Study Scheme & Syllabus of
Bachelor of Technology in Chemical Engineering
(B. Tech. Chemical Engineering)

Batch 2018 onwards

By

Department of Academics
IK Gujral Punjab Technical University

Chapter -1

General, Course structure & Theme

&

Semester-wise credit distribution

The Programme Specific Outcomes (PSO) of B.Tech. Chemical Engineering:

Curriculum of chemical engineering is intended to prepare graduates to attain the following program specific outcomes:

1. An ability to apply knowledge to understand, design and develop various unit operations and processes
2. An ability to formulate, simulate and validate problems pertaining to chemical engineering
3. An ability to adapt and apply chemical engineering principles and other skills in industrial and professional capacity

A. Definition of Credit:

1Hr. Lecture (L) per week	1 credit
1Hr. Tutorial (T) per week	1 credit
3Hr. Practical (P) per week	1.5 credit
2Hours Practical(Lab)/week	1 credit

B. Structure of Undergraduate Engineering program:

S.No.	Category	Break up of credits
1	Humanities and Social Sciences including Management courses	12
2	Basic Science courses	25
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc	24
4	Professional core courses	48
5	Professional Elective courses relevant to chosen specialization/branch	18
6	Open subjects – Electives from other technical and /or emerging subjects	18
7	Project work, seminar and internship in industry or elsewhere	15
8	Mandatory Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Traditional Knowledge]	Non-credit
	Total	160

BASIC SCIENCES COURSE [BSC] – BS

Sl. No	Subject	Semester	Credits
1	Mathematics-I	1	4
2	Physics	1	4
3	Chemistry-I	1	4
4	Physics Lab	1	1.5
5	Mathematics-II	2	4
6	Chemistry Lab	2	1.5
7	Chemistry-II	3	4
8	Biology	3	4
		Total Credits:	**27**

ENGINEERING SCIENCE COURSES [ESC] - GES

Sl. No	Subject	Semester	Credits
1	Engineering Graphics	1	3
2	Thermodynamics-I	2	4
3	Electrical & Electronics Engineering	2	5
4	Computer Lab (Programming for Problem Solving)	2	5
5	Engineering & Solid Mechanics	3	4
6	Engineering Workshop	3	3
7	Material Science	4	3
		Total Credits:	**27**

HUMANITIES AND SOCIAL SCIENCES INCLUDING MANAGEMENT COURSES [HSMC]
HUMANITIES AND MANAGEMENT - HS

Sl. No	Subject	Semester	Credits
1	HASS-I (Communication Skills/ English)	1	3
2	HASS-II	4	3
3	HASS-III	5	3
4	HASS-IV	6	3
		Total Credits:	**12**

PROFESSIONAL CORE COURSES [PCC] – CS

Sl. No	Subject	Semester	Credits
1	Material & Energy Balance Computations	2	4
2	Transport Phenomena	3	4
3	Thermodynamics-II	3	4
4	Heat Transfer	4	4
5	Mass Transfer-I	4	3
6	Fluid Mechanics	4	4
7	Numerical Methods in Chemical Engineering	4	3
8	Chemical Reaction Engineering-I	5	4
9	Mass Transfer-II	5	3
10	Chemical Engineering Lab-I	5	2
11	Particle & Fluid Particle Processing	5	3
12	Chemical Reaction Engineering-II	6	3
13	Process Technology & Economics	6	3
14	Process Control	6	3

15	Chemical Engineering Lab-II	6	2
16	Design and Simulation Lab	7	3
17	Instrumentation & Control Lab	7	3
		Total Credits:	**55**

PROFESSIONAL ELECTIVE COURSES [PEC] – CSEL

Sl. No	**Subject**	**Semester**	**Credits**
1	Elective – I	5	3
2	Elective-II	6	3
3	Elective-III	7	3
4	Elective-IV	7	3
		Total Credits:	**12**

OPEN ELECTIVE COURSES [OEC] – OL

Sl. No	**Subject**	**Semester**	**Credits**
1	Open Elective–I	5	3
2	Open-Elective-II	6	3
3	Open-Elective-III	7	3
4	Open-Elective-IV	7	3
		Total Credits:	**12**

SUMMER INDUSTRY INTERNSHIP [SI] PROJECT

Sl. No	Subject	Semester	Credits
1	Summer Internship		3
2	Project	8	12
Total credits			**15**

I. **Induction Program**

Induction program **(mandatory)**	**3 weeks duration**
Induction program for students to be offered right at the start of the first year.	Physical activity Creative Arts Universal Human Values Literary Proficiency Modules Lectures by Eminent People Visits to local Areas Familiarization to Dept./Branch & Innovations

It is an Under Graduate (UG) Program of 4 years duration (8 semesters)

First Semester **Contact Hrs.: 26**

Course Code	Course Type	Course Title	Load Allocations			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
BTCHE101-18	Basic Science	Mathematics – I	3	1	0	40	60	100	4
BTCHE102-18	Basic Science	Physics	3	1	0	40	60	100	4
BTCHE103-18	Basic Science	Chemistry – I	3	1	0	40	60	100	4
BTHU-101-18	Humanities, Social Sciences including Management	HASS-I (English)	2	0	0	40	60	100	2
BTCHE104-18	Engineering Science Courses	Engineering Graphics*	1	0	4	40	60	100	3
BTCHE105-18	Basic Science Courses	Physics Lab	0	0	3	30	20	50	1.5
BTHU-102-18	Humanities, Social Sciences including Management	HASS-I (English)-Lab	0	0	2	30	20	50	1
BMPD101-18		Mentoring and Professional Development	0	0	2	Satisfactory / Un-Satisfactory			Non-Credit
TOTAL Credits									**19.5**

* No Practical exam to be conducted. Only theory exam will be conducted.

