UNIVERSITY OF CALCUTTA

NotificationNo.CSR/49/19

It is notified for information of all concerned that the Syndicate in its meeting held on 08.8.2019 (vide Item No.55), subsequently confirmed by the Syndicate dated 27.08.019 (Item No.01) approved the revised course syllabus for AICTE model curriculum of 4-year 8-Semester B.Tech course of study in Chemical Technology, under this University, as laid down in the accompanying pamphlet.

The above shall take immediate effect from the session 2019-2020.

26/11/19

Prof.(Dr.) Debasis Das

Registrar

SENATE HOUSE

KOLKATA-700 073

The 26th November, 2019.

26.11.19

UNIVERSITY OF CALCUTTA

Department of Chemical Technology

Faculty of Engineering & Technology

Regulation for 4-year 8-semester B. Tech. course in Chemical Technology

(with effect from the academic year 2019 – 2020)

1	Department of Chemical Technology, Faculty of Engineering and Technology, University of Calcutta shall provide instructions leading towards the 4-year, 8-semester B. Tech. degree in **Chemical Technology**. The course is of four (4) years duration comprised of eight (8) Semesters, each Semester being of six (6) months' duration.	
2	**Eligibility for Admission**	
	(a)	Category-1: For admission into the FIRST YEAR of 4-Year B. Tech. course in **Chemical Technology**, the candidates must have passed Class XII Examinations in the system of 10+2 under West Bengal Council of Higher Secondary Education or equivalent with Physics, Chemistry, Mathematics securing an average of at least 60% marks (or equivalent grade) in these subjects and **cleared West Bengal JEE.**
	(b)	Category-2: For admission of the B.Sc. (Hons.) qualified students into the SECOND YEAR of B. Tech. course in **Chemical Technology**, the candidates must have passed B.Sc. Honours with Chemistry. The selection will be strictly based on merit as adopted and invoked time to time by University of Calcutta. The 'Category-2' students must have to attend and pass 'Workshop' and 'Engineering Drawing' subjects additionally arranged in the FOURTH Semester curriculum. However, no credit points will be awarded and will not be included for SGPA calculation. In the main mark sheet, mention will be made (at the bottom) that he/she has qualified 'Workshop/Drawing' with grade ----. The course of study for students admitted in the 2nd year will be of 6 Semesters (starting from third Semester) in three academic years.
	(c)	Any seat(s) remaining vacant at the end of Second Semester will be filled up by Category-2 candidates.
3	The award of the said B. Tech. Degrees will be conferred to students who are successful in all of the eight (8) / six (6) Semester examinations.	
4	**Attendance:** A student **must attend 75%** of the theoretical and laboratory/ practical classes **and successfully complete sessional assessment** in order to appear at Semester examinations.	

5 Credit based Evaluation

(a) The credit based examination system will be followed for all Semester examinations. The course shall have a certain number of credits assigned to it depending upon the academic load of the course assessed on the basis of *weekly contact hours* of lecture, tutorial and laboratory classes, assignments or field study and/or self study.

Generally, the course shall have an integer number of credits reflecting its weight. The number of credits of a course in a semester shall ordinarily be calculated as under:

(i) Lecture (L)/Tutorial (T): One lecture hour per week shall normally be assigned one credit. One hour of tutorial per week shall be assigned one credit. For determining the credits of a theory course, lectures and tutorials shall be added.

(ii) Practical (P): Three laboratory hours per week shall be assigned two (2) credits. Courses other than Lectures/Tutorials shall be treated as practical courses.

The course credits shall be given as L-T-P. For example, 3-1-0 will mean that it is a lecture based course and has 3 lectures, 1 tutorial, and no practical assigned to it. Similarly, a course with 0-0-3 means that it is a practical course with 3 hours of practical work. Credits will be assigned to seminar, dissertation, project etc. under the practical component.

The 4-year course of study will have subjects covering a total of 180 credits

In general, examinations on theoretical papers will be on 100 marks of 4 Credits, while papers CT301, CT302, CT303, CT403 and CT801 consisting of 2 modules, examination will be on 50 marks for each module having 2 credits per module.

The laboratory/practical papers will carry 50 marks of 2/1.5 Credits.

Credit points of theoretical and practical papers including project work, design, General Viva Voce, plant training, seminar presentation etc. offered by Department are given in Course Structures separately. There will be two components of examinations of theoretical papers: i) Sessional assessment 30% and ii) End Semester examination 70%

(b) **The Sessional assessment components of theory papers are:**

Serial No	Type of evaluation	Marks (100/50)
1	Sessional Assessments through Class Test/ Assignments	25/10
2	Overall conduct, attendance, manners, skills etc.	05

(c) **Evaluation in Laboratory/ practical papers:**

Serial No	Type of evaluation	Marks
1	Report and results	20
2	Viva	20
3	Overall conduct, attendance, discipline, manners, skills etc.	10

(d) **Eligibility of success/failure in a Semester Examination:**

(i) A student admitted in 1st semester of B. Tech. course will get total 6 consecutive academic years from his/her year of admission to pass in all the 8 semesters.

A student admitted in 3rd semester of B. Tech. course will get total 5 consecutive academic years from his/her year of admission to pass in all the 6 semesters.

(ii) A student has to secure at least 50% marks i.e. Grade-D in all subjects individually in order to ***pass the examination.***

(iii) If a student don't secure at least 50% marks or absent in the end semester examination of theory subject needs to appear in that paper in the examination of next academic session(s). In the case of theoretical paper, the marks of Sessional assessment would be retained.

(iv) A student will be eligible to take admission to the next immediate higher semester if the number of non-appeared paper in Theoretical examination does not exceed more than two. A student must have to appear in all the papers of the practical examination of the semester concerned.

(v) If a student does not appear in more than two theoretical papers or any of the practical paper of the semester needs to take readmission in that semester of next academic season.

(vi) A student can appear in current semester and along with that could appear supplementary examination of maximum of 2 previous semesters of the corresponding even or odd semester. (e.g. A students has failed in a paper in 1st semester will get 2 additional chances in 3rd and 5th Semester).

(vii) **Special supplementary examinations** will be arranged only for Semester 7 and 8 just after the declaration of results of 7th and 8th Semester. Students who could not secure 50% marks in Special supplementary examination will have to appear in next academic session. (Provided maximum 6 years span for 4 Year B. Tech. and 5 Years span for 3 Years B. Tech. kept intact).

(viii) **Eligibility for a Degree:** A student needs to pass in all the theoretical and practical papers to qualify for B. Tech. Degree.

'Category 1' student has to pass all the theoretical and practical papers of 8-Semesters in maximum of 6 year periods from admission to obtain B. Tech. degree in corresponding course.

'Category 2' student has to pass all the theoretical and practical papers of 6-Semesters starting from 3rd Semester in maximum of 5 year periods to obtain B. Tech. degree in corresponding course.

(ix) A student failing in any subject should apply to the Secretary, UCSTA through the Head of the Department for appearing at the supplementary examinations within 7 days of the publication of results.

6 (a) On the basis of total marks secured in each paper, **Grade (G)** and **Grade Point (GP)** shall be awarded to a student.

The equivalence between grades, grade points and the percentage marks is given by:

Percentage (%) of marks	**Grade (G)**	**Grade Point (GP)**
≥ 90	Ex	10
89 – 80	A	9
79 - 70	B	8
69 - 60	C	7
59 - 50	D	6
< 50	F	0

(b) Each paper shall carry **Credit (C)** according to the number of hours allotted per week and as indicated in the following table:

Paper/subject	No. of hours/week	Credit (C) assigned
Theoretical	3	4
Tutorial	1	
Practical	3/6	(2/3/4)

(c) The performance of a candidate in n^{th} Semester examination, who earns all the credits of that semester, will be assessed by the '**Semester Grade Point Average' (SGPA), 'S_n'** to be computed as:

$$SGPA\,[S_n\,] = \frac{\sum_k [C_k\, GP_k\,]}{\sum_k C_k}$$

where 'k' denotes the number of papers in a particular semester and

$\sum_k C_k$ denotes the total credits of a particular semester and

GP_k is the grade point of k^{th} paper.

	(d)	On completion of the B. Tech. course in Chemical Technology, the overall performance of a candidate will be assessed by the '**Cumulative Grade Point Average' (CGPA)** to be computed as: $$CGPA = \frac{\sum_n [C_n S_n]}{\sum_n C_n}$$ where, $C_n = \sum_k C_k$ and $\sum_n C_n$ denotes total credits of all the semesters, i.e. 180 credits for Category-1 and 137 credits for Category-2.
	(e)	Each theory and each practical paper will be assessed by internal examiner(s). Design, Project, seminar and General Viva Voce examinations will be assessed by a board consisting of at least two (2) internal examiners and at least one (1) external examiner.
	(f)	If a candidate is unable to appear at any of the theory or practical examination(s), he/she will earn zero (0) credit in that paper(s).
7	Candidates appearing in a semester examination shall join classes in the next semester immediately, wherever applicable, after completion of the examination.	
8	The Calcutta University Syndicate shall publish a list of successful candidates of the B. Tech. examination for each of the Semester examinations.	
9	At the end of each Semester examination, a Grade-Sheet showing the Semester performance (Semester Grade Sheet) indicated by **SGPA** will be issued to the students. However, SGPA will not be calculated for those candidates who fail to earn all the credits in that Semester. The Semester Grade Sheet should have the following basic information: The merit list will be prepared on the basis of the total marks obtained.	

Course Code	Module	Details of courses	Credits	Course Total		Grade Point	Letter Grade	SGPA	Remarks
				Full Marks	Marks obtained				

10	(a)	A consolidated Grade-Sheet, showing the overall performance in the B. Tech course indicated by **CGPA**, will be issued only to those successful students who have earned 180 credits for Category-1 and 137 credits for Category-2 in the B. Tech. course. The consolidated grade sheet shall consist of two components. The first component will have the information of the final Semester as follows:							

Course Code	Module	Details of courses	Credits	Course Total		Grade Point	Letter Grade	SGPA	Remar
				Full Marks	Marks obtained				

		The second component will have a **summary** of all the semesters having the following basic information: The hash (#) in the last row of last column will contain the information regarding the final achievement of the candidate in all the examinations. $This box will contain only one (1) of the following three (3) information: '1st Class' / '2nd Class' / 'Failed'.
	(b)	Candidates securing CGPA at least 7.5 in B. Tech. Examination shall be placed in the First Class and those securing 6.0 or more but less than 7.5 shall be placed in the 'Second Class'. Candidates securing CGPA less than 6.0 shall be declared 'Failed'.
11		The Degree of **"Bachelor of Technology"** under the seal of the University shall be awarded to a successful candidate mentioning the grade and class he/she has obtained. The format will be as follows: UNIVERSITY OF CALCUTTA LOGO ***It is hereby certified that after satisfying all the conditions prescribed by the University*** **----------*(Name)* was on the ---th day of ----(month), -----(year)** **Duly admitted to the Degree of** ***Bachelor of Technology in* CHEMICAL TECHNOLOGY** ***In the ---- Class*** Vice Chancellor Senate House

Semester	Total credit	Credit obtained	Full marks	Marks obtained	SGPA	Cumulative statement	
8th						Total Credit	
7th						Credit Obtained	
6th						Full Marks	
5th						Grand Total	
4th						CGPA	
3rd						Result	#
2nd						$	
1st							

Course Structure and Syllabus for 4-year, 8-semester B. Tech. Course in Chemical Technology

DEPARTMENT OF CHEMICAL TECHNOLOGY
UNIVERSITY OF CALCUTTA

CURRICULUM

B. Tech. in Chemical Technology (Ceramic Engineering/Oil Technology/Petrochemicals & Petroleum Refinery Engineering/Pharmaceutical & Fine Chemical Technology)

(With effect from Academic year 2019 – 2020)

1st Semester

Paper No	Sub Code	Subject	Periods			Cr	Marks		
			L	T	P		IA	UE	TM
Theory									
1.	HU101	Communication English, Management and Social Sciences	2	1	-	3	30	70	100
2.	PH102	Physics-I	2	1	-	3	30	70	100
3.	CH103	Chemistry-I	2	1	-	3	30	70	100
4.	MA104	Engineering Mathematics-I	2	1	-	3	30	70	100
5.	EE105	Basic Electrical Engineering	2	1	-	3	30	70	100
Practical									
6.	HU106	Language Lab	-	-	3	1.5	15	35	50
7.	PH107	Physics Lab –I	-	-	3	1.5	15	35	50
8.	CH108	Chemistry Lab –I	-	-	3	1.5	15	35	50
9.	EE109	Basic Electrical Engineering Lab	-	-	3	1.5	15	35	50
		Total	10	5	12	21	210	490	700

2nd Semester

Paper No	Sub Code	Subject	Periods			Cr	Marks		
			L	T	P		IA	UE	TM
Theory									
10.	CH201	Chemistry-II[#]	2	1	-	3	30	70	100
11.	MA202	Engineering Mathematics-II	2	1	-	3	30	70	100
12.	ME203	Engineering Mechanics	2	1	-	3	30	70	100
13.	CS 204	Basic computer Science and Engineering	2	1	-	3	30	70	100
14.	BE205	Basic Electronics	2	1	-	3	30	70	100
Practical									
15.	CH206	Chemistry Lab–II[#]	-	-	2	1	15	35	50
16.	ME 207	Workshop Practice	-	-	3	1.5	15	35	50
17.	ME 208	Engineering Drawing	-	-	3	1.5	15	35	50
18.	CS 209	Computer Programming Lab	-	-	3	1.5	15	35	50
19.	BE210	Basic Electronics Lab	-	-	3	1.5	15	35	50
		Total	10	5	14	22	225	525	750

3rd Semester

Paper No	Sub Code	Subject	Periods			Cr	Marks		
			L	T	P		IA	UE	TM
Theory									
20.	CT301	Chemical Technology–I							
	Module I	Process Calculation	2	1	-	2	15	35	50
	Module II	Introduction to Statistical Analysis	2	1	-	2	15	35	50
21.	CT302	Chemical Technology–II							
	Module I	Organic Technology	2	1	-	2	15	35	50
	Module II	Inorganic Technology	2	1	-	2	15	35	50
22.	CT303	Chemical Technology–III							
	Module I	Energy Technology	2	1	-	2	15	35	50
	Module II	Biotechnology	2	1	-	2	15	35	50
23.	CT304	Chemical Engineering–I	3	1	-	4	30	70	100
Practical									
24.	CT305	Organic Technology Lab.	-	1	3	2	15	35	50
25.	CT306	Inorganic Technology Lab.	-	1	3	2	15	35	50
26.	CT307	Physical Chemistry Lab.	-	1	3	2	15	35	50
27.	CT308	Instrumental Method of Analysis	-	1	3	2	15	35	50
		Total	15	11	12	24	180	420	600

4th Semester

Paper No	Sub Code	Subject	Periods			Cr	Marks		
			L	T	P		IA	UE	TM
Theory									
28.	CT401	Engineering Thermodynamics	3	1	-	4	30	70	100
29.	CT402	Chemical Engineering – II	3	1	-	4	30	70	100
30.	CT403	Chemical Technology – IV							
	Module I	Process Instrumentation	2	1	-	2	15	35	50
	Module II	Process Dynamics & Control	2	1	-	2	15	35	50
31.	CT404	Special Paper–I*	3	1	-	4	30	70	100
Practical									
32.	CT405	Biotechnology Lab.	-	1	3	2	15	35	50
33.	CT406	Energy Technology Lab.	-	1	3	2	15	35	50
34.	CT407	Special Lab.–I#	-	1	3	2	15	35	50
35.	CT408	Special Lab.–II^	-	1	3	2	15	35	50
		Total	13	9	12	24	180	420	600

*Special Paper–I: Ceramic Engineering I/ Oil Technology I/ Petrochemicals & Petroleum Refinery Engineering I/ Pharmaceutical and Fine Chemical Technology I

#Special Lab–I: Ceramic Engineering Lab I/ Oil Technology Lab I/ Petrochemicals & Petroleum Refinery Engineering Lab. I/ Pharmaceutical and Fine Chemical Technology Lab I

^Special Lab–II: Ceramic Engineering Lab II/ Oil Technology Lab. II/ Petrochemicals & Petroleum Refinery Engineering Lab II/ Pharmaceutical and Fine Chemical Technology Lab II

5th Semester

Paper No	Sub Code	Subject	Periods			Cr	Marks		
			L	T	P		IA	UE	TM
Theory									
36.	CT501	Chemical Engineering–III	3	1	-	4	30	70	100
37.	CT502	Reaction Engineering	3	1	-	4	30	70	100
38.	CT503	Elective –I*	4	-	-	4	30	70	100
39.	CT504	Special Paper–II[#]	3	1	-	4	30	70	100
Practical									
40.	CT505	Chemical Engineering–Lab. I	-	1	3	2	15	35	50
41.	CT506	Environment Technology Lab.	-	1	3	2	15	35	50
42.	CT507	Special Lab.–III^	-	1	3	2	15	35	50
43.	CT508	Special Lab.–IV[$]	-	1	3	2	15	35	50
		Total	13	7	12	24	180	420	600

*Elective –I: A) Safety & Hazard Analysis
B) Industrial Pollution: Control & Management
C) Project Engineering

[#]Special Paper–II: Ceramic Engineering II/ Oil Technology II/ Petrochemicals & Petroleum Refinery Engineering II/ Pharmaceutical and Fine Chemical Technology II

^Special Lab.–III: Ceramic Engineering Lab. III/ Oil Technology Lab. III/ Petrochemicals & Petroleum Refinery Engineering Lab. III/ Pharmaceutical and Fine Chemical Technology Lab. III

[$]Special Lab.–IV: Ceramic Engineering Lab. IV/ Oil Technology Lab. IV/ Petrochemicals & Petroleum Refinery Engineering Lab. IV/ Pharmaceutical and Fine Chemical Technology Lab. IV

6th Semester

Paper No	Sub Code	Subject	Periods			Cr	Marks		
			L	T	P		IA	UE	TM
Theory									
44.	CT601	Material Science & Technology	3	1	-	4	30	70	100
45.	CT602	Chemical Engineering–IV	3	1	-	4	30	70	100
46.	CT603	Elective–II*	4	-	-	4	30	70	100
47.	CT604	Special Paper–III[#]	4	1	-	4	30	70	100
Practical									
48.	CT605	Chemical Engineering Lab.–II	-	1	3	2	15	35	50
49.	CT606	Process Equipment Design	-	1	3	2	15	35	50
50.	CT607	Special Lab.–V^	-	1	3	2	15	35	50
51.	CT608	Special Lab.–VI[$]	-	1	3	2	15	35	50
		Total	14	7	12	24	180	420	600

*Elective –II: A) Nanotechnology
B) Sol-Gel Technology

[#]Special Paper–III: Ceramic Engineering III/ Oil Technology III/ Petrochemicals & Petroleum Refinery Engineering III/ Pharmaceutical and Fine Chemical Technology III.

^Special Lab–V: Ceramic Engineering Lab V/ Oil Technology Lab V/ Petrochemicals & Petroleum Refinery Engineering Lab. V/ Pharmaceutical and Fine Chemical Technology Lab V.

[$]Special Lab–VI: Ceramic Engineering Lab VI/ Oil Technology Lab VI/ Petrochemicals & Petroleum Refinery Engineering Lab VI/ Pharmaceutical and Fine Chemical Technology Lab VI.

7th Semester

Paper No	Sub Code	Subject	Periods			Cr	Marks		
			L	T	P		IA	UE	TM
Theory									
52.	CT701	Modeling & Simulation	3	1	-	4	30	70	100
53.	CT702	Elective–III*	4	-	-	4	30	70	100
54.	CT703	Special Paper–IV[#]	3	1	-	4	30	70	100
Practical									
55.	CT704	Design & Simulation Lab	-	1	3	2	15	35	50
56.	CT705	Project Assessment–I	-	1	2	4	15	35	50
57.	CT706	Plant Design & Feasibility Studies	-	2	2	3	15	35	50
58.	CT707	In Plant Training / Institutional Training	-	-	3	3	15	35	50
		Total	10	6	10	24	150	350	500

*Elective –III: A) Numerical Analysis

B) Optimization method in Chemical Technology

[#]Special Paper–IV: Ceramic Engineering IV/ Oil Technology IV/ Petrochemicals & Petroleum Refinery Engineering IV/ Pharmaceutical and Fine Chemical Technology IV

8th Semester

Paper No	Sub Code	Subject	Periods			Cr	Marks		
			L	T	P		IA	UE	TM
Theory									
59.	CT801	Chemical Technology – V							
	Module I	Business Management	2	1	-	2	15	35	50
	Module II	Industrial Economics	2	1	-	2	15	35	50
60.	CT802	Special Paper–V[#]	3	1	-	4	30	70	100
Practical									
61.	CT803	Grand Viva	-	-	-	2	15	35	50
62.	CT804	Seminar	-	3	-	3	15	35	50
63.	CT805	Project Assessment–II	-	4	4	4	15	35	50
		Total	7	10	4	17	105	245	350

[#]Special Paper–V: Ceramic Engineering V/ Oil Technology V/ Petrochemicals & Petroleum Refinery Engineering V/ Pharmaceutical and Fine Chemical Technology V

Total Credit Point: 21 + 22+ (24x4) + 24 + 17 = 180

(IA: Internal Assessment; UE: University Examination; TM: Total Marks)

UNIVERSITY OF CALCUTTA
DEPARTMENT OF CHEMICAL TECHNOLOGY
Syllabi for Courses for 8-semester B. Tech. in Chemical Technology, University of Calcutta

Semester I
(Theory)

Paper 1

Course HU101 **100 marks /3 Credits**

Communication English, Management and Social Sciences

1.1 Communicative English (Grammar):

Course Objective: The objective of the course is to enhance the understanding of the students on the principles, techniques and application of grammar and to acquire appropriate proficiency and skills in reading, writing, speaking and comprehension.

