meet those targets, the DFB should clearly assess why we are missing and what help can be requested from the Institute and indeed other agencies (like external funding agencies) for us to meet those targets. Also a revision of our administrative system and procedures may be required as and when the need arises in order to ensure smoother implementation of the PoA.
10.14	Questions to which the department seeks answers from the Review Committee	1. Where we stand compared to any other University in Indian and abroad which have been reviewed earlier or got to know their performance? 2. What is the scope for further improvement in general as of today? 3. What are the specific changes that need to be brought in with respect to all components of evaluation? 4. What does the committee think the department should focus on? 5. Whether a committee member will recommend one of his/her colleague to collaborate with the department in teaching and research and product / process development? 6. Whether a committee member would recommend one of his colleague's son/daughter for admission to undergraduate and graduate program of the department? 7. What is the overall grade of the department in 1-10 point scale?

Section 11

INFORMATION IN PUBLIC DOMAIN

Executive Summary: Information in public domain

The Department has maintained good transparency and visibility in the public domain. All the minutes of the various meetings in the past five years are made available in the dept website related to: dept. research committees (DRC), dept faculty board (DFB) meetings, dept undergraduate committee (DUGC) meetings, and professors' committee meetings (COP). In addition, the extended abstracts of Ph.D theses submitted in the past five years is also available on dept website.

11.1. Minutes of all meetings

The minutes of all meetings held in the past five years are available on department website. The minutes are categorized based on (i) DRC (dept research committee) meetings, (ii) DFB (dept faculty board) meetings, (iii) DUGC (dept undergraduate committee) meetings, and (iv) COP (committee of professors) meetings
http://chemical.iitd.ac.in/?q=content/int_doc

11.2. All reports archived in the department libraries

All B.Tech, M.Tech, and PhD thesis reports from the department are available in the dept library. Additionally, extended abstracts of all Ph.D theses submitted in the past five years are archived on the dept website.
http://chemical.iitd.ac.in/?q=content/int_doc

11.3. Past vision documents, review documents, Standing Review Committee documents

Some of these are currently available in department office and they will be made available on department website too.
http://chemical.iitd.ac.in/

11.4. Any other documents developed by the department, a group/section of the department

A *brochure* and a *presentation* about the department are available on department website.
http://chemical.iitd.ac.in/

11.5. Feedback documentation and action taken on the same and its outcome.

Currently no documentation is available on feedback about the department. However, these documents would be made available on the dept website after completion of the first external peer review.