Second Semester **Contact Hrs.: 28**

Course Code	Course Type	Course Title	Load Allocations			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
BTCHE201-18	Basic Science courses	Mathematics – II	3	1	0	40	60	100	4
BTCHE202-18	Engineering Science courses	Thermodynamics – I	3	1	0	40	60	100	4
BTCHE203-18	Engineering Science courses	Electrical & Electronics Engineering	3	1	0	40	60	100	4
BTCHE204-18	Professional Core Courses	Material & Energy Balance Computations	3	1	0	40	60	100	4
BTCHE205-18	Engineering Science courses	Programming for Problem Solving	3	0	0	40	60	100	3
BTCHE206-18	Basic Science courses	Chemistry Lab.	0	0	3	30	20	50	1.5
BTCHE207-18	Engineering Science courses	Programming for Problem Solving - Lab	0	0	4	30	20	50	2
BMPD201-18		Mentoring and Professional Development	0	0	2	Satisfactory / Un-Satisfactory			Non-Credit
	TOTAL								**22.5**

Third Semester **Contact Hrs. : 25**

Course Code	Course Type	Course Title	Load Allocations			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
BTCHE301-18	Engineering Science Course	Engineering and Solid Mechanics	3	1	0	40	60	100	4
BTCHE302-18	Basic Science Course	Chemistry - II	3	1	0	40	60	100	4
BTCHE303-18	Professional Core Courses	Transport Phenomena	3	1	0	40	60	100	4
BTCHE304-18	Basic Science Course	Biology	3	1	0	40	60	100	4
BTCHE305-18	Professional Core Courses	Thermodynamics – II	3	1	0	40	60	100	4
BTCHE306-18	Engineering courses Science	Engineering Workshop*	1	0	4	30	20	50	3
BMPD301-18		Mentoring and Professional Development	0	0	2	Satisfactory / Un-Satisfactory			Non-Credit
	TOTAL								**23**

*No theory exam to be conducted. Only practical exam will be conducted.

Fourth Semester **Contact Hrs. : 23**

Course Code	Course Type	Course Title	Load Allocations			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
BTCHE401-18	Professional Core Courses	Heat Transfer	3	1	0	40	60	100	4
BTCHE402-18	Professional Core Courses	Mass Transfer-I	3	1	0	40	60	100	4
BTCHE403-18	Professional Core Courses	Fluid Mechanics	3	1	0	40	60	100	4
BTCHE404-18	Engineering Core Courses	Materials Science	3	0	0	40	60	100	3
BTXXXXXX-18	Humanities And Social Sciences Including Management Courses	HASS- II (Foundation course in Humanities: Development of Societies/Philosophy)	3	0	0	40	60	100	3
BTCHE405-18	Professional Core Courses	Numerical Methods in Chemical Engineering	2	0	0	40	60	100	2
EVS101-18	Mandatory non-credit course	Environmental sciences	2	0	0	40	60	100	0
BTCHE406-18	Professional Core Courses	Numerical Methods in Chemical Engineering	0	0	2	30	20	50	1
BMPD401-18		Mentoring and Professional Development	0	0	2	Satisfactory / Un-Satisfactory			Non-Credit
	TOTAL								**21**

Fifth Semester **Contact Hrs. : 25**

Course Code	Course Type	Course Title	Load Allocations			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
BTCHE501-18	Professional Core Courses	Chemical Reaction Engineering- I	3	1	0	40	60	100	4
BTCHE502-18	Professional Core Courses	Mass Transfer- II	3	0	0	40	60	100	3
BTCHEXXX-18	Professional Elective Courses	Core Elective- I	3	0	0	40	60	100	3
	Open Elective Courses	Open Elective- I	3	0	0	40	60	100	3
BTXXXXXX-18	Humanities And Social Sciences Including Management Courses	HASS- III (Universal Human Values-II: Self, Society and Nature)	3	0	0	40	60	100	3
BTCHE503-18	Professional Core Courses	Chemical Engineering Lab-I	0	0	4	30	20	50	2
BTCHE504-18	Professional Core Courses	Particle & Fluid Particle Processing	3	0	0	40	60	100	3
BTCHE505-18	Mandatory course	Slot for MC [Constitution of India]	2	-	-	40	60	100	0
BMPD501-18		Mentoring and Professional Development	0	0	2	Satisfactory / Un-Satisfactory			Non-Credit
	TOTAL								**21**

Sixth Semester **Contact Hrs. :22**

Course Code	Course Type	Course Title	Load Allocations			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
BTCHE601-18	Professional Core Courses	Chemical Reaction Engineering- II	3	0	0	40	60	100	3
BTCHE602-18	Professional Core Courses	Process Technology & Economics	3	0	0	40	60	100	3
BTCHEXXX-18	Professional Elective Courses	Core Elective- II	3	0	0	40	60	100	3
BTCHE603-18	Professional Core Courses	Process Control	3	0	0	40	60	100	3
BTXXXXXX-18	Humanities And Social Sciences Including Management Courses	HASS- IV (Humanities Elective)	3	0	0	40	60	100	3
BTCHE604-18	Professional Core Courses	Chemical Engineering Lab- II	0	0	4	30	20	50	2
	Open Elective Courses	Open Elective- II	3	0	0	40	60	100	3
BMPD601-18		Mentoring and Professional Development	0	0	2	Satisfactory / Un-Satisfactory			Non-Credit
	TOTAL								**20**

Seventh Semester **Contact Hrs.:22**

Course Code	Course Type	Course Title	Load Allocations			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
BTCHEXXX-18	Professional Elective Courses	Core Elective- III	3	0	0	40	60	100	3
BTCHEXXX-18	Professional Elective Courses	Core Elective- IV	3	0	0	40	60	100	3
	Open Elective Courses	Open Elective- III	3	0	0	40	60	100	3
	Open Elective Courses	Open Elective-IV	3	0	0	40	60	100	3
BTCHE701-18	Professional Core Courses	Design & Simulation Lab*	1	0	4	30	20	50	3
BTCHE702-18	Professional Core Courses	Instrumentation & Control Lab*	1	0	4	30	20	50	3
BTCHE703-18	Summer Industry Internship Project	Summer internship 12 weeks after sixth semester	-	-	-	60	40	100	3
BMPD701-18		Mentoring and Professional Development	0	0	2	Satisfactory / Un-Satisfactory			Non-Credit
	TOTAL								**21**

*No theory exam to be conducted. Only practical exam will be conducted.