Module 1: Sentences: Clauses, Phrases, Types of Sentences, Sentence Structures and Transformation, Correction of Errors in Sentences.

Module 2: Misplaced Modifiers and Modals.

Module 3: Vocabulary Building and Usage: Word Formations (by adding suffixes and prefixes),Root words from foreign languages and their use in English; Synonyms; Antonyms; One Word Substitution/Single Word for a group of Words, Standard abbreviations; Redundant Words/ Redundancies/Redundantism; Clichés.

Module 4: Remedial Grammar: Noun Pronoun Agreement, Articles, Prepositions, Agreement of Subject and Verb; Fill in the blanks using correct Words.

Module 5: Précis Writing.

Module 6: Essay, Paragraph Writing.

Module7: Comprehension Passage.

Module 8: Rapid reading- 'Bill Moss, Tentmaker' by Robert Gannon.

Module 9: Taking notes: Dictation.

1.2 Communicative English (Technical Communication):

Course Objective: The objective of the course is to enhance the understanding of the students on the principles of effective technical communication and their application in official or professional communication.

Module 1: The Theory of Communication –Definition & Scope; Barriers of Communication; Effective Communication (Verbal / Nonverbal).

Module 2: Job Application Letter; C.V./Bio-data/Resume.

Module 3: Organizational Communication: Memorandum; Notice; Official Notes; Minutes; Report (Technical Report): Progress Report, Event Report; Project Proposal; Brochures; Newsletters; Technical Articles; Manuals; Business Letter Circular, Agenda, Invitation, Seminars, Press Release, Newspaper Insertion.

1.3 Management And Social Sciences:

Course Objective: To understand the principles of management and their application to the functioning of an organization.

Module 1: The Development of Management: Scientific Management - Organic Organization, Networked organization, Postmodern Organization, Debureaucratization, Transformation of Management.

Module 2: Labour Management: Fordism, Post-Fordism and the Flexible Firm.

Module 3: Principles of management and their application to the functioning of an organization Contents: Definition of management, science or art.
Module 4: Manager vs entrepreneur; Types of managers- managerial roles and skills.
Module 5: Evolution of management- scientific, human relations, system and contingency approaches.
Module 6: Types of Business Organizations, sole proprietorship, partnership, company, public and private enterprises.
Module 7: Organization culture and environment.
Module 8: Current trends and issues in management.
Module 9: Nature and purpose of Planning, types of Planning, objectives, setting objectives, policies.
Module 10: Strategic Management, Planning Tools and Techniques, Decision making steps & processes.
Module 11: Nature and purpose of Organizing, formal and informal organization, organization structure, types, line and staff authority, departmentalization, delegation of authority, centralization and decentralization, job design, human resource management, HR planning.
Module 12: Recruitment selection, Training & Development, Performance Management, Career planning and Management.
Module 13: Directing, individual and group behavior, motivation, motivation theories, motivational techniques, job satisfaction, job enrichment.
Module 14: Leadership, types & theories of leadership, effective communication.
Module15: Controlling, system and process of controlling, budgetary and non-budgetary control techniques, use of computers and IT in management control, productivity problems and management, control and performance, direct and preventive control, reporting.

Course Outcomes:

1. The students will acquire basic proficiency in English including reading and listening comprehension, writing and speaking skills.
2. The students will acquire proficiency in formal official communication skills.
3. Upon completion of this course, the students will get a clear understanding of management functions in an organization.

Reference Books:

1. Effective English Communication, by V. Syamala.
2. Best Science Writing: Reading and Insights edited by Robert Gannon prescribed text (Hyderabad: University Press (India) Limited, 1991).
3. Effective Technical Communication, M. Ashraf Rizvi, Tata Mc Graw-Hill.2005
4. Pronunciation Practice Activities – Martin Hewings – Cambridge University Press
5. A Textbook of English Phonetics for Indian Students – T. Balasubhramanian- Macmillan Publications

1. Concise Oxford Dictionary
2. Practical English Usage. Michael Swan. OUP. 1995.
3. Remedial English Grammar. F.T. Wood. Macmillan.2007
4. English For All edited by Nilanjana Gupta

5. Communication Skills. Sanjay Kumar and PushpLata. Oxford University Press. 2011.
6. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press
7. . David F. Beer and David McMurrey, Guide to writing as an Engineer, John Willey. New York, 2004
8. Raman Sharma, Technical Communications, Oxford Publication, London, 2004.
9. Dale Jungk, Applied Writing for Technicians, McGraw Hill, New York, 2004. (ISBN: 07828357-4)
10. Sharma, R. and Mohan, K. Business Correspondence and Report Writing, TMH New Delhi 2002.
11. Robins S.P. and Coulter M., Management, Prentice Hall India, 10th ed., 2009.
12. Stoner JAF, Freeman RE and Gilbert DR, Management, 6th ed., Pearson Education, 2004.
13. P.C. Tripathy& P.N. Reddy, Principles of Management, Tata McGraw Hill, 1999.

Paper 2
Course PH102 **100 marks /3 Credits**
Physics-I
Course objectives:
The objective of the course is to enhance the understanding of the Students' on some basic philosophies and corresponding application based reasoning of Physics. To help the students in acquiring the necessary skills to solve the application based problems useful for almost all branches of physics and engineering, on the basic of theoretical understanding.

2.1. Optics:

Module 1: Introduction to interference and examples -Young's double slit experiment,Newton's rings (qualitative).

Module 2: Diffraction: Introduction to diffraction, Fraunhofer and Fresnel diffraction, Fraunh offer diffraction due to single slit and plane diffraction grating, characteristics of diffraction grating and its applications. The Rayleigh criterion for limit ofresolution and resolving powerof Diffraction gratings.

Module 3: Polarization– Polarisation by reflection, Brewster's law, polarisation by double refraction,polaroids, Malus Law, linearly, circularly and elliptically polarized light (qualitative), half wave and quarter wave plates, Optical activity

Module 4: Fibre Optics: Introduction, total internal reflection, numerical aperture and various fibre parameters, stepand graded index fibres, application of optical fibres.

Module 5: Lasers: Principles and working of Laser: population inversion, pumping, various modes, types of Laser (qualitative), application of Laser

2.2. Thermodynamics:

Module 1: Degrees of freedom and Equipartition of energy, Energy and Work,First Law of Thermodynamics.

Module 2: Second Law of Thermodynamics, Heat engines, Carnot's theorem, Entropy and equilibrium, Change in Entropy, Enthalpy, Free Energy, Chemical Potential, Gibb's function, Maxwell's relations(qualitative).

2.3. Quantum Mechanics- I:

Module 1: Black body radiation, Planck's radiation law and its uniqueness, Compton effect and its significance- wavelength shift and recoil of electrons

Module 2: Wave nature of Particles, De-Broglie hypothesis, Matter wave, Born interpretation of wave function, Uncertainty principle, Operators-Eigen value and Eigen function, operators and expectation values of some dynamical variables like momentum, total energy, angular momentum etc.

Module 3: Schroodinger wave equation in three dimension and one dimension and its' significance, Time-dependent and time independent form, Application of Schroodinger wave equation in case of particle in one dimensional box (qualitative).

2.4. Dielectric and Magnetic Properties of Materials:

Module 1: Divergence and Curl of electrostatic field, Gauss's law and its application, Laplace's and Poisson's equations for electrostatic potential

Module 2: Dipole moments, electric field and potential due to dipole, Bound charges and Dielectric polarization, polar and non-polar dielectrics, Electric displacement vector, dielectric susceptibility, permittivity and dielectric constant, Boundary conditions, simple electrostatics problems in presence of dielectrics

Module 3: Magnetisation, magnetic field ***B*** and ***H***, permeability and susceptibility, classification of magnetic materials, discussion of magnetic field in presence of magnetic materials(qualitative).,

Course Outcomes:

I. Students will be enriched with some basic thoughts of Physics needed for advancement in Technology.
II. Developmentof the idea about the basic concepts of mechanics required for all branches of the engineering.
III. Students will be familiar with the idea about the most important physical phenomena corresponds to different wings of Physics and also will be knowledgeable about the logic behind those phenomena.
IV. Students will be able to utilize the concept which they gather in solving the problem having technological aspects.

Reference books:

1. Introduction to Optics by Hecht E. Addison-Wesley.
2. OPTICS by Ajoy Ghatak, 2nd edition, Tata McGraw Hill
3. Fundamentals of Optics by F. A. Jenkins and H.E. White, McGraw-Hill
4. Geometrical and Physical Optics by B K. Mathur
5. Principles of Optics by M. Born and E. Wolf, Cambridge University Press
6. Introduction to Electrodynamics by David Griffiths, Prentice Hall
7. Principles of Physics by David Halliday, Robert Resnick Jearl Walker , 10ed,Wiley.
8. Electricity, Magnetism, and Light by Wayne M. Saslow, Academic Press.
9. Electromagnetism by Grant and Phillips, John Wiley.
10. 10.Thermodynamics in Materials Science by Robert DeHoff, CRC Press.
11. A treatise on Heat By M. N. Saha and B. N. Srivastava. The Indian Press.
12. Heat and Thermodynamics by Zemansky and Dittman, McGraw-Hill.

13. Fundamentals of Statistical and Thermal Physic by Reif, Sarat Book Distributors.
14. Introduction to Quantum Mechanics by David J. Griffiths, Prentice Hall.
15. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles by Eisberg & Resnick, Wiley.
16. Introduction to Electrodynamics by David Griffiths, Prentice Hall.
17. Electricity, Magnetism, and Light by Wayne M. Saslow, Academic Press.
18. Electromagnetism by Grant and Phillips, John Wiley.
19. Web Platform: NPTEL, SWAYAM, Archive.org etc

Paper 3
Course CH103 **100 marks /3 Credits**
Chemistry-I

Course Objective: The objective is to Impart in depth understanding of fundamental concepts in chemistry that have been introduced at the 10+2 levels in school and to develop analytical skill among students necessary to design and solve the new problems. The course will familiarize students with different analytical techniques used in present day chemistry and explore the relevance in engineering applications.

Module I: Atomic and molecular structure: Introduction to quantum theory: Schrodinger equation. Origin of quantization. Particle in a box and its applications with respect to conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations.
Bonding in molecules: Valence bond theory, Molecular orbital theory. Bonding and plots of molecular orbitals for diatomic and polyatomic molecules. Pi-molecular orbitals of butadiene and benzene and aromaticity.
Crystal field theory: Bonding in octahedral complexes, tetrahedral, tetragonally distorted octahedral and square planar complexes. Magnetic properties of all types of complexes. Color of complexes.
Band structure of solids and the role of doping on band structures.
Module II: Intermolecular forces and real gases: Ionic, dipolar and van der Waals interactions.Deviation of real gas from ideal behavior.Equations of state of real gases and critical phenomena.
Module III: Spectroscopic techniques and applications: Principles of spectroscopy and selection rules. Electronic spectroscopy. Vibrational spectroscopy. Nuclear magnetic resonance spectroscopy. Applications.
Module IV: Electrochemistry: Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies.Free energy and emf.Electrochemical series and its application.Nernst equation and applications of emf measurements. Potentiometric titrations: Acid base, oxidation reduction, precipitation titrations. Corrosion.
Module V: Stereochemistry: Representations of three dimensional structures.Structural isomers and stereoisomers. Symmetry. Chirality and optical activity. Enantiomers, diastereomers, racemates. Configuration. Geometrical and conformational isomerism.Conformations of cyclic and acyclic systems.
Module VI: Organic reactions: Electronic influencing effects, Reactive intermediates. Aromaticity. Introduction to reactions involving rearrangement, substitution, addition,

elimination, oxidation-reduction, cyclization and ring opening. Synthesis of a commonly used drug molecule.

Course Outcome:

The students will be able to

1. Understand and apply the concepts of basic quantum chemistry and chemical bonding to explain the molecular structure and physical/electronic properties of molecules.
2. Apply fundamental principles of electronic, vibrational, rotational and nuclear magnetic resonance spectroscopy towards identifying the structure of organic molecule.
3. Understand and apply fundamental concepts of electrochemistry.
4. Apply basic principles of organic chemistry for analyzing reaction mechanism and to develop methodology for synthesis.

Reference Books:

1. Chemistry: Principles and Applications by M. J. Sienko and R. A. Plane
2. Concise Inorganic Chemistry by J.D. Lee
3. General & Inorganic Chemistry, Vol I and Vol II by R. P. Sarkar
4. Physical Chemistry by P. W. Atkins and J. de Paula
5. Fundamentals of Molecular Spectroscopy by C. N. Banwell
6. Organic Spectroscopy by W. Kemp.
7. Organic Chemistry by I. L. Finar
8. Organic Chemistry by J. Clayden and N. Greeves
9. Organic Chemistry by R. T. Morrison and R. N. Boyd
10. Organic Chemistry by T. W. G. Solomons and C. B. Fryhle
11. A Guidebook to Mechanism in Organic Chemistry by P. Sykes
12. Engineering Chemistry (NPTEL Web book) by B. L. Tembe, Kamaluddin and M. S. Krishnan
13. Engineering Chemistry by Prasanth Rath

Paper 4

Course MA104 **100 marks /3 Credits**

Engineering Mathematics-I

Course Objective:

The objective of this course is to familiarize the prospective engineers with techniques in calculus, multivariate analysis and vector algebra. At the end of this course students will serve them well towards tackling more advanced level of mathematics and applications that they would find useful in their disciplines.

Module 1: Differential calculus:

Differential calculus: Successive differentiation, Leibnitz Rule. Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima.

Multivariable Calculus: Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers.

Module 2: Sequences and series: Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.

Module 3: Vector Algebra: Vector calculus: Brief review of vector algebra, scalar and vector triple products, Directional derivatives, gradient, divergence, curl, vector integration, statements and applications of Gauss's theorem, Green's theorem, Stokes' theorem, examples

Module 4: Integral Calculus (Integration): Int. Calculus: Properties of definite integrals, Quadrature, Rectification, Double integral, Triple integrals, change of order of integration, change of variables, determination of length, area, volume. Applications of definite integrals to evaluate surface areas and volumes of revolutions

Course Outcome:

The students will learn:

- To Use Leibnitz Theorem to determine the nth derivative of product of functions. They will develop series expansion by Taylor's and Maclaurin's series. They will be examine the function for maxima and minima and discover its extreme value.
- To use the tool of power series and Fourier series for learning advanced Engineering Mathematics.
- To deal with functions of several variables that are essential in most branches of engineering.
- To recognize scalar and vector functions. They will evaluate Gradient, Divergence and Curl of a point function depending upon its nature.
- To apply the integral formulae to estimate length, surface area and volume of revolution of a curve.

Reference Books

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 43nd Edition, 2015.
2. P.N. Wartikar & J. N. Wartikar, Applied Mathematics (Volume I and II) PuneVidyarthi Griha Prakashan, 7th Edition, 1994.
3. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons Inc., 10th Edition, 2011
4. Peter V. O' Neil, Advanced Engineering Mathematics, Thomson Brooks/Cole, 7th Edition, 2011.
5. Glyn James, Advanced Modern Engineering Mathematics, Pearson Education, 4th Edition, 2010.
6. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
7. S. S. Sastry, Introductory methods of numerical analysis, PHI, 4th Edition, 2005.
8. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.

Paper 5

Course EE105 **100 marks /3 Credits**

Basic Electrical Engineering

Course Objective: The objective of the course is to enhance the understanding of the Students' on the basics of AC & DC circuits along with basics of three phase circuits and to help the

students to understand the basics of basic electrical machines, also helps the students understand the necessity of power system components.

Module 1: D.C. Circuits: Network theorems – Superposition theorem, Thevenin's theorem, Norton's theorem, Maximum power transfer theorem. Star-Delta & Delta-Star transformation.

Module 2: Magnetic Circuit: MMF, Flux ,Reluctance. B-H Loop.Hysteresis and Eddy current loss. Magnetic circuit analysis with air gap.

Module 3: A.C. Fundamentals: Sinusoidal quantities, phase & phase difference, average & RMS values, form factor & peak factor, concept of Sinusoids, impedance & admittance, power & power factor.

Module 4: A.C. Circuits: Series and parallel R-L-C Circuits, Form Factor, Peak Factor, Phasor concept of Sinusoids. Impedance and Admittance. Power, Power Factor, VA, VAR.

Module 5: Balanced 3-phase: 3-phase AC balanced circuits. Phase-sequence, Star and Delta connections.Connection of wattmeter in 1-ph circuit for power measurement & Connection of two watt meters in 3-ph circuit for power measurement.

Module 6: Power Factor Improvement: Causes & effect of low power factor, advantages of power factor improvement, methods of power factor improvement.

Module 7: DC Machines: Construction, working, different types, EMF equation, characteristic (Generator & Motor), starting and speed control.

Module 8: 1-PhaseTransformer: Construction. EMF equation. Phasor diagram. Equivalent circuits.. Open circuit and Short circuit test. Losses and Efficiency

Module 9: 3-Phase Induction Machine: Types of induction machines. Rotating magnetic field, slip, torque equation, torque speed curve. DOL starting and reduced voltage starting.

Module 10: Power System Structure: Single line diagram of a power system structure.

Course Outcome:

1) The students will be able to understand the basic laws of electrical engineering & its application
2) Students knowledge will be enhanced about the basics of AC & DC circuits
3) Students will get an idea about the three phase system
4) Students will be able to analyses the basic electrical machines with the help of basic concepts of electrical engineering gathered.
5) Get an idea about the components of power system.

Reference Books:

1. Basic Electrical Engineering by I. J. Nagrath, Tata McGraw-Hill Publishing Co. Ltd.
2. Basic Electrical Engineering By T. K. Nagsarkar & M. S. Sukhija, Oxford University Press
3. Electrical & Electronics Technology By Hughes, Dorling Kindersley India, New Delhi
4. Electrical Technology By H. Cotton, CBS Publisher, New Delhi
5. A course in Electrical Engineering Vol-I & II By C. L. Dawes Publisher: McGraw-Hill Book Co. Inc

(Practical)

Paper 6

Course HU106 **50 marks /1.5 Credits**

Language Lab

Course Objective: The objective of the practical classes is to make the students familiar with the applied aspects of the English language, pronunciation, behavioural strategies and realistic

dimensions of interpersonal interaction in the context of organizational communication. The practical exercises include the following topics:

EXERCISES:

- Group Discussion –Principle & Practice [Courtesy- Teaching Cohesion and Coherence strategies for handling criticism and adverse remarks. Teaching strategies of Turn-taking, timing, effective and creative intervention, formal and informal language, kinesics (use of body language), politeness and courtesies and all components of soft skills].
- Mock/Job Interview.
- Role Play/Conversation.
- Formal Presentation [power point presentation/extempore/ public speaking skills, Elementary Phonetics (theory): Pronunciation/ Stress/Intonation/ Rhythm/ Voice modulation/ Pitch and Accent of connected speech].
- Listening Comprehension: Audio File Analysis/Video File Analysis.

Course Outcomes:

1. The students will acquire skills on conflict management, presentation, decorum, grooming, courtesy, appropriate pronunciation.
2. The students will also acquire better verbal ability in Spoken English.

Reference:

The manual corresponding to all the exercises will be provided to the students.

Paper 7

Course PH107 **50 marks /1.5 Credits**

Physics-I Lab

Course objectives:

The objective of the practical classes is to make the students familiar with the technological features of theory as well as to provide hand-on experience of corroboration between model theory and it's practical aspect.

Experiments:

Experiments are based on modern optics-Lasers, general properties of matter, mechanics with advanced measurement techniques and Virtual lab

Reference:

The manual corresponds to all experiments will be provided to the students.

Paper 8

Course CH108 **50 marks /1.5 Credits**

Chemistry-I Lab

Choice of eight to ten experiments from the following:

- Titrations: Acid –base, Conductometric, pH-metric, Complexometric titrations.
- Estimation of hardness of water.
- Determination of chloride content of water
- Colligative properties using freezing point depression
- Determination of the rate constant of are action
- Determination of cell constant and conductance of solutions
- Potentiometry determination of redox potentials and emfs
- Determination of the partition coefficient of a substance between two immiscible liquids

- Determination of surface tension and viscosity
- Thin layer chromatography
- Synthesis of a polymer/drug
- Saponification /acid value of an oil
- Lattice structures and packing of spheres
- Models of potential energy surfaces
- Chemical oscillations-Iodine clock reaction
- Adsorption of acetic acid by charcoal

Paper 9

Course EE109 **50 marks /1.5 Credits**

Course Objective:

The objective of this practical course is to familiarize the students to the various instruments & devices & its hand on use, to run the rotating electrical machines & to familiarize with the construction & use of single phase transformer.

Experiments on the following topic:

- Familiarization experiments (Variac, Potential divider, MCV, MIV, MCA, MIA & Wattmeter)
- Characteristics of Tungsten and Carbon filament lamps
- Experiments on DC circuits and DC machines
- Study of AC series R-L-C series circuit
- Experiments on Single phase Transformer
- Calibration of voltmeter, ammeter and energy meter
- Experiments on magnetic circuit principles

Course Outcome:

The students will be able to learn-

1) The use of different instruments & devices in a circuits
2) How to make an electrical circuit & the safety measures.
3) The practical application of basics of electrical engineering like AC/DC circuits.
4) The practical use of rotating & static electrical machines.