Eighth Semester **Contact Hrs. :**

Course Code	Course Type	Course Title	Load Allocations			Marks Distribution		Total Marks	Credits
			L	T	P	Internal	External		
BTCHE801-18	Summer Industry Internship Project	Project	-	-	-	240	160	400	12
	TOTAL								**12**

Guidelines regarding Mentoring and Professional Development

The objective of mentoring will be development of:

- Overall Personality
- Aptitude (Technical and General)
- General Awareness (Current Affairs and GK)
- Communication Skills
- Presentation Skills

The course shall be split in two sections i.e. outdoor activities and class activities.
For achieving the above, suggestive list of activities to be conducted are:

Part – A
(Class Activities)

1. Expert and video lectures
2. Aptitude Test
3. Group Discussion
4. Quiz (General/Technical)
5. Presentations by the students
6. Team building Exercises

Part – B
(Outdoor Activities)

1. Sports/NSS/NCC
2. Society Activities of various students chapter i.e. ISTE, SCIE, SAE, CSI, Cultural Club, etc.

Evaluation shall be based on rubrics for Part – A & B
Mentors/Faculty incharges shall maintain proper record student wise of each activity conducted and the same shall be submitted to the department.

Induction Programs
A Guide to Induction Program

Introduction

(Induction Program was discussed and approved for all colleges by AICTE in March 2017. It was discussed and accepted by the Council of IITs for all IITs in August 2016. It was originally proposed by a Committee of IIT Directors and accepted at the meeting of all IIT Directors in March 2016.[1] *This guide has been prepared based on the Report of the Committee of IIT Directors and the experience gained through its pilot implementation in July 2016 as accepted by the Council of IITs. Purpose of this document is to help institutions in understanding the spirit of the accepted Induction Program and implementing it.)*

Engineering colleges were established to train graduates well in the branch/department of admission, have a holistic outlook, and have a desire to work for national needs and beyond.

The graduating student must have knowledge and skills in the area of his study. However, he must also have broad understanding of society and relationships. Character needs to be nurtured as an essential quality by which he would understand and fulfill his responsibility as an engineer, a citizen and a human being. Besides the above, several meta-skills and underlying values are needed.

There is a mad rush for engineering today, without the student determining for himself his interests and his goals. This is a major factor in the current state of demotivation towards studies that exists among UG students.

The success of gaining admission into a desired institution but failure in getting the desired branch, with peer pressure generating its own problems, leads to a peer envi-ronment that is demotivating and corrosive. Start of hostel life without close parental supervision at the same time, further worsens it with also a poor daily routine.

To come out of this situation, a multi-pronged approach is needed. One will have to work closely with the newly joined students in making them feel comfortable, allow them to explore their academic interests and activities, reduce competition and make them

[1]A Committee of IIT Directors was setup in the 152nd Meeting of IIT Directors on 6th September 2015 at IIT Patna, on how to motivate undergraduate students at IITs towards studies, and to develop verbal ability. The Committee submitted its report on 19th January 2016. It was considered at the 153rd Meeting of all IIT Directors at IIT Mandi on 26 March 2016, and the accepted report came out on 31 March 2016. The Induction Program was an important recommendation, and its pilot was implemented by three IITs, namely, IIT(BHU), IIT Mandi and IIT Patna in July 2016. At the 50th meeting of the Council of IITs on 23 August 2016, recommendation on the Induction Program and the report of its pilot implementation were discussed and the program was accepted for all IITs.

work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and build character.

Induction Program

When new students enter an institution, they come with diverse thoughts, backgrounds and preparations. It is important to help them adjust to the new environment and inculcate in them the ethos of the institution with a sense of larger purpose. Precious little is done by most of the institutions, except for an orientation program lasting a couple of days.

We propose a 3-week long induction program for the UG students entering the institution, right at the start. Normal classes start only after the induction program is over. Its purpose is to make the students feel comfortable in their new environment, open them up, set a healthy daily routine, create bonding in the batch as well as between faculty and students, develop awarness, sensitivity and understanding of the self, people around them, society at large, and nature.[2]

The time during the Induction Program is also used to rectify some critical lacunas, for example, English background, for those students who have deficiency in it.

The following are the activities under the induction program in which the student would be fully engaged throughout the day for the entire duration of the program.

Induction Program as described here borrows from three programs running earlier at different institutions: (1) Foundation Program running at IIT Gadhinagar since July 2011, (2) Human Values course running at IIIT Hyderabad since July 2005, and (3) Counselling Service or mentorship running at several IITs for many decades. Contribution of each one is described next.

(1) IIT Gandhinagar was the first IIT to recognize and implement a special 5-week Foundation Program for the incoming 1st year UG students. It took a bold step that the normal classes would start only after the five week period. It involved activities such as games, art, etc., and also science and other creative workshops and lectures by resource persons from outside.

(2) IIIT Hyderabad was the first one to implement a compulsary course on Human Values. Under it, classes were held by faculty through discussions in small groups of students, rather than in lecture mode. Moreover, faculty from all departments got involved in conducting the group discussions under the course. The content is non-sectarian, and the mode is dialogical rather than sermonising or lecturing. Faculty were trained beforehand, to conduct these discussions and to guide students on issues of life.

(3) Counselling at some of the IITs involves setting up mentor-mentee network under which 1st year students would be divided into small groups, each assigned a senior student as a student guide, and a faculty member as a mentor. Thus, a new student gets connected to a faculty member as well as a senior student, to whom he/she could go to in case of any difficulty whether psychological, financial, academic, or otherwise.