Semester- II
(Theory)

Paper 10

Course CH201 **100 marks /3 Credits**

Chemistry - II

Course objective:

The objective is to develop understanding of the concepts and applications of chemical kinetics and different analytical techniques. Course will impart knowledge of physical/chemical behavior and applications of various engineering materials and explore water chemistry, green chemistry and non-conventional energy sources.

Module 1: Analytical techniques

Applications of spectroscopic techniques. Surface characterization techniques. Diffraction and scattering. Chromatographic methods of separation and analysis. Mass spectrometry. Thermal analysis.

Module 2: Kinetics of Chemical Reactions

Reversible, consecutive and parallel reactions. Steady state approximation. Chain and oscillatory reactions. Kinetics of photochemical & photophysical processes. Catalysis.

Module 3: Metals and Alloys:

Phase rule and applications to one, two and multi-component systems. Iron-carbon phase diagram. Types of alloys, carbon steel, alloy steel, alloys of Cu, Al, Pb.

Module 4: Polymers

Mechanism of polymerization and synthesis of polymers. Molecular weight, shape and conformation of polymers. Crystallinity, melting point and glass transition. Copolymerization. Viscoelasticity. Elastomers-structure, applications and curing. Conducting polymers and applications.

Module 5: Surfactants and lubricants

Critical micelle concentration and its determination. Hydrophobic and hydrophilic interactions. Micelles and reverse micelles. Detergents. Fricohesity of lubricants and chemical properties, types and mechanism of lubrication. Additives of lubricants and freezing points of lubricants.

Module 6: Nanomaterials

Properties of nanomaterials, size dependent properties, general methods of synthesis, bottom-up and top-down approach, characterization of nanomaterials, electron microscopy, self-assembly, nanoscale materials, Applications of nanomaterials.

Module 7: Environmental and green chemistry

Water chemistry: Sources of water. Hardness of water and softening methods. Alkalinity of water. Boiler feed water. Treatment of water for domestic and industrial use.

Air, water and noise pollution. Optimum level of pollution. Significance and determination of COD and BOD. Solid waste treatment of collection of NKP. Greenhouse effect and global warming. e-Waste. Radioactive pollution. Applications of green chemistry and green technology. Concept ofatomic and molecular economy and its use in green chemistry.

Module 8: Energy science

Analysis of coal. Petroleum refining, liquid fuels, anti-knock agents. Cracking of oils. Limitations of fossil fuels. Alternative and non-conventional sources of energy - solar, wind, geo, hydro-power and biomass. Advantages and disadvantages. Nuclear energy, reactors and nuclear waste disposal. Safety measures for nuclear reactors. Battery technology. Rechargeable batteries. Fuel cells. Photovoltaics.

Course Outcome:

The students will be able to

1. Appreciate the usefulness of new analytical techniques for elucidating the structure of chemical systems.
2. Apply the basic principle of chemical kinetics in order to analyze and develop chemical reactors and reaction systems.
3. Use the knowledge on compounds of interest like polymers, surfactants, nanomaterials and appreciate their engineering applications.
4. Able to apply the principles of green chemistry in designing alternative reaction methodologies to minimize hazards and environmental degradation.

Reference Books

1. Fundamentals of Analytical Chemistry by S. Crouch, D. West, F. Holler, D. A. Skoog

2. Organic Spectroscopy by W. Kemp.

3. Physical Chemistry by P. W. Atkins and J. de Paula

4. Chemical Kinetics, by K. Laidler

5. Introduction to Nanoscience by S. M. Lindsay

6. Nanoscience and Nanotechnology: Fundamentals to Frontiers by M. S. R. Rao, S. Singh

7. A Textbook of Engineering Chemistry by Shashi Chawla

8. Engineering Chemistry by S. S. Dara

9. Engineering Chemistry by P. C Jain and M. Jain

10. A Textbook of Environmental Chemistry by O. D. Tyagi and M. Mehra

11. Engineering Chemistry (WIND) by Wiley editorial

Paper 11

Course MA202 **100 marks /3 Credits**

Engineering Mathematics-II

Course Objective:

The objective of this course is to know the use of mathematical techniques in Linear algebra that are needed by engineers for practical applications, familiarize with differential equation with its application in Laplace transform, introduction to the concepts of improper integrals, Gamma, Beta function which are needed in engineering applications, and finally to acquaint with numerical methods in evaluating polynomial equations, differential equation and integration.

Module 1: Linear Algebra: Matrices, Vectors, Determinants, Linear Systems:

Inverse and rank of a matrix, Determinants, Cramer's Rule, Solutions of Linear Systems: Existence, Uniqueness , rank-nullity theorem, Symmetric, skew symmetric, and orthogonal matrices, Vector Space, Linear dependence of vectors, basis, Eigenvalues and eigen vectors , Cayley-Hamilton Theorem and Orthogonal transformation.

Module 2: Convergence of improper integrals:

Convergence of improper integrals, tests of convergence, Beta and Gamma functions elementary properties.

Module 3: Differential Equation:

First order equations, Exact, linear and Bernoulli's equations, Euler's equations, Equations not of first degree: equations, solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.

Second order linear differential equations with variable coefficients; Method of variation of parameters; Wronskian

Module 4: Integral transform:

Laplace Transform, Properties of Laplace Transform, Laplace transform of periodic functions, inverse Laplace transform, convolution theorem, Evaluation of integrals by Laplace transform, solving ODEs by Laplace Transform method, Fourier transforms.

Module 5: Numerical Methods:

Finite differences, Newton's forward and backward interpolation formulae, Trapezoidal rule and Simpson's 1/3rd rule of integration, Solution of polynomial and transcendental equations, Bisection method, Newton Raphson method and Regular Falsi method, Numerical solutions of first order differential equations by Euler's method and 4th order Runge- Kutta method.

Course Outcomes

The students will learn:

 to solve mathematical tools for the solutions of differential equations that model physical processes.

 the essential tools of matrices and linear algebra including linear transformations, eigenvalues, diagonalization and orthogonalization.

 to familiarize with techniques in improper integrals . They will have a basic understanding of Beta and Gamma functions.
 the different tools of Laplace and Fourier transform for learning advanced Engineering Mathematics.
 To deal with techniques in Numerical Analysis that are essential in most branches of engineering.

Text / Reference Books:

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006.
2. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
3. Veerarajan T., Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
4. Ramana B.V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010.
5. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications,Reprint, 2010.
6. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35th Edition, 2000.
7. Krishnamurthy, V.P. Mainra and J.L. Arora, An introduction to Linear Algebra, Affiliated East–West press, Reprint 2005.
8. S.S. Sastry, Introductory methods of numerical analysis, PHI, 4th Edition, 2005.
9. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984
10. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.

Paper 12
Course ME203 **100 marks /3 Credits**
Engineering Mechanics
Course Objectives

The main objective of a course Mechanics should be build a strong foundation, to acquaint the students with as many general methods of attack as possible , and to illustrate the application of these methods to practical engineering into consideration. The basic essence of this subject resolves around the concept of statics as well as dynamic equilibrium.
Modern day engineering mechanics idealizes the practical problems. Engineering Mechanics deals with the Mechanics of rigid bodies. -Statics and Dynamics- without taking the effect of their deformation structures separately. Therefore to meet the present -day needs, the focus of teaching engineering mechanics turned to the knowledge of proper conceptualization and modeling, assuming that rest of the things will be carried out using standard techniques.

Module 1: Statics: Basic concepts, Scalars and vectors, parallelogram law, Lami's theorem,
Module 2: Application of Vectors in Mechanics, Force Systems in two Dimensions;
Module 3: Moments and Couples; Resultants and Components in concurrent coplanar, forces, parallel forces in a plane, Free Body Diagram Concept
Module 4: Fundamentals of Friction, Limiting angle of Friction, Applications to wedges.
Module 5: Centroid, Moment of Inertia.
Module 6: Plane Trusses; Frames and Machines.
Module 7: Dynamics: Introduction to vector calculus, Definition of vectors in Dynamics.
Module 8: Two dimensional Kinematics in Rectangular Co-ordinates, Rectilinear Motion, Curvilinear motion of particle and description of different coordinate systems, Kinetics.

Module 9: Newton's Law and D' Alembert's principle, and application to rectilinear and curvilinear motion, constrained motion,
Module 10: Energy and Momentum methods. Linear Impulse; Angular Impulse and Momentum – Central Force Motion.
Module 11: Concept of Stress and Strain , Stress-Strain Diagram of Ductile and Brittle Material ,Normal stress , shear stress etc., Relevant numerical.

Course Outcomes:
On successful compulsion at the End of Course, students will able to understand and capable of answering in the following areas.
1. Drawing Free Body diagrams and determination of Resultant of forces and/or Moments.
2. Determination of the centroid and Second Moment of areas of different sections.
3. Analysis of Statically Determinate plane frame.
4. Application of Law of Mechanics to determine the efficiency of simple machines with consideration.
5. Application of Newton's Laws of motion of the moving bodies.
6. Application of D-Alembert's principle and related numerical.
7. Analysis of Plane Curvilinear motion.
8. Basic concept of Strength of materials, Understanding of Stress- Strain Diagram and related numerical.

Reference Books:

1. Engineering Mechanics by S Timoshenko , D H Young and J V Rao , Tata McGraw Hill
2. Engineering Mechanics (Statics & Dynamics, VolumeI&II) by J.L. Meriam and L.G. Kraige, Wiley India Pvt Limited.
3. A Text book of Engineering Mechanics by A. R. Basu ,DhanpatRai& Co.
4. Engineering Mechanics by Basudeb Bhattacharyya, Oxford University Press.
5. Engineering Mechanics by S S Bhavikatti, New Age International (P) Limited.
6. Engineering Mechanics by A. K. Tayal , Umesh Publications.
7. Engineering Mechanics by K L Kumar, Tata McGraw Hill
8. Engineering Mechanics by P.K Nag , SukumarPati & T.K. Jana , McGraw Hill Education (India) Private Limited.
9. Engineering Mechanics by B B Ghosh, S Chakrabarti& S Ghosh, Vikas Publishing House pvt Ltd.
10. Strength of Material by S. S. Ratan, McGraw Hill Education (India) Private Limited.
11. NPTEL on line courses relevant to your topic ;Source: onlinecourses.nptel.ac.in

Paper 13
Course CS204 **100 marks /3 Credits**
Basic Computer Science and Engineering
Course objectives:
The objective of this course is to give the introduction of computing systems to the students. The students will also learn the basics of programming languages. In order to solve good programming problems data structure is also taught.

Module 1: Introduction to Computer: Basic Building blocks, Algorithms, Flowcharts, Pseudo codes, System and Application Software- concepts & terminologies, Concepts of Machine Language, Assembly Language and High level languages, Fundamentals of World Wide Web and Internet
Module 2: Introduction to Programming: Variables, Assignments; Expressions; Input/Output; Conditionals and Branching; Iteration; Functions; Recursion; Arrays; Pointers; Structures;
Module 3: Introduction to Data Structure: Array, Stack, Queue, Linked List Searching: Linear Search, Binary Search, Sorting: Bubble, Insertion, Selection

Course Outcome:
1. The students will have the fundamental knowledge about the computing system.
2. Students will learn different type of data structures, their basic operations and applications.
3. Students will come to know about the basic features of programming language.
4. They will learn to write basic to advanced program.

Reference Books:
1. Computer Fundamentals by P.K.Sinha

2. Data Structures by Seymour Lipschutz

3. Fundamentals of Data Structures in C by E.Horowitz, Sartaj Sahni

4. Data Structures Using C by Reema Thareja

5. The C programming Language by Brian W. Kernighan and Dennis M. Ritchie

6. Programming with C by Byron Gottfried

7. Programming in ANSI C by E. Balagurusamy

8. Understanding Pointers in C by Kanetkar Yashavant P.

Paper 14
Course BE205 **100 marks /3 Credits**
Basic Electronics
Course Objective:
The objective of this course is to acquaint to the students initially the basic concepts of semiconductors and semiconductor devices which are widely used in electronics engineering. Further the electronic circuits used in electronics engineering, comprising of analog electronic and digital electronic circuits will also be introduced in this course. Lastly, the important application areas of electronics engineering, namely communication engineering and sensor and actuators will also be introduced.

Module 1: Concepts of Semiconductors
Basic ideas of electronics, charged particles, review of atomic energy levels, elementary concepts of energy bands in crystals, conduction band and valence band, distinction between metal, semiconductor and insulator, Fermi-Dirac Distribution and definition of Fermi level, intrinsic and extrinsic semiconductors, concepts of majority and minority carries in semiconductors, current flow in semiconductors.
Module 2: Semiconductor Devices
P-N Junction and Diode, Concept of space charge, effects of forward and reverse bias, current-voltage characteristics of P-N junction diode, concept of breakdown, Zener diode principle and applications, equivalent circuit of diodes, concepts of rectifiers, principle of LED. Bipolar junction transistor, mechanism of transistor action, current components in a bipolar transistor, modes of

transistor operation, I-V characteristics of a bipolar transistor, transistor biasing, introduction to field effect transistor, principle of junction field effect transistor, concept of metal semiconductor field effect transistor, p-channel and n-channel, current flow in field effect transistors and I-V characteristic curves.

Module 3: Analog Electronics using Operational Amplifier

Concept of Analog Signal and Analog Electronics, Basic concept of positive and negative feedback, Basic information of operational amplifier, ideal characteristics, 741- OPAMP, Basic OPAMP applications using ideal model: inverting amplifier, non-inverting amplifier, summing amplifier, difference amplifier, differentiation and integration using operational amplifier, comparator circuit using operational amplifier

Module 4: Digital Electronics using Gates

Concept of Digital Signal, Binary Numbers, Signed-binary numbers, Decimal-to-Binary & Binary-to Decimal Conversion, Binary Addition, Subtraction, Multiplication and Division, Hexadecimal Number Systems, Logic Gates like OR, AND, NAND, NOR and NOT, Boolean Algebra, De Morgan's Theorems, Laws of Boolean Algebra, Logic Circuit Implementation of Boolean Expressions, Arithmetic circuits, Combinational circuits: Multiplexers, De-Multiplexers, Encoders Decoder, Comparator, Sequential circuits: counters, registers, ADC and DAC, Basic ideas of flip flops.

Module 5: Electronics Applications

Introduction to communication systems. Principle of modulation including amplitude and frequency modulation. Transmitter and receiver system.

Course Outcome:

As outcome of this course, the students will be trained with the fundamentals of semiconductor devices and circuits and important application areas of electronics engineering.

Reference Books:

1. Electronics: Fundamentals and Applications, D.Chattopadhyay and P.C. Rakshit

2. Electronic Devices and Circuits, J.Millman and C.C. Halkias.

3. Linear Integrated Circuits, D.Roychoudhury and S.Jain

(Practical)

Paper 15

Course CH206 **50 marks /1 Credits**

Chemistry Lab- II

Experiments:

1. Study of kinetics of chemical reactions.
2. Redox titrations: Dichromatometry, Permanganometry, Iodometry and Iodimetry.
3. Experiments based on Chromatography (paper, thin layer, column chromatography)
4. Detection of different functional groups in known and unknown organic samples.

Course Outcome:

The students will be able to

1. Understand the principles of chemical kinetics through experimentation.
2. Understand the fundamental principle of different analytical methods and instruments.
3. Systematically identify organic functional groups.

Paper 16

Course ME207 **50 marks /1.5 Credits**

Workshop Practice

Course Objectives:

Designed for the core course on Workshop Practice offered to all first-year degree level students of engineering, Work shop Practice presents clear and concise explanation of the basic principles of manufacturing processes and equips students with overall knowledge of engineering materials, tools and equipment commonly used in the engineering field. The curriculum describes the general principles of different workshop processes such as primary and secondary shaping processes, metal joining methods. The workshop processes covered also include the hand-working processes such as bench work, fitting, welding, sheet metal work, and carpentry. It also explains the importance of safety measures to be followed in workshop processes and details the procedure of writing the records of the practices. The tools and equipment used in each hand-working process are enumerated before elaborating the process.

Fitting Shop: Introduction to different hand tools, equipment and measuring devices, sawing, filing & drilling process. Practice Jobs on Mild Steel Plate, Production of nuts and bolts.
Carpentry Shop: Specification of wood and wood products, Introduction to Tools and equipment, different wood joints. Practice jobs on Dove Tail Notch or Dovetail Bridle Joint or Cross Joint
Forging Shop: Demonstration of forging a Octagonal Chisel.
Welding Shop: Metal joining process, Arc welding practice.
Sheet metal work: Sheet metal work through, production of funnel.

Course Outcomes:

At the End of Course, students will able to understand as well as familiar with carpentry, fitting, forging, welding and sheet metal work through the following areas.
1. Nomenclature, application use of different hand tools.
2. To get familiarized with the properties of different engineering materials- metals & alloys and non metals.
3. To learn about the various measuring devices and to know about the importance of sequential plans of action in manufacturing through practice in various sections.
4. Acquire knowledge about, different measuring instruments their working principle, application areas and able to handle the same.
5. Hands on practice of simple job related to Fitting shop
6. Hands on practice of simple joint related to Carpentry shop.
7. Overview of Forging Shop.
8. Sheet metal working, through Construction of Funnel.
9. Introduction to welding Process-through practice job using MMAW .

Reference Books:

1. Work shop Technology (Volume- I and Volume-II , By Hazra ,Choudhary),Media Promoters & Publishers Pvt. Ltd.
2. Mechanical Workshop Practice, PHI Learning Pvt. Ltd.
3. Work shop Manual / P.Kannaiah / K. L. Narayana / Scitech Publishers.

Paper 17

Course ME208 **50 marks /1.5 Credits**

Engineering Drawing

Course Objectives

Primary objective of the course of Engineering Drawing is to understand the language of engineers which is very much essential for engineering career. Students of all engineering disciplines to develop a spatial bent of mind to observe, visualize and understand the structure of objects from different perspectives.

Module1: Engineering Lettering, Numbering
Module2: Types of Lines and Dimensioning methods.
Module 3: Construction of Plane Scales, Diagonal Scales & Venier Scales.
Module 4: Engineering Curves – Parabola, Ellipse, Involutes
Module 5: Orthographic Projection of Points, Lines, Surfaces, Solids and Section of solids.
Module 6: Introduction of Isometric projection.
Module 7: Introduction to CAD tools – basics; Introduction of Development and Intersection of surfaces.

Course Outcomes:
Course Outcomes at the End of Course, students will able to solve the problems in the following areas.
I. Construction and Interpretation of drawing scales as per the situation.
II. Generation of simple Curves like ellipse, cycloid and Involutes of circle, square.
III. Visualization and generation of Orthographic projections of points, lines and planes.
IV. Visualization and generation of Orthographic projections of solids like cylinders, cones, prisms and pyramids.
V. Layout development of solids for practical situations.
VI. Development of isometric projections of simple objects.

Reference Books

1. Engineering Drawing By N.D. Bhatt Pvt. Ltd.,
2. Engineering Drawing By N S Parthasarathy and Vela Murali, Oxford University press
3. A Text Book of Engineering Drawing - by R. K. Dhawan.

Paper 18
Course CS209 **50 marks /1.5 Credits**

Computer Programming Lab

Course Objective:
The objective of this practical course is to conceptualize the basic features of programming language. The students will learn how to write the different programs for simple to advanced problems using C language.

Experiments on the following topic:
The assignments will be given based on the topics covered in Module-II and Module-III of CS 204. They will write the programs using C.

Course Outcome:
1. The students will learn how to analyze a given problem.
2. They can identify what types of the variables, data structure are required to solve a problem.
3. Students can write program for a given problem.
4. They will understand how to prepare test set for a given problem.

Reference Books:

1. The C programming Language by Brian W. Kernighan and Dennis M. Ritchie

2. Programming with C by Byron Gottfried

3. Programming in ANSI C by E. Balagurusamy

4. Understanding Pointers in C by Kanetkar Yashavant P.

Paper 19
Course BE210 **50 marks /1.5 Credits**
Basic Electronics Lab
Course Objective:
The objective of this course is to train the students on the working of semiconductor diodes and transistor circuits, analog electronic circuits using operational amplifiers, digital logic circuits using Gates through hands-on-experiments.
Each experiment should be carried over bread boards and/or kits. Experimental observations should be properly tabulated and/or represented graphically. The derived results from experimental data should be compared with theoretical models and errors should be properly reported. Conclusion should be scientifically drawn. Each experiment should be preceded with a theoretical discussion of the concerned topic and identification of the associated circuit components and/or measuring instruments.