The Induction Program defined here amalgamates all the three into an integrated whole, which leads to its high effectiveness in terms of building physical activity, creativity, bonding, and character. It develops sensitivity towards self and one's relationships, builds awareness about others and society beyond the individual, and also in bonding with their own batch-mates and a senior student besides a faculty member.

Scaling up the above amalgamation to an intake batch of 1000 plus students was done at IIT(BHU), Varanasi starting from July 2016.

2.1 Physical Activity

This would involve a daily routine of physical activity with games and sports. It would start with all students coming to the field at 6 am for light physical exercise or yoga. There would also be games in the evening or at other suitable times according to the local climate. These would help develop team work. Each student should pick one game and learn it for three weeks. There could also be gardening or other suitably designed activity where labour yields fruits from nature.

2.2 Creative Arts

Every student would chose one skill related to the arts whether visual arts or performing arts. Examples are painting, sculpture, pottery, music, dance etc. The student would pursue it everyday for the duration of the program.

These would allow for creative expression. It would develop a sense of aesthetics and also enhance creativity which would, hopefully, flow into engineering design later.

2.3 Universal Human Values

It gets the student to explore oneself and allows one to experience the joy of learning, stand up to peer pressure, take decisions with courage, be aware of relationships with colleagues and supporting staff in the hostel and department, be sensitive to others, etc. Need for character building has been underlined earlier. A module in Universal Human Values provides the base.

Methodology of teaching this content is extremely important. It must not be through do's and dont's, but get students to explore and think by engaging them in a dialogue. It is best taught through group discussions and real life activities rather than lecturing. The role of group discussions, however, with clarity of thought of the teachers cannot be over emphasized. It is essential for giving exposure, guiding thoughts, and realizing values.

The teachers must come from all the departments rather than only one department like HSS or from outside of the Institute. Experiments in this direction at IIT(BHU) are noteworthy and one can learn from them.[3]

Discussions would be conducted in small groups of about 20 students with a faculty mentor each. It is to open thinking towards the self. Universal Human Values discussions could even continue for rest of the semester as a normal course, and not stop with the induction program.

Besides drawing the attention of the student to larger issues of life, it would build relationships between teachers and students which last for their entire 4-year stay and possibly beyond.

[3]The Universal Human Values Course is a result of a long series of experiments at educational institutes starting from IIT-Delhi and IIT Kanpur in the 1980s and 1990s as an elective course, NIT Raipur in late 1990s as a compulsory one-week off campus program. The courses at IIT(BHU) which started from July 2014, are taken and developed from two compulsory courses at IIIT Hyderabad first introduced in July 2005.

2.4 Literary

Literary activity would encompass reading, writing and possibly, debating, enacting a play etc.

2.5 Proficiency Modules

This period can be used to overcome some critical lacunas that students might have, for example, English, computer familiarity etc. These should run like crash courses, so that when normal courses start after the induction program, the student has overcome the lacunas substantially. We hope that problems arising due to lack of English skills, wherein students start lagging behind or failing in several subjects, for no fault of theirs, would, hopefully, become a thing of the past.

2.6 Lectures by Eminent People

This period can be utilized for lectures by eminent people, say, once a week. It would give the students exposure to people who are socially active or in public life.

2.7 Visits to Local Area

A couple of visits to the landmarks of the city, or a hospital or orphanage could be organized. This would familiarize them with the area as well as expose them to the under privileged.

2.8 Familiarization to Dept./Branch & Innovations

The students should be told about diff erent method of study compared to coaching that is needed at IITs. They should be told about what getting into a branch or department means what role it plays in society, through its technology. They should also be shown the laboratories, workshops & other facilties.

3.Schedule

The activities during the Induction Program would have an Initial Phase, a Regular Phase and a Closing Phase. The Initial and Closing Phases would be two days each.

Time	Activity
Day 0 Whole Day	Student arrive – Hostel allotment. (Preferably do pre-allotment)
Day-1 09:00 am- 03:00 pm 04:30 pm - 06:00 pm	 Academic Registration Orientation
Day-2 09:00 am - 10:00 am	 Diagnostic Test (for English etc.)
10:15am - 12:25 pm	Visit to respective depts..
12:30 pm - 01:55 pm	Lunch
02:00 pm -02:55 pm	Director’s address
03:00 pm – 05:00 pm	Interaction with parents
03:30 pm – 05:00 pm	Mentor-mentee groups – introduction within group (Same as Universal Human Values groups)

3.2 Regular Phase

After two days is the start of the Regular Phase of induction. With this phase there would be regular program to be followed every day.

3.2.1 Daily Schedule

Some of the activities are on a daily basis, while some others are at specified periods within the Induction Program. We first show a typical daily timetable.

Sessn.	*Time*	*Activity*	*Remarks*
	Day 3 onwards		
	06:00 am	*Wake up call*	
I	06:30 am - 07:10 am	Physical activity (mild exercise/yoga)	
	07:15 am - 08:55 am	*Bath, Breakfast, etc.*	
II	09:00 am - 10:55 am	Creative Arts / Universal Human Values	Half the groups do Creative Arts
III	11:00 am - 12:55 pm	Universal Human Values / Creative Arts	Complementary alternate
	01:00 pm - 02:25 pm	*Lunch*	
IV	02:30 pm - 03:55 pm	Afternoon Session	See below.
V	04:00 pm - 05:00 pm	Afternoon Session	See below.
	05:00 pm - 05:25 pm	*Break / light tea*	
VI	05:30 pm - 06:45 pm	Games / Special Lectures	
	06:50 pm - 08:25 pm	*Rest and Dinner*	
VII	08:30 pm - 09:25 pm	Informal interactions (in hostels)	

Sundays are off . Saturdays have the same schedule as above or have outings.