Experiment 1: Identification of Circuit Components
Study of resistors, capacitors and inductors. Determination of values and comparison of the same with measurement by multi meters/ LCR meters.
Experiment 2: Semiconductor Diodes
(a): Identification of Ordinary P-N diode and Zener Diode.
(b): Study the Forward Bias V-I Characteristics of P-N Junction Diode and determination of impedance.
(c): Forward and Reverse Characteristics of Zener Diode, Load Voltage and Line Voltage Regulation.
Experiment 3: Bipolar Transistors
(a): Identification of NPN and PNP Bipolar Transistors.
(b): Study input & output characteristics of transistor in CE & CB modes and determination of hybrid parameters.
Experiment 4: MOSFET
(a): Identification of MOSFET
(b): Study V (DS) vs. I (D) characteristics and Study V (GS) vs. I (D) characteristics and hence to calculate the MOFET parameters.
Experiment 5: Analog Electronics using Operational Amplifiers
(a): Identification of 741C OPAMP, pin diagram and power supply requirements. Concept of positive and negative supply.
(b): Study of inverting and non-inverting amplifier configurations.
(c): To use integrating and differentiating circuits with 741C OPAMP and study with C.R.O.
Measurement of phase and frequency with C.R.O.
Experiment 6: Digital Electronics using Logic Gates
(a): Identification of various digital logic gates.
(b): Study of NOT, OR, AND, NAND, NOR & XOR gates and verification of truth tables.

Course Outcome:

As outcome of this course, the students will develop a mindset to verify the principles of electronics using practical devices and components. The practical utilities and performance of basic electronic devices and circuits will thus be clearly demonstrated.

Semester III
(Theory)

Paper 20
Course CT301
Chemical Technology –I

Module I: Process Calculation **50 marks /2 Credits**

Units and Dimensions: Basic and derived Units, Different ways of expressing units of quantities and physical constants. Dimensional analysis and representation of results.
Stoichiometric principles: Properties of gases, liquids and solids, Critical properties.
Properties of mixtures and solutions and phase equilibria, vaporisation, drying, condensation. Wet and dry bulb thermometry. Concept of relative humidity, molal humidity, dew point, partial saturation.
Material Balance: Recycle, purging, bypass in batch, stage wise and continuous operations in systems with and without chemical reactions.
Energy balance: Thermophysics – concept of and calculations involving energy. Heat, work and enthalpy of reversible processes and combustion of fuels.
Thermochemistry – heat of formation, combustion, solution, dilution and the effects of pressure on them.
Calculation of theoretical and actual flame temperature during combustion of fuels.
Energy balance of systems with and without chemical reactions, unsteady state material and energy balances.
Combined material and energy balances for nuclear, electrochemical, photochemical and biochemical and less conventional separation processes.
Typical industrial applications.

Recommended Books :

1. Basic Principles And Calculations in Chemical Engineering - D. M. Himmelblau, PHI Learning Pvt. Ltd.
2. Stoichiometry and Process Calculations - Narayanan K.V., Lakshmikutty B, PHI
3. Introduction to Process Calculations Stoichiometry - KA. Gavhane, Nirali Prakashan
4. Elementary principles of chemical processes - R. M. Felder and R. W.Rousseau 3rd Ed., Wiley, 1999.
5. Handbook of Chemical Engineering Calculations- N. Chopey, 3rd Ed., Mc-Graw Hill, 2004
6. Chemical Process Principles, Part 1: Material and Energy Balances- A. Olaf, K.M. Watson and R. A. R.Hougen John Wiley & Sons, 1968

Module II: Introduction to Statistical Analysis **50 marks /2 Credits**

Review of elementary probability theory, Bayes theorem, Random variables, Functions of random variables, probability distribution functions, expectation, moments and moment generating functions, Joint probability distributions, binomial, Poisson, and Normal distribution. Sampling distributions, Point and interval estimations, Statistical hypothesis tests, t-tests for one and two samples, F-test, χ^2-test, tests of hypothesis for proportion, Simple Applications.
Statistical Methods for Data Fitting: Linear, multi-linear, non-linear regression, ANOVA
Differential Calculus: Review and Concepts, Higher order differentiation and Leibnitz Rule for the derivative, Rolle's and Mean Value theorems, Taylor's and Maclaurin's theorems, Maxima/Minima, convexity of functions, Asymptotes, Radius of curvature; Nonparametric statistics; wilcoxan rank, friedman analysis

Recommended Books:

1. Fundamentals of statistics, volume 1 - Gun Gupta and Das Gupta, World Press

2. Statistical Methods - N G Das, M Das co

3. Textbook of Differential Calculus - Akhtar and Ahsan, PHI learning

Paper 21
Course CT302
Chemical Technology –II

Module I: Organic Technology **50 marks /2 Credits**

Spectroscopic analysis of organic compounds involving UV, NMR and MS.
Heterocyclic chemistry of compounds of industrial importance.
Dyes and pigments – chemistry and applications
Feedstock sources for the organic chemical industries and uses of principal organic chemicals in industries based on these chemicals.
Principal organic chemical industries manufacturing Polymers, Adhesives, Paints and Varnishes, Printing Inks, Dyes, Products by Fermentation, Synthetic fibres, Sugars, Paper and Explosives – Production statistics, raw materials, processes employed, safety and pollution aspects.
Studies of the principles of unit processes viz., Nitration, Sulphonation, Halogenation, Hydrogenation and the application of these processes for the manufacture of principal organic chemicals.
Stereospecific synthesis, stereochemical analysis and structure elucidation.
Concepts of combinatorial chemistry.

Recommended Books:

1. Advanced organic chemistry (organic synthesis, heterocyclic compounds and biomolecules) publisher: Books and Allied Organic Chemistry (A modern approach), Vol-lll, McGraw hill.
2. Unit Processes in Organic Synthesis, P.H. Groggins, McGraw hill, 2001.

Module II: Inorganic Technology **50 marks /2 Credits**

Water treatment and conditioning, Scale and sludge formation, Desalination of water, Membrane process, Piezodialysis and Reverse Osmosis.
Chemistry and applications of rare earth elements and their oxides.
Selected chemical industries – Fertilizers, caustic soda, chlorine, soda ash.

Electrochemical Industries and important products.
Electrothermal Industries - Artificial abrasives, Calcium Carbide, Graphite.
Nuclear Fuels, Nuclear Reactor.
Important industrial gases – CO_2, H_2, O_2, He.
Production of important mineral acids – H_3PO_4, H_2SO_4, HCl and HNO_3.
Commercial Production of Dichromate, Permanganate and Alum.

Recommended Books
1. Dryden's outlines of Chemical Technology for the 21st century

   M. Gopala Rao & Marshall Sittig

2. Manual of Chemical Technology

   Inorganic Products - D. Venkateswarlu

Paper 22
Course CT303
Chemical Technology –III

Module I: Energy Technology **50 marks /2 Credits**

Energy crisis in India. Conventional energy sources: solid fuels, fossil fuel: coal it's origin and classification. Testing and processing of coal: preparation, washing, storage, and carbonization.
Liquid fuel: liquid fuel from crude oil. Synthetic and other liquid fuels. Storage and handling of liquid fuels.
Gaseous fuels: Natural gas. Manufacture of other commercial gaseous fuels. Analysis of fuel gases.
Non conventional, renewable energy sources: Introduction to solar energy, nuclear energy, wind energy, geothermal energy, tidal energy, biogas energy.
Furnaces: General classification and description of different types of furnaces with special reference to furnaces used in ceramic, glass, petroleum, oils and pharmaceutical industries. Heat saving applications.
Burners.
Refractories and insulating materials.
Combustion stoichiometry and heat balance calculations.

Recommended Books :

1. Fuels & Combustion, 3rd edition, Dr. Samir Sarkar, Universities Press
2. Elements of Fuels, Furnaces & Refractories – Prof. O.P.Gupta, Khanna Publishers

Module II: Biotechnology **50 marks /2 Credits**

Introduction to Biotechnology:
Classification of enzymes, sources and characteristics; Bioprocesses, whole cell and cell free systems. Kinetics of enzyme reactions, rapid reaction kinetics, kinetics in water rich and water deficient medium.

Bioreactors, types of bioreactors, bioreactor design and control parameters; Fermentation process technology; Biomaterial separation processes.
Industrial biotechnology for food, antibiotics, organic acids, enzymes, alcohols, perfumery chemicals and biodegradable polymers.
Biotechnology products and processes as applied in i) fats and oil technology, ii) pharmaceutical & fine chemical technology, iii) petrochemicals & petroleum refinery technology, iv) Ceramic technology, v) biomaterials and composites, vi) metallurgy and mineral dressing.
Environmental biotechnology concepts and application: Industrial waste management, air quality and control, bio-waste management.
Energy Biotechnology: Biogas, biodiesel, alternative energy sources like methane, hydrogen, biotransformations bioenergy economics.

Recommended Books:

1. Text book of Biotechnology by R.C. Dubey. S. Chand. Edition- 5th.
2. Biotechnology for beginners by Reinhard Renneberg.
3. Academic Press. Edition- 2nd.

Paper 23
Course CT304 **100 marks /4 Credits**
Chemical Engineering I
(Fluid Mechanics)

Module I

Introduction to fluids, Forces on fluids, Normal & shear stresses
Fluid Statics: Pressure distribution, Manometry, Forces on submerged bodies, Buoyancy
Euler's equation of motion, Bernoulli's equation and applications, Fanning equation, Friction factor vs. Reynold's plot, Concept of equivalent length; Boundary layer theory, Laminar and turbulent flow
Pressure drop and energy considerations in flow of fluids, Flow through packed bed, Settling of solids, Free settling, Hindered settling, Concept of fluidization

Module II

Flow measurement (Venturimeter, Orificemeter, Rotameter, Pitot Tube, Weir)
Fluid transportation equipment and accessories, Process pumps: reciprocating, rotary and centrifugal pumps, NPSH, Cavitation, Construction and application of valves, Blowers and compressors.

Recommended Books :

1. R. W. Fox and A. T. McDonald, Introduction to fluid mechanics, 5th Ed., John Wiley & Sons, 1998.
2. W. L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 6th Ed., McGraw - Hill, International Edition, 2001.
3. B. R. Bird, E. W. Stewart, and N. E. Lightfoot, Transport Phenomena, John Wiley & Sons, 2nd Ed., 2003.

4. J. M. Coulson and J.F. Richardson, Chemical Engineering, Vol-1: Fluid flow, Heat Transfer and Mass Transfer, Pergamon Press, 4th Ed., 1990.

(Practical)

Paper 24

Course CT305 **50 marks /2 Credits**

Organic Technology Lab.

1. Calibration of thermometers for, the determination of melting points and boiling points.
2. Complete qualitative analysis and identification of single organic compound having one or more functional groups.
3. Preparation of organic compounds involving some typical organic reactions and separation and purification -techniques.
4. Isolation of some natural products.
5. Estimation of organic compounds via functional groups.
6. Some Industrial organic estimation.

Recommended Books:

1. Vogel's Textbook of Quantitative Chemical Analysis, 6th Ed. by J Mendham**,** Pearson
2. Vogel's Textbook of Practical Organic Chemistry, 5th ed., A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford, P.W.G. Smith, Pearson Education

Paper 25

Course CT306 **50 marks /2 Credits**

Inorganic Technology Lab

1. Water analysis, Hardness, chlorides, TDS
2. Application of $Hg_2(NO_3)_2$ in estimation of Fe^{3+} in inorganic materials
3. Complexometric method of determination of cations using EDTA: Mg^{2+}, Ca^{2+}, Ba^{2+}, Zn^{2+}, Cd^{2+}, Fe^{3+}, Al^{3+}, Bi^{3+}, Mn^{2+}, Cr^{3+}, Cu^{2+}, Ni^{2+}, Co^{2+} and some of their mixtures.
4. Volumetric method of determination of anions: SO_4^{2-}, Cl^-, P_2O_5.
5. Standardization of HCl and $KMnO_4$ by EDTA.
6. Estimation of some trace elements in inorganic materials by colorimetric, flame photometric titration.
7. Application of atomic absorption spectroscopy for analysis of trace elements.
8. Differential Thermal analysis of some inorganic minerals and ores
9. Neutralization reactions by pH meter.

Recommended Books :

1. Quantitative Inorganic Analysis – A. I. Vogel

Paper 26

Course CT307 **50 marks /2 Credits**

Physical Chemistry Lab

1. Determination of viscosity coefficient
2. Determination of surface tension
3. Determination of distribution coefficient
4. Determination of equilibrium constant (homogeneous)
5. Determination of phase diagram (ternary system)
6. Determination of adsorption isotherm.

Recommended Books :

1. Advanced Practical Chemistry – Subhas C. Das

Paper 27

Course CT308 **50 marks /2 Credits**

Instrumental Method of Analysis

1. Basic Principles, Instrumentation and application of
   a. GC
   b. HPLC
   c. UV and VIS spectrophotometers
   d. IR
   e. DTA and
   f. TGA.
2. Instrumentation and Application of
   a. Conductometry and
   b. Potentiometry.

Semester IV
(Theory)

Paper 28

Course CT401 **100 marks /4 Credits**

Engineering Thermodynamics

Module I

Introduction- scope of thermodynamics, Dimensions and Units, Temperature, Pressure, Work, Energy, Heat. 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 .

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. Heat effects-latent heat, sensible heat, standard heats of formation, reaction and combustion.

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.

Thermodynamic property of fluids, Maxwell relations, 2-phase systems, graphs and tables of thermodynamic properties. Application of thermodynamics to flow processes-pumps, compressors and turbines.

Thermodynamic analysis of steam power plants; Rankine cycle; Internal combustion engine, Otto engine; Diesel engine; Jet engine. The Carnot refrigerator; Vapor-compression cycle; Absorption refrigeration; Heat pump, Liquefaction processes.

Vapor-liquid equilibrium: phase rule, simple models for VLE; VLE by modified Raoult's law; VLE from K-value correlations; G-D Equation, VLE for non-ideal solution (Van Laar equation), Flash calculations.

Module II

Solution Thermodynamics: fundamental property relationships, free energy and chemical potential, partial properties, definition of fugacity and fugacity coefficient of pure species and species in solution, the ideal solution and excess properties.

Liquid phase properties from VLE, Models for excess Gibbs energy, heat effects and property change on mixing. Liquid-Liquid Equilibria; Vapor-Liquid-Liquid Equilibria; Solid-Liquid Equilibria; Solid-Gas Equilibria.

Chemical reaction equilibria: equilibrium criterion, equilibrium constant, evaluation of equilibrium constant at different temperatures, equilibrium conversion of single reactions, multireaction equilibria.

Introduction to molecular/statistical thermodynamics

Recommended Books

1. Introduction to Chemical Engineering Thermodynamics: J. M. Smith, H. C. Van Ness and

M. M. Abbot, 6th Edn. MGH, 2001.

2. A Text Book of Chemical Engineering Thermodynamics, Narayanan, PHI

3. Chemical Engineering Thermodynamics: Y. V. C. Rao.

4. Chemical Engineering Thermodynamics - S. I. Sandler, Wiley, New York, 1977.

Paper 29
Course CT402 **100 marks /4 Credits**
Chemical Engineering II (Process Heat Transfer)
Module I
Heat transfer fundamentals: Modes of heat transfer

Conductive heat transfer: Conduction mechanism of heat transfer, Fourier's law, Steady state of heat transfer through composite slabs and composite cylinders, Heat transfer from extended surfaces, Concept of unsteady state heat transfer
Convective heat transfer: Heat flow mechanism by convection, Individual and overall heat transfer coefficient, Log-mean temperature difference, Forced convection inside tubes and ducts – Dittus-Boelter equation, Reynold's analogy, Natural convection
Design of heat transfer equipment: Types of heat exchange equipment and design of heat exchangers –shell and tube heat exchangers, double pipe heat exchangers
Basics of heat transfer with phase change: Introduction to boiling, Introduction to condensation, Condensers and reboilers

Module II
Introduction to radiative heat transfer: Concept of black body and laws of black body radiation, Kirchoff's law, Emissivity, Radiant heat transfer between surfaces separated by non-absorbing media
Evaporation: Mechanism of vaporization, Single and multiple effect evaporator, Calculations for optimum number of effects

Recommended Books

1. Process Heat Transfer - D. Q. Kern, MGH.
2. Heat Transfer Principles and Application - B. K. Dutta, PHI.
3. Heat Transfer - A Basic Approach: M. Necati Ozisik, McGraw-Hill International Edition, Singapore.
4. Heat Transfer: A Practical Approach - Yunus A. Cengel, McGraw-Hill.
5. Fundamentals of Heat and Mass Transfer - Frank P. Incropera, David P. DeWitt, Theodore L. Bergman, Adrienne S. Lavine, Wiley.
6. A Heat Transfer Textbook - John H. Lienhard IV and John H. Lienhard V, Cambridge, Massachusetts : Phlogiston Press.
7. Heat Transfer - J. P. Holman, 8th Ed., McGraw - Hill, 1997.
8. Unit Operations of Chemical Engineering - W. L. McCabe, J. Smith and P. Harriot, 6th Ed., McGraw - Hill, International Edition, 2001.

Paper 30
Course CT403
Chemical Technology –IV
Module I: Process Instrumentation **50 marks/2 Credits**
Characteristics of Measurement System: Functional elements, classification and performance, characteristics of instrumental system. Instrument as an element of control system. Response characteristics for 1st order and 2nd order instrumental system.
Transducer, signal conditioning and display devices with block diagram.
Errors and Lags associated with instruments. Calibration of instruments.

Temperature measurement: Temperature measurement using change in physical properties. Electrical type temperature sensors. Optical and radiation pyrometers.
Pressure Measurement: Industrial manometers, elastic type pressure gauges, vacuum measuring gauges.
Flow measurement: Head flow and area flow meters, mass flow meters, solid flow measuring methods.
Liquid level measurement: Float type, displacer type devices, hydrostatic method, ultrasonic and nucleonic methods.
Instruments for viscosity, humidity, pH measurements. Instruments for gas analysis and composition analysis.

Module II: Process Dynamics & Control **50 marks/2 Credits**

Degrees of freedom, deviation variables, steady state gain, time constants, review of Laplace transform, input-output model, system response for first order and higher order systems, dynamics with dead time, inverse response.
Transfer function, 1^{st} order system, 2^{nd} order system, Examples of 1^{st} order system & 2^{nd} order system.
Introduction to chemical process control with examples, objectives of process control, control strategies and alternative control schemes, process stability, concept of optimum performance of chemical process.
Mathematical modeling of liquid level problems, stirred tank heater, mixing processes, CSTR, distillation column, absorption column, distributed parameter systems, linearization, SISO and MIMO systems.
Feedback control, P, PI, PID controllers and their response.
Control system instrumentation: sensors for liquid level, flow, pressure, temperature, and pH measurement, transmission line, comparator, controller, and final control elements, control valve sizing, pneumatic and electronic controllers.
Closed loop control systems, transfer function of individual elements, servo and regulator problems, dynamics of P, PI and PID controllers.
Stability of closed loop control systems, Routz-Hurwitz test, root locus analysis.
Feedback controller design, controller tuning, Ziegler-Nichols rules, Cohen and Coon rules, Integral error criteria, controller selection, process identification.
Frequency response, Bode plot and Nyquist diagram.
Introduction to advance control strategies: feed forward, control, cascade control, ratio control, adaptive control and inferential control.
Digital computer control, Z-transformation, discrete time dynamics, digital feedback controller design. Design of control system for complete process plants.

Recommended Books

1. Process Instrumentation, Control & Dynamics for Chemical Engineers – Uttam Ray Chaudhuri, Asian Books Pvt. Ltd.
2. Fundamentals of Automatic Process Control - Uttam Ray Chaudhuri, Taylor & Francis

Paper 31

Course CT404 CER/OLT/PPR/PFC **100 marks /4 Credits**

CER: Ceramics Engineering I

Module I: Ceramic Fabrication Process

Introduction to ceramic raw materials – their availability, geology and microstructure.
Hand moulding, ramming, extrusion, injection moulding.
Fabrication by pressure: classification according to water content. Dry and semi-dry pressing. Hot pressing and reactive hot pressing, cold and hot isostatic pressing.
Application of different types of monolithics and gunning materials.
Fusion casting: Different types of moulds and presses.
Slip casting processes of clay based systems and non-plastic bodies: properties of the slip, mechanism of slip casting, nature of plaster moulder.
Fabrication processes used in forming of glass articles:
Blowing, pressing, drawing and sheet making.
Sintering and controlled vitrification of shaped bodies.
Particle packing – Westman diagram.
Drying: Critical moisture content, different types of dryers.
Firing: Physicochemical changes, different kilns.

Recommended Books:-

1. Introduction to the principles of ceramic processing - J. S. Reed
2. Industrial Ceramics: Singer and Singer
3. Ceramic Processing and Sintering –M. N. Rahaman
4. Rheology of Ceramic systems: F. Moore
5. The Chemistry and Physics of clays and other ceramic materials: Rex W. Grimshaw
6. Ceramic Processing before firing : Onoda and Hench

Module II: Physics and Chemistry of Ceramic Clays

Introduction to different types of clays used in ceramic industries – the availability and applications. Origin and classification of clays – geological aspects. Influence of different internal and external factors on the attributes of clays.
Basic features of silicate structures.
Structural classification of clay minerals.
Atomic disposition and charge distribution in different layer lattice minerals.
Physico-chemical relationship in clay-water system. Rheological properties and their applications. Plasticity of clays.
Methods of identification of clay minerals.
Effect of heat treatment on the phase transformation of clay minerals.
Differential thermal analysis of clay minerals. Ion exchange properties - its importance and methods of measurement. Colloidal properties of clay-water systems. Particle size, shapes and their distribution in relation to properties. Suitability of clay for particular industries.
Processing and beneficiation of some commercial clays and conversion to mono-ionic forms.