3.2.2 Afternoon Activities (Non-Daily)

The following five activities are scheduled at diff erent times of the Induction Program, and are not held daily for everyone:

1. Familiarization to Dept. / Branch & Innovations
2. Visits to Local Area
3. Lectures by Eminent People
4. Literary
5. Proficiency Modules

Here is the approximate activity schedule for the afternoons (may be changed to suit local needs):

Activity	*Session*	*Remarks*
Familiarization with Dept/Branch & Innovations	IV	For 3 days (Day 3 to 5)
Visits to Local Area	IV, V and VI	For 3 days - interspersed (e.g., 3 Saturdays)
Lectures by Eminent People	IV	As scheduled - 3-5 lectures
Literary (Play / Book Reading / Lecture)	IV	For 3-5 days
Proficiency Modules	V	Daily, but only for those who need it

3.3 Closing Phase

Time	*Activity*
Last But One Day	
08:30 am - 12 noon	Discussions and finalization of presentation within each group
02:00 am - 05:00 pm	Presentation by each group in front of 4 other groups besides their own (about 100 students)
Last Day	
Whole day	Examinations (if any). May be expanded to last 2 days, in case needed.

3.4 Follow Up after Closure

A question comes up as to what would be the follow up program after the formal 3-week Induction Program is over? The groups which are formed should function as mentor-mentee network. A student should feel free to approach his faculty mentor or the student guide, when facing any kind of problem, whether academic or financial or psychological etc. (For every 10 undergraduate first year students, there would be a senior student as a *student guide*, and for every 20 students, there would be a *faculty mentor*.) Such a group should remain for the entire 4-5 year duration of the stay of the student. Therefore, it would be good to have groups with the students as well as teachers from the same department/discipline[4].

Here we list some important suggestions which have come up and which have been experimented with.

3.4.1 Follow Up after Closure – Same Semester

It is suggested that the groups meet with their faculty mentors once a month, within the semester after the 3-week Induction Program is over. This should be a scheduled meeting shown in the timetable. (The groups are of course free to meet together on their own more often, for the student groups to be invited to their faculty mentor's home for dinner or tea, nature walk, etc.)

3.4.2 Follow Up – Subsequent Semesters

It is extremely important that continuity be maintained in subsequent semesters.

It is suggested that at the start of the subsequent semesters (upto fourth semester), three days be set aside for three full days of activities related to follow up to Induc-tion Program. The students be shown inspiring films, do collective art work, and group discussions be conducted. Subsequently, the groups should meet at least once a month.

Summary

Engineering institutions were set up to generate well trained manpower in engineering with a feeling of responsibility towards oneself, one's family, and society. The incoming undergraduate students are driven by their parents and society to join engineering without understanding their own interests and talents. As a result, most students fail to link up with the goals of their own institution.

The graduating student must have values as a human being, and knowledge and meta-skills related to his/her profession as an engineer and as a citizen. Most students who get demotivated to study engineering or their branch, also lose interest in learning.

The *Induction Program* is designed to make the newly joined students feel comfortable, sensitize them towards exploring their academic interests and activities, reducing compe-tition and making them work for excellence, promote bonding within them, build relations between teachers and students, give a broader view of life, and building of character.

The *Universal Human Values* component, which acts as an anchor, develops awareness and sensitivity, feeling of equality, compassion and oneness, draw attention to society and

[4]We are aware that there are advantages in mixing the students from diff erent depts. However, in mixing, it is our experience that the continuity of the group together with the faculty mentor breaks down soon after. Therefore, the groups be from the same dept. but hostel wings have the mixed students from diff erent depts. For example, the hostel room allotment should be in alphabetical order irrespective of dept.

nature, and character to follow through. It also makes them reflect on their relationship with their families and extended family in the college (with hostel staff and others). It also connects students with each other and with teachers, so that they can share any difficulty they might be facing and seek help.

References:

Motivating UG Students Towards Studies,

Rajeev Sangal, IITBHU Varanasi, Gautam Biswas, IIT Guwahati, Timothy Gonsalves, IIT Mandi, Pushpak Bhattacharya, IIT Patna, (Committee of IIT Directors), 31 March 2016, IIT Directors' Secretariat, IIT Delhi.

Contact: *Prof. Rajeev Sangal* Director, IIT(BHU), Varanasi, (director@iitbhu.ac.in)

Undergraduate Degree in Engineering & Technology

Branch/Course: CHEMICAL ENGINEERING

First Year Courses

BASIC SCIENCE COURSES

BTCHE101-18	**Mathematics - I**	**3L:1T:0P**	**4 credits**

Objectives

Basic concepts of linear algebra and vector calculus.

1.Linear Algebra: Matrices, Vectors, Determinants, Linear Systems(12L + 4T)

- Matrices, Vectors: Addition and Scalar Multiplication
- Matrix Multiplication
- Linear Systems of Equations, Gauss Elimination
- Linear Independence. Rank of a Matrix. Vector Space
- Solutions of Linear Systems: Existence, Uniqueness
- Determinants, Cramer's Rule
- Inverse of a Matrix. Gauss-Jordan Elimination

2.Linear Algebra: Matrix Eigenvalue Problems (9L + 3T)

- Eigenvalues, Eigenvectors
- Applications of Eigenvalue Problems
- Symmetric, Skew-Symmetric, and Orthogonal Matrices

3.Vector Differential Calculus. Grad, Div, Curl (12L + 4T)

- Vectors in 2-Space and 3-Space
- Inner Product (Dot Product), Vector Product (Cross Product)
- Vector and Scalar Functions and Fields, Derivatives

- Curves. Arc Length. Curvature
- Gradient of a Scalar Field,Directional Derivative
- Divergence of a Vector Field
- Curl of a Vector Field.

4.Integral Calculus. Integral Theorems(12L + 4T)

- Line Integrals, Path Independence of Line Integrals
- Green's Theorem in the Plane
- Surfaces for Surface Integrals
- Surface Integrals

Total 60 (L + T)

Course outcomes

Students will be able to solve

System of linear algebraic equations

Vector algebra, vector differential calculus and vector integral calculus

BTCHE102-18	**Physics**	**3L:1T:0P**	**4 credits**

Objectives:

Basic concepts of optics and its applications, electricity and magnetism, and quantum physics.