Recommended Books:

1. The Chemistry and Physics of clays and other ceramic materials: Rex W. Grimshaw

2. Clays and ceramic raw materials: W. E. Worral
3. Properties of ceramic raw materials: W. Ryan
4. Industrial Ceramics: F. Singer and S. S. Singer
5. Handbook of Clay Science: F. Bergaya, D. K. G. Theng and G. Lagaly

OLT: Oil Technology I
Module I

Chemistry & Analysis of Fats, Oils and Waxes

Introduction to molecular nature and uses pattern of fats & oils; demand and supply position of edible and non-edible oils. Source and availability of fats and oils; vegetable source, marine and land animal source and microbial source.
Physical properties of fats and oils: thermal rheology, polymorphism, surface active, spectral and optical properties.
Chemical composition of fats and oils; fatty acids, triglycerides, non-triglycerdes, minor constituents. Nomenclature; Basic reactions of fats and oils basee on double bonds & ester bonds); Hydrogenation, oxidation and auto -oxidation, polymerization, hydrolysis, esterification, interesterification, sulphonation,amidati-on, pyrolysis etc. Frying reactions.
Fats and oils analysis : Basics of various methods of analysis; physical and chemical methods of analysis; chromatographic methods of analysis(TLC, GLC, HPLC): spectroscopic methods of analysis (UV, IR, NMR, MS): detection of adulteration by chemical, spectroscopic, colour and other instrumental methods.
Bio-availability and digestibility of fats & oils; Fats in nutrition, health and disease and dietary guidelines.

Module II: Introduction to Polymer Basics and Surface Coating Technology

Definition and classification of coatings, present Status of coatings, coating ingredients and coating applications.
Corrosion & its prevention
Fundamentals of clear coatings
Drying oils: their modification, mechanism of film formation and film deterioration on ageing
Solvents and Plasticizers: Their characteristics and classifications.
Manufacturing of varnishes: types of equipments, composition and uses, faults and defects of varnishes and varnish films. Manufacture of lacquers and their applications.

Recommended Books:

1. Chemistry & Technology of Oils & Fats – M. M. Chakraborty
2. Principles of Polymer Chemistry – P. J. Flory
3. Basics of Paint Technology – V.C. Malshe & Meenal Sikchi
4. The Chemical Constitution of Natural Fats- T. P. Hilditch and P. N. Williams
5. Paint and Surface Coatings - R. Lambourne and T. A. Strivens
6. Organic Coating Technology – H. F. Payne

PPR: Petrochemicals & Petroleum Refinery Engineering I

Module I : Natural Gas, Crude Oil & Petroleum Products overview

Natural Gas & Crude Oil Exploration, Production &Transportation – Properties of Natural Gas, Shale Gas, Shale Oil, Gas Hydrates & Crude Oil and various methods of exploration. Cross-country transfer of crude oil & gas to refineries & petrochemical plant.
Crude Oil Evaluation, Analysis – Crude assay, Four cut method
Petroleum Products overview with Specifications and Standard Test methods – BIS specification, Euro specification, IP test methods

Module II : Refinery Operations I

ASTM & TBP Distillation- preparation of EFV & TBP curves
Atmospheric and Vacuum Distillation, Absorber, Stripper, Splitter, Prefractionator; Distillation with Valve trays & Packed bed, Divided wall column
Desalting – theory, operating conditions, technology & application.
Gas Plant operations – objectives, process & application.

Recommended Books

1. Fundamentals of Natural Gas processing (2^{nd} Ed) – A. J. Kidnay, W. R. Parrish, D. G. McCartney, CRC Press
2. Petroleum Refinery Engineering (4^{th} Ed) – W. L. Nelson, McGraw –Hill
3. Fundamentals of Petroleum and Petrochemical Engineering, U. Ray Chaudhuri, *CRC* Press, Taylor & Francis group, 2013
4. Crude Oil Chemistry, V. Simanzhenkov, R. Idem, Marcel Dekker, Inc., 2016
5. Modern Petroleum Technology, Vol. II, A. G. Lucas, John Wiley & Sons Ltd., 2000
6. Fundamentals of Petroleum Refining, M. A. Fahim, T.A. Alsahhaf, A. Elkilani, Elsevier, 2010

PFC: Pharmaceutical and Fine Chemical Technology I

Module I: Pharmaceutical Chemistry

Principles of pharmacopoeial analysis, Source of pharmaceuticals and impurities concepts, API and excipients studies.
Source, biogenesis, extraction techniques and chemistry of alkaloids, terpenoids, steroids, glycosides and polyphenols.
Instrumental techniques in drug analysis including UV-Vis, FTIR, NMR, AAS, Flourimetry, HPLC and HPTLC. Principles and applications of Tracer techniques and Imaging analysis in optical microscopy, SEM, TEM, AFM.

Module II: Biochemistry & Microbiology

Metabolic pathways and electron transport chain, proteins biosynthesis, DNA/RNA biogenesis. Enzymes, classification, kinetics, coenzymes, inhibitors, immobilization and biotransformation.
Classification of microbes, identification, isolation, preservation, growth and kinetics. Sterilization techniques and disinfection. Principles of cell based studies like flow cytometry and confocal microscopy.

Recommended Books:

1. D. A. Skoog: Principles of Instrumental Analysis (Saunders College Publishing Philadelphia)
2. M. Orchin and H. H. Jaffe – Theory and applications of ultra violet spectroscopy (John Wiley and Sons, N. Y.)
3. Silverstein, Basserler, Moriil – Spectrometric identification of organic compounds (John Wiley and Sons, N. Y.)
4. Willard, Merritt, Dean – Instrumental Methods of Analysis (CBS Publishers and Distributors, Delhi)
5. J. R. Dyer – Applications of Absorption Spectroscopy of Organic compounds (Prentice Hall, London)
6. C. N. R. Rao – Chemical application of Infra-red spectroscopy (Academic press, N.Y.)
7. Higuchi: Instrumental Methods of Analysis (CBS Publishers)
8. Analytical Chemistry by open learning series
9. R. J. Hamilton – Introduction to High Performance Liquid chromatography, (Chapman and hall, London).
10. Ewing – Instrumental Methods of Chemical Analysis (McGraw Hill Book Co. New York)
11. Indian Pharmacopoeia, VIIth Ed, 2014, Indian Pharmacopoeia Commission
12. Vogel's Textbook of Quantitative Chemical Analysis, 6th Ed. by J Mendham**,** Pearson
13. J H Block, F Roche, I O Soine and C O Wilson, Inorganic Medicinal and Pharmaceutical Chemistry, Lea and Febiger, Phildelphia, P A.
14. Handbook of Pharmaceutical Excipients, Raymond C. Rowse, Paul J. Sheskey, Marian E. Quinn, Pharmaceutical Press, 2009.
15. Essentials of Biochemistry by U Satyanarayana. Publisher- Books and Allied (p) Ltd. Edition- 5th.
16. The Cell: A Molecular Approach by Geoffrey M. Cooper. Publisher- Sinauer Oxford University Press. Edition- 7th.
17. Lehninger Principles of Biochemistry by David L. Nelson, Michael M. Cox. Publisher W.H. Freeman. Edition- 7$^{th.}$
18. Biochemistry by Debajyoti Das. Publisher- Academic Publishers. Edition- 14th.
19. Microbiology by Michael Pelczar. Publisher- McGraw-Hill Inc. Edition- 6th.
20. Nester's Microbiology: A Human Perspective by Denise G. Anderson. Publisher- McGraw-Hill Education. Edition- 8th.
21. General Microbiology by Roger Stanier. Publisher- Palgrave Macmillan. Edition- 5th.
22. Fundamental Principles of Bacteriology by Anthony Joseph Salle. Publisher- Tata McGraw-Hill Education. Edition- 4th.

(Practical)

Paper 32

Course CT405 **50 marks /2 Credits**

Biotechnology Lab

1. Microbial culture. Microbial cell growth and kinetics, Staining and microscopy study of microorganisms.
2. Preparation and characterization of immobilized enzyme, Bio-conversion studies with enzymes, Effect of pH and temperature on enzyme activity, Kinetics of enzyme inhibition activity.
3. Production of metabolites in synthetic and complex media, Monod equation, Estimation of monod parameters in batch, fed-batch and continuous cultures and solid state fermentation.
4. Sterilization of medium, sterilization cycle. Inoculation and microbial preservation techniques.
5. Stirred Tank Reactor operation for controlled bacterial growth; Study of rheology of fermentation broth in batch bioreactor.

Recommended Books:

1. Laboratory Manual for Biotechnology Students, A. S. Verma, S. Das, A. Singh, Publisher S. Chand, 2014.

Paper 33

Course CT406 **50 marks /2 Credits**

Energy Technology Lab

Sampling techniques for solid, liquid and gaseous fuels for analysis.

Test of solid fuels: proximate and ultimate analysis of coal and coke. Calorific value of coal and coke. Sulphur in coal. Phosphorous in coke. Washability tests of coal. Carbonization assay of coal.

Tests of liquid fuels: viscosity, flash point, fire point, water content, carbon residue, ash, calorific value, aniline point.

Tests of gaseous fuels: Orsat analysis, calorific value.

Calibration of thermocouples.

Thermal conductivity of insulating materials.

Recommended Books:

1. Fuels & Combustion, 3rd edition, Dr. Samir Sarkar, Universities Press
2. Fuel Combustion Energy Technology, S. N. Saha, Dhanpat Rai Publication Co.
3. Elements of Fuel Technology, Himus

Paper 34

Course CT407 CER/OLT/PPR/PFC **50 marks /2 Credits**

Special Lab I

CER : Ceramic Engineering Lab I (at least 5)

Chemical Analysis of Ceramic Raw Materials and Products:
Opening of different types of ores and minerals by chemical interaction.
Chemical analysis of water and acid soluble materials:
Water glass, Borax, Portland cement (complete analysis and insoluble residue), Zeolites, Blast furnace slag, Magnesite, Dolomite, Limestone.
Analysis of materials by fusion method:
Refractories: Bauxite, Kyanite, Sillimanite, Chromite, Quarzite.
Fluxes: Feldspar, Slags, Nepheline Syenite
Clays: China clay, Fire clay, Bentonite, Mica and Vermiculite.
Miscellaneous: Rock phosphate, Gypsum, Hematite, Ilmanite, Talc and Cryolite.
Direct estimation of CaO, Fe_2O_3 and SiO_2 in Portland cement.
Estimation of some special constituents in:
Zircon, Chromite, Lepidolite, Fluorapatite, Synthetic mullite.

OLT: Oil Technology Lab I
Analysis of oils & meals
Analysis Oils: Physical tests- density, refractive index, slip point, cloud point, cooling curve, solubility – tests in solvents, color measurements, etc. Fatty acid composition analysis by GLC. Conjugated diene, triene content by UV method.
Chemical tests – acid value, peroxide & anisidine values, saponification and iodine values, hydroxyl values, oxirane values, Reichert-Meissl, Reichert-Polenske, Kirchner values, unsaponifiable matter, gum (phospholipids) content, wax content, acetone and benzene insolubles, color reactions of oils. Detection of adulterants.

Recommended Books

1. Official Methods and Recommended Practices AOCS of the AOCS
2. A Treaties on Analysis of Food, Fats & Oils – A.R.Sen, N.K.Pramanik, S.K.Roy
3. FSSAI Manual of Methods of Analysis of Foods, Oils & Fats , 2015

PPR: Petrochemicals & Petroleum Refinery Engineering Lab I
Evaluation of Crude Oil
Fractionation of Crude Oil
Evaluation of Crude oil & Crude Assay.
Construction of Mid percent and Yield curves

Recommended Books

1. IP Standard Test Methods for Analysis & Testing of Petroleum and related Products, Energy Institute, 2012
2. Annual Book of ASTM Standards, ASTM International, 2019.
3. Petroleum Refinery Engineering (4^{th} Ed) – W.L.Nelson, McGraw –Hill

PFC: Pharmaceutical and Fine Chemical Technology Lab – I
Pharmaceutical Chemistry I

1. Pharmacopoeial tests and assay of representative organic and inorganic compounds like sodium chloride, sodium benzoate, aluminium hydroxide gel etc.
2. Limit tests for arsenic, heavy metals and anions.
3. Laboratory preparation for Pharmacopoeial compounds in one or two step: aluminium hydroxide gel, sodium benzoate, sodium chloride.

Recommended Books:

1. AH Beckett & Stenlake, Text Book of Practical Pharmaceutical Chemistry, Vol. I & II.
2. Indian Pharmacopoeia, VIIth Ed, 2014, Indian Pharmacopoeia Commission

Paper 35
Course CT408 CER/OLT/PPR/PFC **50 marks /2 Credits**
Special Lab II

CER: Ceramics Engineering Lab II (at least 5)

Chemical Analysis of Ceramic Raw Materials and Products by Instrumental Techniques:
Analysis of some redox systems.
Alkalis in feldspar and glass.
Boric Oxide in glass.
Estimation of ceramic material by atomic absorption spectroscopy:
Fe^{3+}, Ti^{4+}, Co^{2+}, Ni^{2+} and Mn^{2+} .
Identification of phases in ceramic raw materials and products by:
Microscopic technology, XRD, DTA & TGA.
Evaluation of some solid industrial waste materials and their utilization.

Recommended Books:

Quantitative Inorganic Analysis – A. I. Vogel
Analysis of ceramic raw materials – S. Kumar and D. Ganguli

OLT: Oil Technology Lab II
Fats and Oil Processing
Practical on oilseeds and Oils/Fats etc.; Pretreatment and storage of oil-bearing materials; Extraction of oils and fats from vegetable and animal sources: pressing, solvent rendering; Analysis of seed cakes; Extraction of protein and other non-oil components such as dietary fibre, carbohydrate etc.
Detection of adulteration

Recommended Books

1. Official Methods and Recommended Practices AOCS of the AOCS
2. A Treaties on Analysis of Food, Fats & Oils – A. R. Sen, N. K. Pramanik, S. K. Roy
3. FSSAI Manual of Methods of Analysis of Foods, Oils & Fats , 2015

PPR: Petrochemicals & Petroleum Refinery Engineering Lab II
Testing of Crude Oil & Petroleum Products
ASTM Distillation of Crude oil & Petroleum products.
Standard ASTM/IP tests of different products – flash point, pour point, carbon residue, burning quality, sulfur content, water content, sediment, smoke point, softening point, drop point, cone penetration, needle penetration etc.

Recommended Books:

1. IP Standard Test Methods for Analysis & Testing of Petroleum and related Products, Energy Institute, 2012
2. Annual Book of ASTM Standards, ASTM International, 2019

PFC: Pharmaceutical and Fine Chemical Technology Lab II

Microbiology I
1. Different media preparations
2. Sterilization by dry heat, moist heat and filtration.
3. Validation of sterilization
4. Environmental control tests
5. Microbial staining
6. Identification and isolation from soil sources.
7. Tests and quantification for proteins, carbohydrates, fats and amino acids.

Recommended Books:

1. Microbes in action: A Laboratory Manual of Microbiology, H.W. Seeley, W.H. Freeman, 4^{th} Edn.

Semester V
(Theory)

Paper 36
Course CT501 **100 marks /4 Credits**
Chemical Engineering III
Mass Transfer Operations: General principles of diffusion and mass transfer, Molecular and eddy diffusion of fluids, Diffusivities,
Convective mass transfer: Mass transfer coefficients and their relationships, Interphase mass transfer, N.T.U., H.T.U. methods.
Mass transfer theories and models
Distillation: Vapour-liquid equilibria, batch and equilibrium distillation, Steam distillation, azeotropic and extractive distillation, Enthalpy concentration diagram, Rectification column design, McCabe – Thiele method, Ponchon – Savarit method.
Simultaneous heat and mass transfer operations: Humidification and Dehumidification principles, psychometric chart, Drying principles and driers.

Recommended Books :

1. 1 Mass Transfer Operations - R. E. Treybal, 3rd Ed., McGraw -Hill International Edition, 1981.
2. Principles of Mass Transfer and Separation Processes - B.K. Dutta, 1st Ed., Prentice Hall of India, 2007.
3. W. L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 6th Ed., McGraw - Hill International Edition, 2001
4. P. C. Wankat, Equilibrium-Staged Separations, Prentice Hall, 1989
5. C. J. Geankoplis, Transport Processes and Unit Operations, 3rd Ed., Prentice Hall, India, 1993.

Paper 37

Course CT502 **100 marks /4 Credits**

Reaction Engineering

Module I

Effects of process variables on rate of reaction, interpretation of kinetic data in batch and flow systems.

General feature and design equation for batch, plug flow, semi batch, stirred tank reactors.

Elementary problems in the design of homogeneous reactors, batch and flow tubular and stirred tank reactors.

Analysis and correlation of experimental kinetic data – data collection & plotting, linearization of rate equations, differential and integral method of analysis.

Multiple reactions – conversion, selectivity, yield, series, parallel and mixed series –parallel reactions.

Combination of reactors

RTD theory and analysis of non-ideal reactors.

Module II

Introduction to Catalysis, homogeneous and heterogeneous catalysis, preparation and characterization of catalysts

Physical & chemical adsorption, Adsorption Isotherms, measurement of catalyst surface area and catalyst porosity

Mass transfer, Diffusion and chemical reactions in catalysts, Effects of external mass transfer and heat transfer, Effectiveness factor. Design aspects of catalytic reactors.

Laboratory reactors for gas-solid reactions, design concepts.

Gas liquid reactions, film & penetration theories and gas-liquid reactors.

Recommended Books:

1. Octave Levenspiel, Chemical Reaction Engineering, 2nd Ed., Wiley Eastern, 1972.
2. J. M. Smith, Chemical Engineering Kinetics, 3rd Ed., McGraw Hill, 1980.
3. H. S. Fogler, Elements of Chemical Reaction Engineering

Paper 38

Course CT503 **100 marks /4 Credits**

Elective I (Safety & Hazard Analysis/Industrial Pollution: Control and Management/ Project Engineering)

A. Safety & Hazard Analysis

Introduction: Safety program, engineering ethics, accident and loss statistics, acceptable risk, public perception. Material safety data sheet (msds), storage, handling and use of hazardous chemicals, occupational health hazards.

Toxicology: How toxicants enter & eliminate from biological system.

Industrial hygiene: Government regulations, identification, evaluation, control

Fires and explosions: The fire triangle, distinction between fire and explosions; definitions, flammability characteristics of liquids and vapors, loc and inerting, ignition energy, auto ignition, auto oxidation, adiabatic compression, explosions.

Designs to prevent fires and explosions: Inerting, explosion proof equipment and instruments, ventilation, sprinkler systems.

Introduction to reliefs: Relief concepts, definitions, location of reliefs, relief types, relief systems.

Hazards identification: Process hazards checklists, hazard surveys, hazop & hazan study.

QRA, Logic trees, FTA, ETA, Boolean notation.

Safety Audit, Legal aspects of Safety (Factory's Act), on site Emergency plan.

Recommended Books:

1. System Safety Engineering and Risk Assessment: A Practical Approach, Second Edition, By Nicholas J. Bahr, CRC Press.
2. Elements of Industrial Hazards: Health, Safety, Environment and Loss Prevention, by Ratan Raj Tatiya, CRC Press.

B. Industrial Pollution: Control and Management

Environmental pollution from Industries with special reference to Process Industries. Pollutants-nature, types and sources; consequences.

Air and Water Pollution, Solid wastes. Episodes of Industrial hazards and pollution: Minamata, Love Canal, Flixborough, Bhopal and Chernobyl.

Elements of Ecology and Environment. Atmosphere, Hydrosphere and Lithosphere. Short and long term Ecosystem and Biosystem impacts of Pollution. Bioaccumulation and Biomagnification, Ecotoxicity, Carcinogens, Hormone disruptors, Radiation Hazards

Water as Environmental Resource, Criteria of Water Pollution: Physical, Chemical and Biological Criteria-Suspended and Dissolved matter; Organics-Biodegradable and Non-biodegradable; Heavy metals and other inorganic pollutants.

Water Quality. Assessment of water quality: Sampling and Analysis. Dissolved Oxygen, Chemical and Biochemical Oxygen Demands. Total Organic Carbon, Colorimetric and Gas Chromatographic Analysis. Toxic Inorganic Pollutants-Arsenic, fluoride, mercury, chromium, cadmium, lead. Coliform test.

Water Quality Standards: Drinking water, Effluent Discharge Standards, Minimum National Standards (MINAS).

Pollution load of Wastewater/Effluent, Treatment of wastewater. Primary, Secondary and Tertiary methods, Bioreactors. Activated sludge and Fixed film treatment methods. Design criteria of a bioreactor. Pond treatment and Soil treatment systems. Bioremediation.
Recycling and Zero-Discharge industries.
Air: Composition and Quality. Chemical and Photochemical reactions in the atmosphere. Ozone formation and depletion. Green House Effect and Green House Gases.
Air Pollution Criteria: Particulates, SO_x, No_x, CO, Hydrocarbons (HCs) and others. Dispersion and Modelling, Vehicular pollution. Smog episodes. Sampling and Analysis of air for pollutants.
Air Pollution Control-Precipitators, Electrostatic Precipitators (ESP), Scrubbers. Vehicular Pollution and Control. Real-time analysis and air pollution monitoring. Monitoring of Combustion and Emission.
Sound Pollution, Intensity Levels and Control.
Solid Wastes-Municipal, Industrial and Electronic (E-waste), Extent, Constituents and Management. Isolation, Incineration, Landfill, Disposal Options for toxic and hazardous wastes. Industrial sources and nature of solid wastes and sludge, Minimization options.
Industrial Processes and Pollution- Case studies-Cement, Paper, Fertilizer, Paint, Pharmaceuticals, Petrochemicals.
Environmental Legislation-Provisions in Factories Act, Water (prevention and control of pollution) Act, Air (prevention and control of pollution) Act, Environment (protection) Act. Manufacture, Storage and Handling of Hazardous Chemicals Rules, Solid Waste Rules.
Management Concepts and Systems. Environment Impact Assessment (EIA), Energy and Environment Audit, Polluters Pay Principle, Life Cycle Assessment (LCA), ISO certification for Environment.
Sustainability Concepts, Ecosystem approach.
Green Chemistry Principles and Practices

Recommended Books :

1. Introduction to Environmental Management, Mary K Theodore, SOAS, Univ of London
2. Wastewater Engineering (Including Air Pollution),B.C. Punmia, Ashok Kumar Jain, Arun Kumar Jain
3. Air Pollution Control Engineering -Noel De Nevers (McGraw-Hill)
4. Handbook of Water and Wastewater Treatment Technology, Nicholas P. Cheremisinoff (CRC Press)
5. Water Quality Control Handbook; E. Roberts Alley, McGraw Hill, New York, 2000

C. Project Engineering

Module I
Role of a project engineer, Development of project- Laboratory bench scale experiment to pilot & semi-commercial plant operation, scale up and scale down techniques, pre-design cost estimation, fixed capital and working capital, Manufacturing cost, plant location factors, selection of plant site, process design development, plant lay-out.
Module II
Time value of money, simple interest, Nominal & effective interest rates, continuous interest, present worth & discount, Annuities, perpetuities and capitalized cost, Depreciation,: Types of

depreciation, Depletion, Concepts of service life, Salvage value and Book value; Depreciation calculation by straight line method, Text book and double declining balance method, sum-of-the-years digit method and sinking fund method.
Profitability analysis method: Return on investment (ROI), payout period, Optimum design, Break-even point, Optimum production rate, Optimum conditions in cyclic operations, optimum economic pipe diameters, optimum flow rate, & cooling water.

Module III

Project scheduling: Bar chart, Milestone chart, Concept of network analysis: PERT, CPM, statistical distribution associated with PERT network, Earliest expected time, and latest allowable occurrence time calculation, Slack, determination of critical path, concept of float.

Module IV

Inventory and Quality Systems: Function of Inventories, Category of Stocks, Procurement costs, Inventory Holding costs, Inventory Control, ABC analysis, Inventory control, EOQ, Inventory control modelling, Re Order Point, Lot Sizing and Analysis. Current Approaches: Concepts of MRP and JIT-based production systems, Concept of zero inventory, Computerization of inventory and production management systems.

Managing for Quality: Total quality emphasis, Quality circles, Quality analysis and control, Control Charts, UCL, LCL.

Recommended Books:

1. Projects, 8th Ed. by Prasanna Chandra, McGraw Hill Education
2. Production and Operation Management: Concepts, Models, and Behavior by Everett E Adam , Ronald J Ebert, Prentice Hall
3. Plant design and Economics for Chemical Engineers by Max S Peters, Klaus D Timmerhaus, Ronald E. West, McGraw-Hill Education
4. NPTEL lectures on Project Engineering and Management, https://nptel.ac.in

Paper 39
Course CT504 CER/OLT/PPR/PFC **100 marks /4 Credits**
Special Paper II
CER: Ceramics Engineering II

Module I: Refractories: Processing and Properties

Refractory raw materials: Selection, availability and processing, mining, preliminary treatment, microstructure and purity (chemical). Synthetic raw materials.
Classification of refractory materials, scope of refractory industry.
Preliminary concept of binary and ternary phase diagrams related to important ceramic systems.
Different types of shaping processes: Mould materials, design, evaluation of the shaped compacts.
Drying of the shaped materials. Different types of driers, controlling factors influencing drying efficiency.

Forming. Selecting the different types of intermittent and continuous kilns. Temperature measurement in kilns.
Specification of different types of refractories.
Refractory properties and testing: Fusion point, Load bearing capacity (RUL, MOR, Creep). Thermal, mechanical and structural spalling, slag resistance, thermal expansion, CO disintegration, BD, AP and PLCAR.

Module II: Glass & Vitreous Coating

Glass:

Concept of Glassy state, Structural requirement, Role of different glass forming oxides. Silicate and non-silicate glasses. Structure of Glass – XRD, SAXS and other methods of determining glass structure.
Different types of commercial glasses and their compositions.
Raw materials for glasses – their availability, processing and batch calculation.

Design of the glass tank furnace and physicochemical considerations involved in the melting operations and refining. Batch melting reactions. Melting operations.
Properties imparted by different constituents.
Finishing, annealing of glasses. Strains, its detection, measurement and remedial measures, Devitrification of glass.
Viscosity of glass, measurement at different temperatures, its importance in different stages of glass melting , rheology of glass, elastic and visco-elastic properties of glasses.
Physical properties of glass – Density, refractive index of glass, thermal expansion, specific heat of glass, electrical conductivity of glass, dielectric properties, mechanical properties, surface properties.
Optical properties of glasses – refractive index, molar volume, ionic refractivity, birefringence. Ligand Field theory, UV-Visible absorption. Dispersion, Abbe Number, Stress-optic effect.
Thermodynamic basis of phase separation in glasses. Immiscibility in glasses. Kinetics of demixing. Application of immiscibility diagrams. Spinoidal and binodal decomposition. Additive rules.

Vitreous Coating:

Concept of glassy coatings on metals. Characterization of different types of metals: Cast iron, steel, aluminum and various alloys used for enameling. Preparation of metal and non-metal surfaces for enameling.
Enamel raw material. Enamel composition and properties imparted by different constituents. Frit making: Smelting, quenching, drying, milling, milling additives. Properties of enamel slip and their control. Application of enamel slip, drying and firing.
Properties of enamel melts: Thermal, Mechanical, optical and chemical.
Enamel defects: Their cause and remedies.
Opacity and adherence mechanism of enamel with metal.
Enameling of Aluminium and De-enameling
Application of enamel article in different field.

Recommended Books:-

1. Introduction to Ceramics – W. D. Kingery, H. K. Bowen, D. R. Uholmann

2. The Technology of Ceramics and Refractories – P. P. Budnikov
3. Hand book of Ceramics (Vol. I & II) – S. Kumar
4. Properties of Glass – F. Moorey
5. Introduction to glass science and technology – J. H. Shelby
6. Fundamental of inorganic glasses – A. K. Vershneya
7. Hand book of glass manufacture (Vol I & II) – Tooley
8. Technology of enamels – V. V. Vargin
9. Porcelain Enamels – A. I. Andrews

OLT: Oil Technology II

Module I : Extraction & Purification of Fats & Oils

Extraction

Handling, storage, grading and pretreatments (Mechanical and Heat Treatments) of oil -bearing materials: Extraction of fats and oils (Theory and Practice): extraction by pressing (Expeller, Extruder) solvents (polar and nonpolar) and biorenewable solvents (super critical gases, alcohols, acetone, water). Extraction by biotechnology process , extraction technology for recovery of starch, protein, dietary fibre and other constitutents from seeds, cakes and meals for food, feed and industrial processes.

Rendering technology for recovering animal fats and marine oils

Utilisation of oil cakes; Desolventisation and utilization of oil meals

Purification

An overview on different undesirable components and need for purification etc.; subsequent purification techniques, Removal of fat insoluble impurities (filtration, sedimentation, centrifugation etc.)

Removal of fat soluble impurities: degumming (chemical and enzymatic), deacidification (chemical refining, physical refining, esterification, miscella – single & mixed solvent refining, etc.), bleaching (chemical, adsorptive & enzymatic), deodorization, winterization, dewaxing etc.

Utilization of refinery by-products (gums, soap stocks, deodorizer distillates, fatty acid distillates, waxes, spent bleaching earth, etc.)

Module II : Paints & Pigments

Mechanism of polymerization and kinetics of polymerization process

Polymer structures, molecular weights, mechanical properties, glass transition temperate & crystallinity of polymers in relation to molecular weight, kinetics of free radical and addition polymerization, thermodynamics of polymerization

Fundamentals of pigmented coatings; Principles of paint colour matching; Pigment- binder geometry, oil absorption, critical pigment volume concentration (CPVC) and its relation with paint properties.

Recommended Books :

1. Baileys's Industrial Oil and Fat Products
2. Physical Chemistry of Polymers - A Tager
3. Organic Coatings - Zeno W. Wicks, Jr. Frank N. Jones, S. Peter Pappas, Douglas A. Wicks
4. Formulating and Processing for Application - Richard D. O'Brien
5. Organic Coating Technology – H. F. Payne

PPR: Petrochemicals & Petroleum Refinery Engineering II

Module I : Refinery Operations II

Processing of Light Distillates : Alkylation, Isomerization, Catalytic Reforming, Polymerization, Sweetening by Merox treatment or Hydrodesulfurization – stoichiometry and process technologies covering operating conditions & application, role of catalyst in reaction mechanism & catalyst selection.

Thermal and Catalytic Cracking : Visbreaking, Coking, FCC, DCC

Hydrotreatment & Hydrocracking : hydrodesulfurization, hydrodenitrification, olefin saturation, aromatic saturation; hydrocracking of crude and vacuum distillate

Resid hydrotreatment & cracking : desulfurization of residue, hydrocracking of residue – theory, process technologies covering operating conditions, catalyst use and application.

Module II : Petrochemicals Fundamentals

Petrochemical Industries Overview.

Feedstocks for Petrochemical Industries: Natural gas, Refinery Off gas LPG, Naphtha, Gas oil – yield, product slate cost etc.

Basic Petrochemicals such as Synthesis Gas, Olefins, Aromatics, Naphthenes & Dienes – manufacture, thermodynamic and kinetic aspects.

Recommended Books

1. Petrochemical Processes – Technical & Economical Characteristics – A. Chauvel & G. Lefebvre , Institute Francis Du Petrole
2. Petrochemical Industries –Technology & Processes – C. R. Lahiri & Dipa Biswas, CBS Publishers
3. Chemical Process Technology – J. A. Moulijn, M. Makkee, A. van Diepen, Wiley Publishers
4. Handbook of Petroleum Refining Processes, Robert A. Meyers, McGraw-Hill, 2004
5. Fundamentals of Petroleum Refining, M. A. Fahim, T.A. Alsahhaf, A. Elkilani, Elsevier, 2010
6. Petroleum Refining Processes, James Speight, CRC Press, Taylor & Francis group, 2014
7. The Chemistry & Technology of Petroleum, James Speight, CRC Press, Taylor & Francis group, 2006

8. Petroleum Refining, 3 Conversion Processes, P. Leprince, Editions Technip, 2001

PFC: Pharmaceutical and Fine Chemical Technology II

Module I: Medicinal Chemistry-I

Concepts of pharmacokinetics, pharmacodynamics and bioavailability.

Medicinal Chemistry of drugs acting on cardiovascular systems like cardiac glycosides, vasodialators, anti-anginal, anti-hypertensives. Local anaesthetics and NSAIDs.

Module II: Industrial Pharmacy and Biotechnology I

Unit 1: Manufacturing techniques of different solid dosage forms, like tablets, capsules, powders and granules. Testing techniques and compliance for different solid oral dosage forms. Machinery requirements.

Manufacturing techniques and formulation concepts for different semisolid dosage forms including emulsions, suspensions, ointments, lotions, creams and suppositories. Testing techniques and compliance for semisolid dosage forms. Machinery requirements.

Unit 2: Bacterial Genetics. Recombinant DNA Technology and applications.

Types of Immunity, Application principles and manufacturing techniques for different immunological products.

Recommended Books:

1. Goodman and Gilman: Pharmacological Basis of Therapeutics, Pregamon Press, New York.
2. Foye's Principles of Medicinal Chemistry, 7th Ed, Thomas L. Lemke, David A. Williams, Victoria F. Roche, S. William Zito, Wolters Kluwer, 2012.
3. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, Charles Owens Wilson, Lippincott Williams & Wilkins, 2004.
4. Basic Concepts in Medicinal Chemistry, Marc W. Harrold and Robin M. Zavod, American Society of Health-System Pharmacists, 2013.
5. Medicinal Chemistry, Ashutosh Kar, New Age International
6. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Loyd Allen and Howard C. Ansel, Lippincott Williams & Wilkins, 2013.
7. Pharmaceutical Preformulation and Formulation: A Practical Guide from Candidate Drug Selection to Commercial Dosage Form, Mark Gibson, CRC Press, 2016
8. Remington: The Science and Practice of Pharmacy, David B. Troy, Paul Bering, Lippincott Williams & Wilkins, 2006
9. The Theory and Practice of Industrial Pharmacy, Herbert Lieberman and Leon Lachman, CBS Publishers, 2013
10. Aulton's Pharmaceutics: The Design and Manufacture of Medicines, Michael E. Aulton, Kevin Taylo, Elsevier Health Sciences, 2013

11. Kuby Immunology by Thomas J. Kindt,Barbara A. Osborne, Richard Goldsby. Publisher- W H Freeman & Co (Sd). Edition- 6th.
12. Cellular & Molecular Immunology by Abul K. Abbas and Andrew H. Lichtman. Publisher- Saunders. Edition- 7th.
13. Prescott and Dunn's Industrial Microbiology by Gerald Reed. Publisher- Chapman & Hall. Edition- 4th.
14. Industrial Microbiology by A.H. Patel. Publisher- Trinity Press. Edition- 2nd.

(Practical)

Paper 40

Course CT505 **50 marks /2 Credits**

Chemical Engineering Lab. I

Experiments on

1. Flow of fluid through packed beds
2. Fluidization
3. Elutriation
4. Flowmeters
5. Pumps
6. Heat transfer coefficients
7. Mass transfer coefficients
8. Evaporation
9. Leaching
10. Valves and fillings
11. Verify Bernoulli's equation
12. Terminal velocity.

Recommended Books :

1. W. L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 6th Ed., McGraw – Hill, International Edition, 2001.
2. J. P. Holman, Heat Transfer, 8th Ed., McGraw - Hill, 1997
3. R. W. Fox and A. T. McDonald, Introduction to fluid mechanics, 5th Ed., John Wiley & Sons, 1998.
4. R. E. Treybal, Mass Transfer Operations, 3rd Ed., McGraw –Hill, International Edition, 1981.
5. J. T. Banchero, Introduction to Chemical Engineering, Tata McGraw-Hill, International Edition, 1997.
6. C. J. Geankoplis, Transport Processes and Unit Operations, 3rd Ed., Prentice Hall, India,1993.
7. D.Q. Kern, Process Heat Transfer, 2nd Ed.,Tata McGraw - Hill, 1997.

Paper 41

Course CT506 **50 marks /2 Credits**

Environment Technology Lab

Tutorial:
Introduction to all prevailing international standards of Health, Safety, and Environment (HSE); Environmental laws and regulations; Standards (air quality, noise, water)
Environmental impact assessment, Life cycle assessment (LCA)
Pollution – Definition & types (1. Air pollution, 2. Water pollution, 3. Soil pollution, 4. Marine pollution, 5. Noise pollution, 6. Thermal pollution, 7. Nuclear hazards)
Air pollution; Air pollutants: sources (specific pollutants), effects, and dispersion modeling, air pollution, air quality, pollutants minimisation and control, fugitive emissions (source and control)
Wastewater treatment; Groundwater and surface water pollution, removal of specific water contaminants; Solid waste; Hazardous waste
Pollution prevention in chemical manufacturing, effluent treatments

Practical:

1. Classification of chemically hazard compounds and MSDS. BOD, COD and TOC studies
2. Analysis of heavy metal including arsenic and anions like fluorides, dye and pesticides in water and soil.
3. Estimation of sulphur compounds and carbon monoxide in air

Recommended Books:

1. A laboratory manual for environmental chemistry, R. Gopalan, A. Anand, R.W. Sugumar, One K Internal Publishing House Pvt. Ltd., 2008.

Paper 42
Course CT507 CER/OLT/PPR/PFC **50 marks /2 Credits**
Special Lab III

CER: Ceramics Engineering Lab III (at least 5)

Physical Testing of Ceramic Raw Materials and Products- I:
Raw materials: Hardness, texture, thermal analysis - DTA and TGA, FTIR, XRD.
Refractories: Fusion range, Refractoriness under load, Porosity, Modulus of rupture, Thermal expansion, reheat shrinkage, Thermal spalling, Thermal conductivity.
Glass: Viscosity, density, strain. Preparation of Soda-lime-silica glass with different coloring oxides, e.g. cobalt and iron oxides ; Borosilicate glass with alkali and alkaline earth oxides; opal glass with different opacifying agents, e.g. fluoride and phosphate; low melting Phosphate glass in various systems.
Fine ceramics: Mechanical, thermal and electrical properties.

Recommended Books:-

1. Quantitative Inorganic Analysis – A. I. Vogel
2. Analysis of ceramic raw materials – S. Kumar and D. Ganguli
3. Refractories: Production and Properties– J. H. Chester

OLT: Oil Technology Lab III
Fats and Oil Processing

Refining (degumming, deacidification, bleaching, deodorisation and physical refining) of fats/oils; Modification (hydrogenation, interesterification, fractionation, blending) of fats/oils for edible and industrial products; Hydrolysis of oils/fats (chemical and biochemical); Esterification, epoxidation and hydroxylation of oils. Edible fat products like margarine and cocoabutter substitute. Preparation and analysis of biodiesel.

Recommended Books

1. Official Methods and Recommended Practices AOCS of the AOCS
2. A Treaties on Analysis of Food, Fats & Oils – A.R.Sen, N.K.Pramanik, S.K.Roy
3. FSSAI Manual of Methods of Analysis of Foods, Oils & Fats , 2015

PPR: Petrochemicals & Petroleum Refinery Engineering Lab III
Solvent Extraction
Aromatic Separation by Solvent Extraction and Construction of Equilibrium Curve

Recommended Books:
1. Principles of Mass Transfer and separation Processes, B. K. Dutta, Prentice-Hall of India, 2007

PFC: Pharmaceutical and Fine Chemical Technology Lab II
Pharmaceutical Chemistry II
1. Pharmacognostic studies of crud drugs and constituents.
2. Extraction and estimation of alkaloids.
3. Tests and quantification of natural products like alkaloids, steroids, terpinoids, polyphenolics.
4. Estimation of alcohol in bonded preparations.
5. Standardization of fats and oils.
6. Analysis of vitamins.

Books Recommended:
1. Trease and Evans Pharmacognosy, William Charles Evans, Daphne Evans, George Edward Trease, Saunders/Elsevier, 2009
2. Practical Pharmacognosy: Techniques and Experiments, 19th Ed K. R. Khandelwal, Nirali Prakashan, 2008.
3. Indian Pharmacopoeia, VIIth Ed, 2014, Indian Pharmacopoeia Commission
4. The Analysis of Fats and Oils, V. C. Mehlenbacher, Garrard Press
5. Vitamin Analysis for the Health and Food Sciences, Ronald R. Eitenmiller, W. O. Landen, Jr, Lin Ye, CRC Press, 2016

Paper 43
Course CT508 CER/OLT/PPR/PFC **50 marks /2 Credits**
Special Lab IV

CER: Ceramics Engineering Lab IV (at least 5)

Physical Testing of Ceramic Raw Materials and Products- II:
Thermal shock test on glass wares, density of glass.
Physical testing of cement: initial and final setting time
Soundness, compressive and tensile strength, surface area.
Clay testing: Particle size distribution by Andreasen pipette method.
Water of plasticity, Atterberg plasticity Index.
PH titration curves.
Physical texture and hardness testing.

Recommended Books:
1. Bureau of Indian Standard (BIS) manuals

OLT: Oil Technology Lab IV
Surface Coating I
Preparation, analysis and testing of stand oil, blown oil, double boiled oil, dehydrated castor oil, and chemically modified drying oils.
Preparation, analysis and testing of Linoleate, rosinate, octoate, and naphthenate of Lead, Cobalt, Manganese and Zinc;
Analysis and testing of solvents;
Preparation, analysis and testing of ester gum, limed rosin, phenolics, oleoresinous varnish and spirit varnish

Recommended Books

1. Official Methods and Recommended Practices AOCS of the AOCS
2. A Treaties on Analysis of Food, Fats & Oils – A. R. Sen, N. K. Pramanik, S. K. Roy
3. FSSAI Manual of Methods of Analysis of Foods, Oils & Fats , 2015

PPR: Petrochemicals & Petroleum Refinery Engineering Lab IV
Catalyst preparation and Hydrodesulphurisation & Hydrocracking operations
Catalysts Preparation for Hydrodesulphurization and Hydrocracking
Hydrodesulphurization and Hydrocracking operation in High Pressure Batch Reactor.

Recommended Books:
1. Catalyst in Petroleum Refining and Petrochemical Industries, M. Absi-Halabi, J. Beshara, H. Qabazard, A. Stanislaus, Elsevier, 1996

PFC: Pharmaceutical and Fine Chemical Technology Lab IV
Microbiology II
1. Differential staining
2. Isolation of lipase, amylase and protease producing organism and quantitative analysis.
3. Environmental studies like BOD, COD determination
4. CFU of bacteria
5. Pathogenicity testing of E. coli, Salmonella, Staphylococcus and Pseudomonas

Recommended Books:

1. Microbes in action: A Laboratory Manual of Microbiology, H. W. Seeley, W. H. Freeman, 4th Edn.

Semester VI
(Theory)

Paper 44

Course CT601 **100 marks /4 Credits**

Material Science & Technology

Module-I

Engineering materials – classification and application. Structure-property-processing-performance correlations.