1. Optics and Fibre Optics (12L + 4T)

- Diffraction: Introduction to interference and example; concept of diffraction, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction at single slit, double slit, and multiple slits; diffraction grating, characteristics of diffraction grating and its applications.
- Polarisation: Introduction, polarisation by reflection, polarisation by double refraction, scattering of light, circular and elliptical polarisation, optical activity.
- Fibre Optics: Introduction, optical fibre as a dielectric wave guide: total internal reflection, numerical aperture and various fibre parameters, losses associated with optical fibres, step and graded index fibres, application of optical fibres.
- Lasers: Introduction to interaction of radiation with matter, principles and working of laser: population inversion, pumping, various modes, threshold population inversion, types of laser: solid state, semiconductor, gas; application of lasers.

2. Electromagnetism and Magnetic Properties of Materials (15L + 5T)

- Laws of electrostatics, electric current and the continuity equation, laws of magnetism. Ampere's Faraday's laws. Maxwell's equations. Polarisation, permeability and dielectric constant, polar and non-polar dielectrics, internal fields in a solid, Clausius-Mossotti equation, applications of dielectrics.
- Magnetisation, permeability and susceptibility, classification of magnetic materials, ferromagnetism, magnetic domains and hysteresis, applications.

3. Quantum Mechanics (18L + 6T)

Introduction to quantum physics, black body radiation, explanation using the photon concept, photoelectric effect, Compton effect, de Broglie hypothesis, wave-particle duality, Born's interpretation of the wave function, verification of matter waves, uncertainty principle, Schrodinger wave equation, particle in box, quantum harmonic oscillator, hydrogen atom.

Total 60 (L + T)

Course outcomes

Students will be familiar with

Bragg's Law and introduced to the principles of lasers, types of lasers and applications Various terms related to properties of materials such as, permeability, polarization, etc.

Some of the basic laws related to quantum mechanics as well as magnetic and dielectric properties of materials

Simple quantum mechanics calculations.

BTCHE103-18	**Chemistry – I**	**3L:1T:0P**	**4 credits**

Objectives

Concepts of quantum chemistry, bonding, stereochemistry, and those of Synthesis methodologies and reactivity of organic compounds.

1. Introduction to quantum theory for chemical systems: Schrodinger equation, Applications to Hydrogen atom, Atomic orbitals, many electron atoms (6L + 2T)

2. Chemical bonding in molecules: MO theory, Structure, bonding and energy levels of bonding and shapes of many atom molecules, Coordination Chemistry, Electronic spectra and magnetic properties of complexes with relevance to bio-inorganic chemistry, organometallic chemistry (12L + 4T)

3. Introduction to Stereochemistry: Stereodescriptors – R, S, E, Z. Enantiomers and Diastereomers. Racemates and their resolution. Conformations of cyclic and acyclic systems. (6L + 2T)

4. Reactivity of organic molecules: factors influencing acidity, basicity, and nucleophilicity of molecules, kinetic vs. thermodynamic control of reactions (9L + 3T)

5. Strategies for synthesis of organic compounds: Reactive intermediates substitution, elimination, rearrangement, kinetic and thermodynamic aspects, role of solvents (12L + 4T)

Total 60(L+T)

Course outcomes

Students will be able to

Appreciate quantum theory of chemical systems

Appreciate aliphatic chemistry and stereochemistry Write simple mechanisms

BTCHE105-18	**Physics Lab**	**0L:0T:3P**	**1.5 credits**

Objectives

Physics lab provides students the first hand experience of verifying various theoretical concepts learnt in theory courses.

1. About 10 – 12 experiments to illustrate the concepts learnt in Physics (Number of lab. Hrs. 3 per experiment)

Suitable number of experiments from the following categories:
Optics and its applications

Electricity & Magnetism
Quantum Mechanics

Total 48 lab. Hrs.

Laboratory outcomes

Students should be able to

State various laws which they have studied through experiments
Describe principles of optical fibre communication

BTCHE201-18	**Mathematics – II**	**3L:1T:0P**	**4 credits**

Objectives:

Basic concepts of transforms, ordinary and partial differential equations

Contents :

1.Transforms [6L + 2T]

- Laplace Transforms
- Fourier Series and Transforms

2. First-Order ODEs [9L + 3T]

- Basic Concepts
- Solutions of Separable ODEs, Exact ODEs, Linear ODEs

- Solving ODEs by Laplace Transforms

3. Second-Order Linear ODEs [9L + 3T]

- Homogeneous Linear ODEs of Second Order
- Euler-Cauchy Equations
- Wronskian
- Nonhomogeneous ODEs, Solution by Variation of Parameters

4. Series Solutions of ODEs, Special Functions [12L + 4T]

- Power Series Method
- Legendre.'s Equation, Legendre Polynomials
- Bessel's Equation, Bessel Functions
- Sturm-Liouville Problems, Orthogonal Functions

5.Partial Differential Equations (9L + 3T)

- Basic Concepts, Classification
- Solution of PDEs: Separation of Variables, Fourier Series, Laplace Transforms

Total 60(L+T)

Course outcomes

Students should be able to solve

Simple first and second order ODE by Analytical methods
First and second order differential equations numerically
Partial differential equations numerically

Problems relating to Laplace transforms

BTCHE206-18	**Chemistry Lab**	**0L:0T:3P**	**1.5 credits**

Objectives

Chemistry lab provides students the first hand experience of verifying various theoretical concepts learnt in theory courses.

1. About 10 – 12 experiments to illustrate the concepts learnt in Chemistry-I, Chemistry-II (No. of lab. Hours 4 per experiment).
Suitable number of experiments from the following categories:

Identification of an organic compounds through group detection, physical constants (m.p and b.p)

Synthesis of organic compounds involving reactions such as hydrogenation, oxidation, esterification, etc.