Atomic structure and bonding in materials. Crystal structure of materials. Crystal systems, unit cells and space lattices, miller indices of planes and directions, packing geometry and close packed structures.

Concept of amorphous, single and polycrystalline structures, Nucleation and grain growth. Non-crystalline materials: silicate glasses, glass transition temperature, viscoelasticity.

Imperfections in crystalline solids: point, line, surface and volume defects, non-stoichiometry. Phases in metallic system, solid solutions, phase rule, binary phase diagrams, iron-iron carbide phase diagram and its application in iron and steel metallurgy, isothermal transformation, T-T-T diagram, martensite formation, continuous cooling transformation.

Ferrous and non-ferrous metallurgy (Al, Cu, Zn etc): Principles and applications. Blast furnace, Steel making processes, Classification of steel, Wrought iron and Cast iron, Carbon steel and alloy steel. Heat treatment of steel – annealing, hardening, tempering, normalizing, spheroidising, flame hardening. Fick's law and its application – carburizing, nitriding, cyaniding etc.

Basic principles of powder metallurgy.

Module-II

Polymerization, classification of polymers – thermoplasts, thermosets, elastomers – structure, properties, processing and applications.

Advanced materials: Optical fiber, Laser glass, Superconductors, Piezoelectric, Ferroelectric, Optoelectric materials, Carbon-based materials, Polymer nanocomposites, Biomaterials, Shape memory alloys, Fuel cells, Sensors, Membranes, Liquid crystals and amphiphiles, Zeolites.

Mechanical properties: Stress-strain diagram of metallic, ceramic and polymeric materials, modulus of elasticity, tensile strength, yield strength, toughness, plastic deformation, hardness, ductile and brittle fracture, creep, fatigue, role of reinforcement-matrix interface strength on composite behavior.

Electronic properties: Band theory of metals, conductors, semiconductors, insulators, electrical conductivity, dielectric properties.

Fundamentals of thermal, electrical, optical and magnetic properties.

Corrosion and oxidation of materials, principles and prevention.

Introduction to experimental techniques for materials characterization: XRD, NMR, PSA etc.; relationship between molecular structure and macroscopic properties.

Recommended Books :

1. Elements of Materials Science and Engineering – L. H. Van Vlack
2. Materials Science and Engineering : A First Course – V. Raghavan
3. Materials Science and Engineering: An Introduction – W. D. Callister and D. G. Rethwisch
4. Materials Science and Engineering – W. F. Smith, J. Hashemi and R. Prakash
5. The Science and Engineering of Materials – D. R. Askeland

Paper 45

Course CT602 **100 marks /4 Credits**

Chemical Engineering IV

Module I: Separation Process

Absorption of a single component from gas mixtures, Wetted-wall column, Packed columns, Plate column, Design of absorption towers, Desorption.
Liquid-liquid extraction: Equilibrium data, Use of triangular diagrams, Selectivity and choice of solvent, Extraction efficiency.
Principles of leaching.
Crystallization: Theory and crystallizers.
Adsorption
Modern separation processes: Membrane processes, Ion-exchange, Molecular sieve

Module II: Mechanical Operations

Size reduction: Energy and power requirements in comminution, size reduction equipment.
Screening: Particle size analysis, screening equipment, classification, cyclone separation, electrostatic precipitation, elutriation, jigging, flotation.
Filtration: Theory, equipment, filter medium, filter aid, centrifuges.
Mixing and agitation.

Recommended Books :

1. W. L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 6th Ed., McGraw - Hill, International Edition, 2001.
2. W. L. Badgerand J. T. Banchero, Introduction to Chemical Engineering, Tata McGraw-Hill, International Edition, 1997.
3. C. J. Geankoplis, Transport Processes and Unit Operations, 3rd Ed., Prentice Hall, India,1993

Paper 46

Course CT603 **100 marks /4 Credits**

Elective II (Nanotechnology/ Sol-Gel Technology)

A. Nanotechnology

Module-I

Concepts in nanoscale; Time and length scale in structures; Dimensionality and size dependent phenomena; 0D,1D,2D structures- size effects; Specific surface energy and surface stress; Effect

on the lattice parameter; Material properties in nanoscale (optical, mechanical, electronic, magnetic and biological).
Nanoscale phenomenon; Quantum confinement of superlattices and quantum wells; Plasmonic response; Magnetic moment in clusters – Magnetocrystalline anisotropy –Dielectric constant in nanoscale silicon;
General methods for synthesis of nanostrutures – Physical, chemical and biological methods. Aggregation – stability of colloidal Dispersions; Spontaneous condensation of nanoparticles: Post condensation effects – Nanoparticles' morphology.

Module-II
Nanomaterials for electronics, nanophotonics, nanofluidics, nanocomposites etc.
Special materials in nanoscale – Carbon materials, fullerenes, graphene, nanotubes; Metals and metal oxides, Quantum wire, Quantum well, Quantum dots, Biomacromolecules.
Nanoscale devices for different applications (electronics, photovoltaics, medical diagonostics etc). Nanotechnology and environment.

Principles of analysis in Dynamic Light Scattering (DLS); Atomic Force Microscopy (AFM); Field Emission Scanning Electron Microscopy (FESEM), Environmental Scanning Electron Microscopy (ESEM); Transmission Electron Microscopy (TEM), High Resolution Transmission Electron Microscope (HRTEM), Scanning Tunneling Microscope (STM)- Raman Spectroscopy, Nano-litography.

Recommended Books :

1. Introduction to Nanotechnology – C. P. Poole Jr. and F. J. Owens
2. Nanotechnology : Principles and Practices -- S. K. Kulkarni
3. Introduction to Nanoscale Science and Nanotechnology – M. Di.Ventra, S. Evoy and J. R. Heflin Jr.
4. Nanoscience and Nanotechnology: Fundamentals of Frontiers – M. S. R. Rao and S. Singh
5. Nanochemistry: A Chemical Approach to Nanomaterials – G. A. Ozin and A. C. Arsenault

B. Sol-Gel Technology

Module 1
The colloidal state, Sol and Gel, Basic ideas on kinetic, optical and electrical properties, Colloidal stability, Structure of double layer, DLVO theory, Polymeric and particulate gels.
Synthesis of simple sol–gel precursors of silica, alumina, titania, zirconia etc, fabrication of ceramics via sol gel, gelation, ageing, drying and heat treatment.
Preliminary idea on clay colloids.

Module 2
Sol-gel coating techniques e.g. dip, spin, drain and meniscus coatings.
Techniques for characterization of sol-gel materials.
Applications of sol gel glass, coatings, powders, fibres, monoliths, porous gel, membranes, catalysts, gas sensors, novel sol-gel materials, future prospects.

Recommended Books:-

1. Sol-Gel Science: The Physics and Chemistry of Sol-Gel Processing : C. Jeffrey Brinker, George W. Scherer
2. Handbook of Sol-Gel Science and Technology: Processing, Characterization and Applications : Sumio Sakka
3. Sol-Gel Materials: Chemistry and Applications: J.D. Wright, Nico A.J.M. Sommerdijk

Paper 47

Course CT604 CER/OLT/PPR/PFC **100 marks /4 Credits**

CER: Ceramic Engineering III

Module I: Refractories – Applications

Introduction to various high temperature process and refractory materials.
Details of silica semisilica, aluminosilicate,, spinel, magnesite, dolomite, chromite, chrome-magnesite, high alumina and zirconia refractories.
Fusion cast, thermal insulating, , carbon and carbon bearing refractories, refractory composites, non-oxide refractories. Crystalline phases and microstructure of refractories.
Selection of refractories for different applications–Iron and Steel Industry, Non-ferrous industries, Cement, Glass and hydrocarbon processing industries.
Monolithics:Ramming mass, Gunning materials; Castables–low cement, ultra low cement, zero cement, self flow castables. Carbon containing and nano-bonded refractory castables.
Basic castables. Different bonding mechanism in refractory castables e.g. hydraulic, coagulation and chemical bonding.

Module II: Glass Technology

Different types of furnaces, refractories and fuel required for glass melting.
Different types of glass forming processes: Blowing, pressing, drawing by semiautomatic and automatic process. Sheet glass by different methods, fabrication of glass ware.
Glass fibre. Toughened glass.
Optical Glass: Methods of manufacture, defects. Optical fibre.
Coloured glasses: Colour forming constituents, redox equilibria, solarisation, photosensitive and photo-chromic glass, opal glass, chalcogenide glass, IR absorption glass, colloidal colours.
Concept of Glass Ceramics. Properties and applications. Bioglass.
Chemical durability of glass: Glass aqueous phase reaction, controlling factors and methods of measurement, improvement of durability.
Different types of glass defects and their elimination.

Recommended Books:-

1. Steel plant refractories – J. H. Chester
2. The Technology of Ceramics and Refractories – P.P. Budnikov
3. Refractories – F. H. Norton.
4. Fundamental of inorganic glasses – A. K. Vershneya
5. Chemistry of glasses – A. K. Paul
6. Introduction to glass science and technology – J. H. Shelby

OLT: Oil Technology III

Module I: Technology of Soaps and Synthetic detergents

Definitions of soaps & detergents and their classifications; Present status of soap and detergent industries; Raw materials for soap industry and their selection; Kinetics and Phase reactions in soap boiling.

Physico-chemical properties of soap solutions; Plants and Processes employed in soap manufacture. Recovery of by-products, various households and industrial soaps, soap additives, metallic soaps, miscellaneous application of soap-based products; Testing and evaluation of soaps. Chemistry and Technology of production synthetic detergents (anionic, cationic, non-ionic, and amphoteric), detergent additives. Formulations and processing of detergent powders, tablets, liquid and pastes for household and industrial applications; Bio-surfactants and enzyme detergents, dry cleaning systems; Natural saponin based surfactants.

Bio-degradation and life cycle of surfactants, Eutrophication and Ecological aspects, Eco-friendly washing systems.

Modern trends in detergent formulations; Testing and evaluation of synthetic surfactants

Module II : Chemistry & Technology of Paints and Paint additives

Pigments & Extenders

Technology of natural resins; rosin, copal, damar, shellac, asphalts, pitches, bitumens, their modifications.

Technology of phenolic, maleic, coumarone-indene, and petroleum resins, CNSL and BNSL, their modifications.

Technology of synthetic resins like alkyds and other polyesters, polyurethanes, UF, MF, epoxy, silicones, rubber resins, etc.

Types and mechanism of polymerization reactions; concepts of functionality, polymeric resins like NC, acrylics, vinylics, etc. Methods of different polymerization systems, viz., bulk, solution, suspension and emulsion and their mechanisms

Kinetics of Emulsion Polymerization, Suspension Polymerization, Ionic Polymerization and Methods of Determination of Polymer Molecular Weight, Gel Permeation Chromatography, Osmometry

Metallic driers and auxiliaries: technology of linoleates, rosinates, napthenates and octoates of lead, cobalt, manganese, zinc, iron, calcium and rare earth metals.

Functions and uses of additives like anti-skinning agents, anti-mildew agents, flatting agents etc

Recommended Books :

1. Surface Active Agents and Detergents - Schwartz & Perry
2. Gemini Surfactants - Raoul Zana & Jiding Xia
3. Textbook of polymer science - Fred W. Billmeyer
4. Surfactants and Interfacial Phenomena - Milton J. Rosen & Joy T. Kunjappu

5. Macromolecules, an introduction to polymer science, F. A. Bovey and F. H. Winslow
6. Handbook of Surfactant Analysis - Chemical, Physico-chemical and Physical Methods - Dietrich O. Hummel

PPR: Petrochemicals & Petroleum Refinery Engineering III

Module I: Refinery Operations III

Lube base oil processing – solvent deasphalting, solvent aromatic extraction, solvent dewaxing, hydrofinishing, catalytic hydrotreatment and dewaxing.

Blending of Products – Octane blending, Flash point blending, Viscosity blending, Penetration blending etc.: calculation method, nomographs, application

Lube blending and Grease manufacture – formulation, operating condition and application.

Module II: Petrochemical manufacturing processes and Important Individual Petrochemicals

Oxo synthesis, Polymerization etc.

Individual Petrochemicals viz. Methanol, Urea, Acrylonitrile, Styrene, Phenol, Ethylene & Propylene oxide, Vinyl Acetate, Caprolactum, Purified Terephthalic Acid etc. – manufacture, operating conditions, catalyst, properties and application.

Recommended Books

1. Petrochemical Processes – Technical & Economical Characteristics – A. Chauvel & G. Lefebvre , Institute Francis Du Petrole
2. Petrochemical Industries –Technology & Processes – C.R.Lahiri & Dipa Biswas, CBS Publishers
3. Petroleum Refining: Separation Processes, Jean-Pierre Wauquier, Pierre Trambouze, Jean-Pierre Favennec, Editions Technip, 2001
4. Process Chemistry of Lubricant Base Stocks By Thomas R. Lynch, CRC Press, Taylor & Francis group, 2008
5. Chemistry & Technology of Lubricants, R. M. Mortier, M. F. Fox, S. T. Orszulik, Springer, 2010
6. Petroleum Refinery Engineering (4^{th} Ed) – W. L. Nelson, McGraw –Hill

PFC: Pharmaceutical and Fine Chemical Technology III

Module I: Quality Assurance & Regulatory Affairs

Drugs and Cosmetics acts and rules, Responsibilities of regulatory authorities, International patent regulation. ICH guidelines.

GMP regulations; Air and water handling system, CGMP – Status and regulations, GLP, GCP, GDP concepts. Quality audit. Documentation and records. Approval Process.

Principles and techniques in validation, Analytical Method Validation and Process validation.

Module II: Industrial Pharmacy and Biotechnology II

Unit 1: Manufacturing techniques and formulation of liquid and sterile dosage forms and aerosol preparations. Testing techniques and compliance for sterile dosage forms and aerosols. Machinery requirements.

Unit 2: Pharmaceuticals from cellular origin, examples and applications. Principles of fermentation Technology and reactor design. Antibiotics manufacturing in fermentation and

semi-synthetic pathways. Examples for fermentative production of alcohols, vitamins, dextrans, probiotics and food products.

Recommended Books:

1. Drugs and Cosmetics Act – Schedule M, Schedule L1, Schedule Y; www.cdsco.nic.in
2. Quality Assurance of Pharmaceuticals Volume 1, Volume 2. published by WHO http://www.who.int/medicines/areas/quality_safety/quality_assurance/QualityAssurancePharmVol1.pdf and QualityAssurancePharmVol2.pdf
3. WHO Technical Reports; TRS 992, TRS 986. www.who.int/biologicals/technical_report_series
4. ICH guidelines – www.ich.org
5. Analytical Method Development and Validation, Michael E. Swartz, Ira S. Krul, Marcel Dekker Inc, NY, 1997
6. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Loyd Allen and Howard C. Ansel, Lippincott Williams & Wilkins, 2013.
7. Pharmaceutics: Formulations and dispensing pharmacy, S. Bharath, 2013
8. Pharmaceutical Suspensions: From Formulation Development to Manufacturing, Alok K. Kulshreshtha, Onkar N. Singh, G. Michael Wall, AAPS Press, Springer 2009.

(Practical)

Paper 48
Course CT605 **50 marks /2 Credits**
Chemical Engineering Lab. II
Experiments on

1. Specific surface area of powders
2. Raleigh equation
3. Vapour-liquid equilibrium data
4. Spray drying
5. Crushing and grinding
6. Distillation
7. Liquid-liquid extraction
8. Absorption
9. Drying and
10. Filtration.

Recommended Books :

1. W. L. McCabe, J. Smith and P. Harriot, Unit Operations of Chemical Engineering, 6th Ed., McGraw – Hill, International Edition, 2001.

2. W. L. Badgerand J. T. Banchero, Introduction to Chemical Engineering, Tata McGraw-Hill, International Edition, 1997
3. R. W. Fox and A. T. McDonald, Introduction to fluid mechanics, 5th Ed., John Wiley & Sons, 1998.
4. R. E. Treybal, Mass Transfer Operations, 3rd Ed., McGraw –Hill, International Edition, 1981
5. C. J. Geankoplis, Transport Processes and Unit Operations, 3rd Ed., Prentice Hall, India,1993.

Paper 49

Course CT606 **50 marks /2 Credits**

Process Equipment Design

Each student is required to submit two bound type-written copies of the design report on the complete design including drawing with specifications of process equipment reactors of a plant manufacturing product(s) related, to one's course / subject to be worked out under the guidance of a faculty member.

The design should be as far as practicable and be based on the consideration of optimum technical process operating condition and shall include proper instrumentation and control. The examination shall include a viva-voce examination on the design report.

Paper 50

Course CT607 **50 marks /2 Credits**

Special Lab V

CER: Ceramics Engineering Lab V (at least 5)

Synthesis, Fabrication and Characterization of Ceramics:
Preparation of silica gel, precipitated silica, microfine silica, alumino-silicate hydrogel.
Determination of alkali resistance of glass, alkalinity of glass. chemical durability.
Observations of strain in glassware by polariscope, demonstration of cord viewer.
Fabrication of some high alumina & basic bricks, fabrication and evaluation of refractory castables. Fabrication of refractory shapes by semi dry and dry process, drying and firing characteristics. Synthesis of aggregates, bonding materials and precursors by conventional and non-conventional method. Testing and evaluation of various important properties of refractories as per IS specification. Refractory corrosion test.

Recommended Books:-

1. Quantitative Inorganic Analysis – A. I. Vogel
2. Analysis of ceramic raw materials – S. Kumar and D. Ganguli
3. Refractories: Production and Properties– J. H. Chester

OLT: Oil Technology Lab V:

Soaps & Detergents

Technical analysis of soaps and synthetic detergents.

Preparation of different types of soaps and synthetic detergents and evaluation of their various physicochemical and performance characteristics.
Identification, isolation and purification of surfactants from unknown mixtures.
Surface tension, interfacial tension, CMC measurements

Recommended Books

1. Official Methods and Recommended Practices AOCS of the AOCS
2. A Treaties on Analysis of Food, Fats & Oils – A. R. Sen, N. K. Pramanik, S. K. Roy
3. FSSAI Manual of Methods of Analysis of Foods, Oils & Fats , 2015

PPR: Petrochemicals & Petroleum Refinery Engineering Lab V
Preparation & Testing of Petrochemical Products

Preparation & Testing of some petrochemical products by Polymerization, Alkylation, Disproportionation, Condensation etc.

Recommended Books:
1. Polymer science and technology, P. Ghosh, Tata McGraw Hill, 2011
2. Plastic Materials, J. A. Brydson, B-H publishers, 1999

PFC: Pharmaceutical and Fine Chemical Technology Lab V
Pharmaceutical Chemistry III

1. Synthesis of drugs, fine chemicals and drug intermediates using multistep reactions.
2. Applications of different name reactions in drug synthesis.
3. Synthesis, assay and pharmacopoeial compliance for representative compounds like diphenyl hydantoin, paracetamol, iso-nicotinic acid hydrazide (INH), indole acetic acid, xylocaine.

Recommended Books :
1. Strategies for Organic Drug Synthesis and Design, 2nd Ed. Daniel Lednicer, Wiley, 2009
2. Advanced Practical Medicinal Chemistry, Ashutosh Kar, New Age International Publisher, 2007

Paper 51
Course CT608 **50 marks /2 Credits**
Special Lab VI

CER: Ceramics Engineering Lab VI (at least 5)

Preparation of Whiteware body, Milling of raw materials, rheological measurement of slip, fabrication of green body, by slip casting, pressing, drying & firing biscuit and glost firing.
Preparation of glazes & application of glaze on body, and firing. Determination of water absorption, True density, Bulk density & Modulus of rupture of various fired whiteware bodies. Determination of thermal shock resistance of fired white ware bodies. Measurement of glaze

thickness by Penetrometer. Determination of acid solubility of ceramic body & glaze. Determination of alkali solubility of ceramic body & glaze.
Compilation of some traxial composition and fabrication by slip casting, tape casting technique.
Metal surface preparation – cleaning, pickling, Ni dipping and neutralization. Formation and melting of enamel frits, compounding of a recipe of enamel slip with frit, opacifiers and other additions, melting. Sieve analysis of milled enamels, determination of consistency of enamel slip. Application of enamel by dipping, spraying. Firing of enamel wares. Study of defects of enameled ware. Testing of vitreous enamel wares: Test of resistance to Acid and Alkali, resistance to boiling water, resistance to thermal shock, resistance to impact, warpage and abrasion resistance, adherence to enameled specimens by Adherence meter method. Testing of ceramic/vitrified tiles.

Recommended Books:-
1. Bureau of Indian Standard (BIS) manuals

OLT: Oil Technology Lab VI
Surface Coating II
Preparation of alkyds, polyesters, acrylics etc.; Preparation of inorganic and organic pigments and their testing according to specifications.
Preparation of different types of paints like primer, ready mixed paints, synthetic enamels, stoving enamels, etc.
Preparation of panels. Testing of surface coating according to specifications. Examinations and reporting of weathered and defective surface coatings.
Preparation of paint additives like anti-settling agent, anti-skinning agent, dispersing agent, etc.

Recommended Books

1. Official Methods and Recommended Practices AOCS of the AOCS
2. A Treaties on Analysis of Food, Fats & Oils – A. R. Sen, N. K. Pramanik, S. K. Roy
3. FSSAI Manual of Methods of Analysis of Foods, Oils & Fats , 2015

PPR: Petrochemicals & Petroleum Refinery Engineering Lab VI
Preparation & Characterization of Resins
Phenol-formaldehyde, Urea-formaldehyde etc. and their characterization.