Use of analytical instruments for characterization and identification of compounds
Measurements of kinetics of simple reactions

Total 48 lab. Hrs

Course Outcomes

Students will be able to

List steps for identifying simple organic compounds
Use different analytical instruments

Identify reaction rate parameters

ENGINEERING SCIENCE COURSES

BTCHE104-18	**Engineering Graphics**	**1L:0T:4P**	**3 credits**

Objectives

Students would be introduced to methods to aid visualisation of engineering objects and communicating the same to other professionals. This includes engineering drawings, CAD systems and tools for processing and presentation of time evolving systems in the form of animation, free-hand sketching of engineering objects and interpretation of drawings as a visualisation and communication tool. Design of simple assemblies would be involving theory of constraints, generation of assembly views from part drawings, animation of assemblies. Use of 3D models of rigid and soft systems in conjunction with physics engines for representation of time evolving system.

1. Instructions for graphic science and visualization (1L+1P)

2. Free hand sketching of isometric & orthographic views and interpretation of drawings (3L+3P)

3. Dimensioning, sectioning and datum planes. (4L+4P)
4. Constraints and assembly drawings (2L+2P)
5. Engineering animation including motion curves, coordinating multiple moving parts under joint-constraints and the notion and impact of lighting and camera (3L+3P)

6. Compositing and physics engines (gravity, collision, dynamics, fluid simulation (2L+2P)

Total 15L+15P[*] [*]1L means one lecture turn (typically, 1 hour) and 1P means one practical turn (typically, 3-4 hours).

Course outcomes

Students will be able to read drawing and can understand different views.

BTCHE202-18	**Thermodynamics-1**	**3L:1T:0P**	**4 credits**

Objectives:

Principles and application of first and second law of thermodynamics, and phase equilibria.

Contents :

1. Introduction- scope of thermodynamics, Dimensions and Units, Temperature, Pressure, Work, Energy, Heat [3L + 1T]

2. Energy conservation & first law of thermodynamics; State functions; Equilibrium; Phase Rule; Reversible process; Constant P,V, T processes; Mass and energy balances for open systems .

[6L + 2T]

3. Phases, phase transitions, PVT behavior; description of materials – Ideal gas law, van der Waals, virial and cubic equations of state; Reduced conditions & corresponding states theories; correlations in description of material properties and behavior [6L + 2T]

4. Heat effects-latent heat, sensible heat,standard heats of formation, reaction and combustion. [3L + 1T]

5. Statements of the second law; Heat engines, Carnot's theorem,; Thermodynamic Temperature Scales; Entropy; Entropy changes of an ideal gas; Mathematical statement of the second law; Entropy balance for open systems; Calculation of ideal work, Lost work. (6L + 2T)

6. Thermodynamic property of fluids, Maxwell relations, 2-phase systems, graphs and tables of thermodynamic properties. (6L + 2T)

7. Application of thermodynamics to flow processes-pumps, compressors and turbines (3L + 1T)

8. Thermodynamic analysis of steam power plants; Rankine cycle; Internal combustion engine, Otto engine; Diesel engine;Jet engine. (6L + 2T)

9. The Carnot refrigerator; Vapor-compression cycle; Absorption refrigeration;Heat pump, Liquefaction processes.. (6L + 2T)

Total 60(L+T)

Suggested Text Books

1. J.M. Smith, H.C. Van Ness and M.M. Abbott, Introduction to Chemical Engineering Thermodynamics, 7th edition, McGraw-Hill International Edition,2005.

Suggested References Books

1. M J Moran, H N Shapiro, D D Boettner and M B Bailey, Principles of Engineering Thermodynamics, 8th Edition, Willey .

Course outcomes

Students should be able to

Apply mass and energy balances to closed and open systems
Evaluate the properties of non-ideal gases

Solve problems involving liquefaction, refrigeration and different power cycles.

BTCHE203-18	**Electrical & Electronics Engineering**	**3L:1T:0P**	**4 credits**

Objectives

An insight to the importance of electrical energy in chemical plants. Basics of electricity, selection of different types of drives for a given application process. Basic insight into power supplies, instrumentation amplifiers in industries.

Contents :

1. Elements in an Electrical circuit: R, L, C, Diode, voltage and current sources [3L + 1T]

2.DC circuits, KCL, KVL, Network theorems, Mesh and nodal analysis [6L + 2T]

3.Step response in RL, RC, RLC circuits [3L+1T]

4. Phasor analysis of AC circuits [6L+2T]

5. Single-phase and 3-phase circuits. (3L+1T)

6. Two port networks, BJT, CE and small signal model, operational amplifiers, model and applications. (3L+1T)

7. Introduction to digital circuits (6L+2T)

8. Transformers: modelling and analysis. (6L+2T)

9. Energy in magnetic field. (3L+1T)

10. Electromechanical energy conversion: principles and examples (3L+1T)

11. Principles of measurement of voltage, current and power (3L+1T)
Total 60 (L+T)

Course outcomes

Students will be able to

Understand the basic concepts of D.C., single phase and three phase A.C. supply and circuits, and solve basic electrical circuit problems

Understand the basic concepts of transformers and motors used as various industrial drives
Understand the concept of power factor improvement for industrial installations and concept of most economical power-factor

BTCHE205-18	**Computers Lab (Programming for Problem Solving)**	**3L:0T:0P**	**3 credits**
BTCHE207-18	**Programming for Problem Solving**	**0L:0T:4P**	**2 credits**

Objectives

To make students familiar with the use of computers for scientific calculations, use of programming languages and the logic for writing computer programs involving problems from Mathematics and Statistics, Physics, Chemistry.

1.About 10 – 12 assignments to be done using computers, such as: (No. of contact. Hrs: 4 per experiment, Lectures to cover material in sync)

Organization of Computing Systems. Concepts of algorithms
Basics of programming languages using, arrays, loops, if-else, switch case, functions
Using the above for solving problems such as:
Curve fitting and regression, Data analysis and handling, linear and non-linear equations, etc.

Total 48 contact Hrs

Course outcomes

Students will be able to solve simple problems in statistics, chemistry and physics using programming languages.

PROFESSIONAL CORE COURSES

BTCHE204-18	**Material and Energy Balance Computations**	**3L:1T:0P**	**4 credits**

Objectives

The course will serve as a basis for all further chemical engineering courses that are part of the curriculum**.**

Contents :

1. Introductory concepts of units, physical quantities in chemical engineering, dimensionless groups, "basis" of calculations [3L + 1T]

2. Material Balance: Introduction, solving material balance problems without chemical reaction [6L+2T]

3. Material Balance: With chemical reaction, Concept of stoichiometry and mole balances, examples, including combustion[6L+2T]

4. Material Balances with recycle, bypass and purge [6L+2T]

5. Gases, Vapours and Liquids: Equations of state, Vapour pressure, Clausius-Clapeyron equation, Cox chart, Duhring's plot, Raoult's law,. (6L+2T)

6. Energy balance: open and closed system, heat capacity, calculation of enthalpy changes (6L+2T)

7. Energy balances with chemical reaction: Heat of reaction, Heat of combustion (6L+2T)

8. Crystallization, Dissolution. (3L+1T)

9. Humidity and Saturation, humid heat, humid volume, dew point, humidity chart and its use. (3L+1T)

Total 60 (L+T)

Suggested Text Books

1. Himmelblau, D. M., Riggs, J. B. "Basic Principles and Calculations in Chemical Engineering", Eighth Ed., Pearson India Education Services, 2015.
2. Bhatt, B. I., Vora, S. M., "Stoichiometry", Fourth Edition, Tata McGraw Hill Publishing

1. Felder, R. M.; Rousseau, R. W., "Elementary Principles of Chemical Processes", Third Edition, John Wiley & Sons, 2000
2. Hougen, O. A., Watson, K. M., Ragatz, R. A., "Chemical Process Principles, Part-I Material & Energy Balances", Second Edition, CBS Publishers & Distributors, 2004
3. Venkataramani, V., Anantharaman, N., Begum, K. M. Meera Sheriffa, "Process Calculations", Second Edition, Prentice Hall of India.

4. Sikdar, D. C., "Chemical Process Calculations", Prentice Hall of India.

Course outcomes

Students completing the course will

Develop mastery over process calculations relevant to chemical engineering processes Bee able to handle elementary flow-sheeting, material and energy balance calculations without and with chemical reactions, and involving concepts like recycle, bypass and purge. Be familiar with equations of state and properties of gases and liquids, including phase transition

Humanities and Social Sciences

Curricular Structure

Total Credits: 12

Semester	L-T-P-C	Course No. & Title
1	2-0-2-3	English and English Lab
4	3-0-0-3	Foundation Course in Humanities (Development of Societies or Philosophy)
5	3-0-0-3	Universal Human Values – II
6	3-0-0-3	Humanities elective

CONTENTS

BTHU-101 English 2L: 0T: 0P 2 credits

Course Outcomes:

- The objective of the course is to help the students become the independent users of English language.
- Students will acquire basic proficiency in reading & listening, comprehension, writing and speaking skills.
- Students will be able to understand spoken and written English language, particularly the language of their chosen technical field.
- They will be able to converse fluently.
- They will be able to produce on their own clear and coherent texts.

Detailed contents

Unit-1 Vocabulary Building & Basic Writing Skills

- The concept of Word Formation

- Root words from foreign languages and their use in English
- Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives
- Synonyms, antonyms, and standard abbreviations.
- Sentence Structures
- Use of phrases and clauses in sentences
- Importance of proper punctuation
- Creating coherence
- Organizing principles of paragraphs in documents
- Techniques for writing precisely

Unit-2 Identifying Common Errors in Writing

- Subject-verb agreement
- Noun-pronoun agreement
- Misplaced modifiers
- Articles
- Prepositions
- Redundancies
- Clichés

Unit-3 Mechanics of Writing

- Writing introduction and conclusion
- Describing
- Defining
- Classifying
- Providing examples or evidence

Unit-4 Writing Practices

- Comprehension
- Précis Writing
- Essay Writing
- Business Writing-Business letters, Business Emails, Report Writing, Resume/CV

Suggested Readings:

(i) *Practical English Usage*. Michael Swan. OUP. 1995.

(ii) *Remedial English Grammar*. F.T. Wood. Macmillan.2007

(iii) *On Writing Well*. William Zinsser. Harper Resource Book. 2001

(iv) *Study Writing*. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press. 2006.

(v) *Communication Skills*. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.

(vi) *Exercises in Spoken English*. Parts. I-III. CIEFL, Hyderabad. Oxford University Press

BTHU-102 (English Laboratory)

0L: 0T: 2P 1 credit

Course Outcomes:

- The objective of the course is to help the students become the independent users of English language.
- Students will acquire basic proficiency in listening and speaking skills.
- Students will be able to understand spoken English language, particularly the language of their chosen technical field.
- They will be able to converse fluently
- They will be able to produce on their own clear and coherent texts.

Detailed contents

Interactive practice sessions in Language Lab on Oral Communication

- Listening Comprehension
- Self-Introduction, Group Discussion and Role Play
- Common Everyday Situations: Conversations and Dialogues
- Communication at Workplace
- Interviews
- Formal Presentations

Suggested Readings:

(i) *Practical English Usage*. Michael Swan. OUP. 1995.

(ii) *Communication Skills*. Sanjay Kumar and Pushp Lata. Oxford University Press. 2011.

(iii) *Exercises in Spoken English*. Parts. I-III. CIEFL, Hyderabad. Oxford University Press