Recommended Books:
1. Polymer science and technology, P. Ghosh, Tata McGraw Hill, 2011
2. Plastic Materials, J. A. Brydson, B-H publishers, 1999

PFC: Pharmaceutical and Fine Chemical Technology Lab VI

Industrial Pharmacy
Formulation and testing of different dosage forms, like tablet, capsule, suspension, emulsion, ointment, granules, effervescent granules, syrup and invert syrup.

Recommended Books:

Pharmaceutical Compounding and Dispensing, Christopher A. Langley, Dawn Belcher, Fasttrack 2012

Semester VII
(Theory)

Paper 52
Course CT701
Modeling and Simulations

100 Marks/ 4 Credits

Module I: Models and model building

Introduction, principles of model formulation, fundamental laws - continuity equation, energy equation, equations of motion, transport equations, equations of state, equilibrium and kinetics, classification of mathematical models.

Numerical solutions of model equations – Linear and non linear algebraic equations in one and more than one variables, ordinary differential equations in one and more than one variables.

Module II: Lumped Parameter Models

Formulation and solution techniques to be discussed for Vapour liquid equilibrium models, dew point and flash calculations for multicomponent systems, boiling operations, batch and continuous distillation models, tank models, mixing tank, stirred tank with heating, CSTR with mutiple reactions. Non-isothermal CSTR - mutiplicity and stability, control at the unsteady state. Non-ideal CSTR models - multi-parameter models with dead space and bypassing, staged operations.

Module III: Distributed Parameter Models (Steady State)

Formulation and solution of split boundary value problems - shooting technique, quasilinearization techniques, counter current heat exchanger, tubular reactor with axial dispersion, counter current gas absorber, pipe line gas flow, tubular permeation process, pipe line flasher.

Module IV: Unsteady State Distributed Parameter Models

Solution of partial differential equations using finite difference method, convective problems, diffusive problems, combined convective and diffusive problems. Unsteady state conduction and diffusion, unsteady state heat exchangers, dynamics of tubular reactor with dispersion. Transfer function models for distributed parameter systems.

Module V: Model Parameters Estimation

Introduction, method of least squares, curve fitting, parameter estimation of dynamic transfer function models – step and impulse response models, Auto regressive Moving Average models, least square and recursive least square methods, parameter estimation of RTD models – moments method.

Recommended Books:

1. Denn M. M., "Process Modeling", Longman, 1986.
2. Holland C. D., "Fundamentals and Modeling of Separation Processes", Prentice Hall., 1975.
3. Luyben W. L., "Process Modeling Simulation and Control for Chemical Engineers", 2nd Ed., McGraw Hill, 1990.
4. Najim K., "Process Modeling and Control in Chemical Engineering", CRC, 1990.

Paper 53

Course CT702 **100 marks /4 Credits**

Elective III (Numerical Analysis/ Optimization method in Chemical Technology)

A. Numerical Analysis

Introduction, Approximation and Concept of Error & Error Analysis

Linear Algebraic Equations: Methods like Gauss elimination, LU decomposition and matrixinversion, Gauss-Siedel method, Chemical engineering problems involving solution of linearalgebraic equations

Root finding methods for solution on non-linear algebraic equations: Bisection, Newton-Raphson and Secant methods, Chemical engineering problems involving solution of non-linearequations

Interpolation and Approximation, Newton's polynomials and Lagrange polynomials, spline interpolation, linear regression, polynomial regression, least square regression

Numerical integration: Trapezoidal rule, Simpson's rule, integration with unequal segments,quadrature methods, Chemical engineering problems involving numerical differentiation and integration

Ordinary Differential Equations: Euler method, Runge-Kutta method, Adaptive Runge-Kutta method, Initial and boundary value problems, Chemical engineering problems involving single,and a system of ODEs

Introduction to Partial Differential Equations: Characterization of PDEs, Laplace equation, Heat conduction/diffusion equations, explicit, implicit, Crank-Nicholson method

Recommended Books:

1. Numerical Methods for Chemical Engineering: Applications in MATLAB,
2. Kenneth J. Beers, Massachusetts Institute of Technology, Cambridge University Press.
3. Introduction to Numerical Methods in Chemical Engineering, Pradeep Ahuja, PHI publication.
4. Numerical Methods with Chemical Engineering Applications, Kevin D. Dorfman and Prodromos Daoutidis, Cambridge Series in Chemical Engineering.

B. Optimization method in Chemical Technology

Module I: Nature and organization of optimization problems, fitting models to data, method of least squares, factorial experimental designs, formulation of objective functions.

Module II: Optimization theory and methods - basic concepts of optimization, optimization of unconstrained functions, one dimensional search, mutivariable optimization.

Module III: Linear programming and applications, nonlinear programming with constraints, optimization of staged and discrete processes.

Module IV: Optimum recovery of waste heat, optimum shell and tube heat exchanger design, optimization of heat exchanger networks, optimization of multistage evaporators, optimization of liquid liquid extraction processes, optimal design and operation of staged distillation columns.

Module V: Optimal pipe diameter, minimum work of gas compression, economic operation of fixed bed filter, optimal design of gas transmission network, optimal design and operation of chemical reactors.

Recommended Books:

1. T. F. Edgar and D. M. Himmelblau, Optimization of Chemical Processes, McGraw Hill, International Editions: Chemical Engineering Series, 1989.
2. G. S. Beveridge, and R.S. Schechter, Optimization Theory and Practice, McGraw Hill, New York, 1970.
3. G. V. Rekllaitis, A. Ravindran and K. M. Ragsdell, Engineering Optimization- Methods and Applications, John Wiley, New York,

Paper 54
Course CT703 CER/OLT/PPR/PFC **100 marks /4 Credits**

Special Paper IV
CER: Ceramics Engineering IV

Module I: Hydraulic Binders and Concrete

Different types of Hydraulic binders and their classification.
Introduction to different types of commercial cements
Portland cement: Raw materials, quality, availability, processing, granulometry of raw materials, phase diagram of binary systems and some ternary systems. Additives for clinker making. Reactions during clinker formation in rotary kilns. Factors influencing the compound formation. Design of rotary and shaft kilns, Refractories used. Component of Portland cement and their phase relationships. Properties imparted by different phases.
Specifications of different types of cements, their properties and application. Theories of setting and hardening of Portland cement. Cement testing processes as per specifications.
Refractory cement: High alumina cement, their chemistry, manufacturing and characterization of different phases. Applications of high alumina cement. Different types of cements; White cement, oil well cement, Portland blast furnace slag, expansive cement, sorel cement , polymer modified cement and non calcareors cement. Different types and action of slag activators.
Cement concrete: Nature of aggregates and reaction. Fibre reinforced cement concrete.
Pozzolana: classification, factors affecting pozzolanic activity, lime-pozzolana reaction.

Module II: Fine Ceramics

Development and scope of fine ceramics. Characterisation and classification of different pottery wares and vitrification nature. Raw materials: evaluation, processing and availability, testing. Composition of different types of triaxial bodies. Incorporation of industrial solid wastes in triaxial composition.
Classification of ceramic tiles, wall and floor ceramic tiles, concept on double charge body, twin press body, vitrified polished tiles, multifunctional coatings on ceramic/poecelain tiles.

Nature of high temperature reactions in triaxial systems and the related phase changes.
Commercial kilns and furnaces and their operations.

Physical and chemical properties of pottery wares. Hard and soft porcelain, electrical insulator, hotel china, chemical porcelain, sanitary wares.
Ceramic glaze: nature of glazes and classification, glazed raw materials and processing, glaze compositions, fritting rules. Application of glazes and firing. Testing of glazes, glaze defects, different types of glazes and decorations. Ceramic color and methods of decorations.

Optical and electronic ceramics, and piezo electric materials.
Types of ferrites, soft and hard ferrites, process Technology, Microstructure and magnetic characteristics. Steatite and cordierite ceramics, titanate ceramics.

Recommended Books:

1. Chemistry of Cement – F. M. Lea
2. Cement Chemistry - F.W. H. Taylor
3. High Alumina Cement - T. D. Robson
4. Concrete Technology – A.M.Neville and J.J.Brooks
5. Ceramic Whitewares – Sudhir Sen
6. Industrial Ceramics – F. Singer & S. S. Singer
7. Fine Ceramics – F. H. Norton

OLT: Oil Technology IV

Module I : Technology and processing of Fats and other derivatives for edible purposes

Hydrogenation process technology of fats and oil (selectivity, catalyst, process parameters, hydrogenation techniques, low trans hydrogenation, hydrogen production, process control, product characteristics, Government regulations, costing, etc.); Interesterification processes of fats and oils (chemical and biochemical); Fractionation of fats (dry, solvent and detergent fractionation); Blending of fats (government regulations, nutritional aspects, shelf life, etc.); Production of Butter and Ghee; Margarine, low cost spread fats, shortenings, confectionery fats. Fat based structured molecules and Nutraceuticals production technology & applications.
Plants and equipments associated with modification techniques.

Module II : Manufacturing & application of paints

Process steps and equipment required for paint manufacturing.
Use of ball and pebble mills; sand, bead and shot mills; attritor and vibration mills.
Paint mixing and dispersion equipments like HSD, High speed stone and colloid mills; Assesment of pigment dispersion, Mill base let down operations. Various Industrial (Automotive & Marine Coatings, etc.) and Architectural paints; Formulation of various solvent and water based coatings, specialized paint finishes like wrinkle, polychromatic, flame buoyant, hammertone, etc.
Surface preparations and paint application systems;

Recommended Books:

1. Lipid Technologies and Applications - Frank D. Gunstone & Fred B. Padley

2. Outlines of Paint Technology - W.M. Morgans
3. Baileys's Industrial Oil and Fat Products
4. Coatings Materials and Surface Coatings - Arthur A. Tracton

PPR: Petrochemicals & Petroleum Refinery Engineering IV

Module I : Plants & Equipments in Refineries and Petrochemical Industries; Utilities,Offsite facilities & Environment control

Equipments viz. Pumps, compressors, Heat exchangers, Pipestill Heaters, Reactors – batch & continuous, fixed bed, fluidized bed, ebullated bed, single stage & multi stage, single stage once-through & with recycle, Distillation Columns, Extractors, Absorbers, PSA, TSA etc.
Corrosion & its prevention, Materials of Construction.
Refinery Utilities – Power & Steam generation, Plant air, Instrument air, Inert Gas system, Cooling water, DM water, Boiler Feed water, Service water, Treatment chemicals
Offsite facilities : Storage tanks – fixed roof, floating roof, Horton sphere, cryogenic storage tanks ; Pipelines for feeding & dispatch ; Classification of tank farms & safety guidelines ; Various dispatch facilities of products – Tank-truck (road transport) , tank-wagon; Fire water network & Fire fighting system
Environment control – Effluent treatment plant, Ambient air quality monitoring station, Furnace stack monitoring system, Storm water management, soil treatment, Incineration.

Module II : Preparation & Characterization of Important Polymers

Polyethylene, Polypropylene, PVC, Nylon, PET, Polyacrylates etc- stoichiometry, operating conditions, catalyst & application.
Synthetic rubber, Synthetic fibre, Synthetic resins, Synthetic detergents.
Moulding of Plastics, Vulcanization of Rubber.

Recommended Books :

1. Plastic Materials – J.A.Brydson
2. Principle of Polymer Chemistry – P J Flory
3. Textbook of Polymer Science – Fred W Billmeyer, JR
4. Rubber Technology & Manufacture – C M Blow
5. Fundamentals of Petroleum and Petrochemical Engineering, U. Ray Chaudhuri, CRC Press, Taylor & Francis group, 2013
6. Refining Process Handbook, Surinder Parkash, Elsevier, 2003.
7. Petroleum Refining 4. Materials & Equipment, P. Trambouze, TECHNIP, 2000
8. Corrosion Problems and Solutions in Oil refining and Petrochemical Industry, Alec Groysman, Springer, 2017

PFC: Pharmaceutical and Fine Chemical Technology IV

Module I: Pharmaceutical Technology

Preformulation studies. Stability analysis.
Novel drug delivery devices and sustained drug delivery. Transdermal drug delivery devices, design, formulation and evaluations.

Compartment models and bioequivalence studies.
Packaging requirements and regulatory requirements. Primary and secondary packaging materials types and quality testing. Bar coding, quarantine and identification.

Module II: Medicinal Chemistry II

Medicinal Chemistry of drugs acting on sympathetic and parasympathetic nervous systems. Drugs acting on central nervous systems like sedative hypnotics, anti-epileptics, and antimicrobial agents, like sulfa-drugs, antitubercular compounds, antifungals, antimalarials and other antiprotozoals.
Medicinal Chemistry of antihistaminics, diuretics, antiemetics and oral hypoglycemics. Classification and chemistry of vitamins.

Recommended Books:

1. Goodman and Gilman: Pharmacological Basis of Therapeutics, Pregamon Press, New York.
2. Foye's Principles of Medicinal Chemistry, 7th Ed, Thomas L. Lemke, David A. Williams, Victoria F. Roche, S. William Zito, Wolters Kluwer, 2012.
3. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, Charles Owens Wilson, Lippincott Williams & Wilkins, 2004.
4. Basic Concepts in Medicinal Chemistry, Marc W. Harrold and Robin M. Zavod, American Society of Health-System Pharmacists, 2013.
5. Medicinal Chemistry, Ashutosh Kar, New Age International
6. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Loyd Allen and Howard C. Ansel, Lippincott Williams & Wilkins, 2013.
7. Pharmaceutical Preformulation and Formulation: A Practical Guide from Candidate Drug Selection to Commercial Dosage Form, Mark Gibson, CRC Press, 2016
8. Remington: The Science and Practice of Pharmacy, David B. Troy, Paul Bering, Lippincott Williams & Wilkins, 2006
9. The Theory and Practice of Industrial Pharmacy, Herbert Lieberman and Leon Lachman, CBS Publishers, 2013
10. Aulton's Pharmaceutics: The Design and Manufacture of Medicines, Michael E. Aulton, Kevin Taylo, Elsevier Health Sciences, 2013

(Practical)

Paper 55

Course CT704 **50 marks /2 Credits**

Design & Simulation Lab

1. Introduction to Software Packages
2. Setting up models for simulation
3. Steady State simulation using ASPEN

4. Flow-sheeting concepts (sequential modular, equation oriented)
5. Dynamic simulation using MATLAB,
6. CFD simulations using FLUENT
7. Geometry & meshing

Paper 56

Course CT705 **50 marks /4 Credits**

Project Assessment I

Each student shall be required to carry out under the supervision of Faculty member (s) and/or External member as the case may be, an original investigation on an industrial problem related to one's course/subject. She/he shall submit two typewritten bound copies of a report on Research Work at least 15 days before the commencement of final semester examination and shall defend her/his report in a Viva-voce Examination.

Paper 57

Course CT706 **50 marks /3 Credits**

Plant Design & Feasibility Studies

Each student shall be required to submit two bound type written copies of a project report on a proposed chemical plant manufacturing product/ products related to one's course/ subject to be worked out under the supervision of a faculty member.

The report shall include mass and energy balances, type and capacity of equipment selected and recommended, plant layout, feasibility analysis highlighting market survey, pattern of assistance available from the central and state governmental agencies, banks and financial institutions. Assistance for technology, raw materials, finance.

Legal obligation.

The student has to appear at a viva voce examination.

Paper 58

Course CT707 **50 marks /3 Credits**

In Plant Training / Institutional Training

Each student shall be required to undergo a course in 'In plant Training' for a specified period (4 - 6 weeks) in an industry related to one's course/subject.

She/he shall submit one copy of training report within 30 days of completion of training and shall appear at a Viva-voce Examination.

Semester VIII
(Theory)

Paper 59

Course CT801

Chemical Technology V

Module I: Business Management **50 marks/2 Credits**

The historical background of industrial development in India. The management function, evolution of management thought, management and social responsibility.

Process of basic management decisions in industry. Fundamental consideration in Industry: basic management decisions.

Organisation development and types of organization: Co-ordination and morale.
Total Quality Management (TQM) ISO 9000/BIS 14000
Product development and research, simplification and standardization of product and materials, processes and materials inspection.
Plant location.
The factory building and plant layout, material handling, the maintenance department.
Motion and time study, establishing time value by time study, utilizing time study data.
The sale and purchase department, budget, managerial control and office administration, classification and identification.
Material and production control: routine, scheduling and mass production industries.
Business statistics, index numbers, charting, trend curves, management ratios, forecasting, trade indices, budgeting, statistical methods in industry, quality control.
Economic planning and policy in India.
Position and problems of chemical industries in India.
Treatment of the subject should have a bias in regard to chemical industry.

Recommended Books :

1. Management – Harold Koontz & Heinz Weihrich
2. Operations Research – V K Kapoor
3. Principles & Practice of Management – Shyamal Banerjee
4. Statistical Methods – N G Das
5. Financial Management – I M Pandey
6. Cost Accounting – B K Bhar
7. Personnel Management & Industrial Relations – P C Tripathi
8. Marketing Management – Philip Kotler

Module II: Industrial Economics **50 marks/2 Credits**

World resources: fuels, water, power, iron and steel, manganese steel alloys, non-ferrous metals, position of India in World Trade.
Industrial Revolution: The historical process, rise of the factory system, social effects of the Industrial Revolution, growth of monopoly capital, the development of machinery, the steel age, the age of electricity, the commercialization of inventions.
Price system and resource allocation; concepts of demand, marginal revenue, demand elasticity, consumer's surplus and the interrelationships between them, concept of time in economics and short run and long run cost curves – total cost, marginal cost, average cost; forms of market and price determination of a commodity in different markets. Concepts of national income; theory of equilibrium national income determination, theory of investment; money market and theory of rate of interest; inflation theories – brief outline; commercial banking and central banking; fiscal policy; balance of trade and balance of payments; measures to correct balance of payments disequilibrium.

Recommended Books:

5. Modern Economic Theory - K. K. Dewett, M. H. Navalur, Janmejoy Khuntia.S. Chand & Co.
6. Modern Economics – H. L. Ahuja, S. Chand & Co.
7. An Introduction to Microeconomics & Indian Economy – Anasuya Kar, S. Chand & Co.

Paper 60
Course CT802 CER/OLT/PPR/PFC **100 marks /4 Credits**

CER: Ceramics Engineering V

Module I: Advanced Ceramics I

Advanced Processing Technologies of Ceramics: Chemical vapour deposition etc, Sol–gel, Microwave Processing, Sonochemical techniques, Spark Plasma sintering.
Ray theory of fibres, Wave theory of fibres, Types of optical fibres, Transmission and dispersion characteristics, fibre fabrication process, Mechanical strength of fibres, optical fibre systems.Laser glass, Zero expansion glass and Bulk metallic glass. Radiation shielding glass. Dosimeter glass, Scintillation glass, Photonic glass, Agricultural glass, Faraday rotator glass, Photo thermo refractive index glass and IR transmission glasses.
Superhard ceramic materials, diamond, BN, Si_3N_4, C_3N_4
Composites, Nanostructured materials, nano-ceramics, non-oxide ceramics, nano fibres and nanoclays.
Ceramic sensors, Solid Oxide Fuel Cell, Smart Ceramics, Semi conducting, Conducting & Super conducting Ceramics, Thin Films, Membranes, Optical, Dielectric and Magnetic materials.

Module II: Advanced Ceramics II

Ceramic gas and moisture sensors, optical sensors, micro sensors, actuators, Ceramics for heat engines, Ceramic for nuclear sectors, Ceramic microstructures.
Bioceramics - processing, properties and application.
Carbon nanotubes – single walled and multiwalled, nanolithography, molecular imprinting, Quantum dots and nanowires, CMOS – MEMS, patterning techniques in microelectronics.
Advanced characterization techniques of ceramics : Small angle neutron scattering, Scanning Tunneling Microscope (STM), Raman Spectroscopy, Nuclear Magnetic Resonance, HRTEM, Photoluminescence (PL), EDS, Mossbauer Spectroscopy, Scanning Electron microscopy, FTIR,DSC, AFM, X-Ray Diffraction, X-Ray absorption near edge structure, X-Ray Photoelectron Spectroscopy (XPS). Non-destructive testing, Weibull modulus.

Recommended Books:-

1. Introduction to Ceramics – W. D. Kingery, H. K. Bowen, D. R. Uholmann
2. Ceramic Materials for Electronics - R.C. Buchanan
3. Glass-Ceramic Technology - Wolfram Holand, George H. Beall
4. Introduction to Bioceramics – L. L. Hench and J. Wilson
5. Electroceramics –A. J. Moulson & J. M. Herbert
6. Ceramic Processing and Sintering: M. N. Rahaman
7. Fundamentals of Ceramics – M. W. Barsoum

OLT: Oil Technology V

Module II : Fat based Industrial Chemicals

An overview on oleochemicals: oleo chemicals raw materials, basic oloeochemicals, oleochemical derivatives, etc.

Fat splitting (low, medium and high pressure splitting), recovery, purification and distillation of glycerol, separation of fatty acids, distillation of fatty acids.

Fatty alcohols and Fatty amines (raw materials, properties, processes and uses) and their derivatives;

Fat based chemicals in synthetic lubricants, plasticizer, Metallic soaps, biodiesel, etc.

Fat based and synthetic process auxiliary chemicals for application in different chemical industries like leather, paper, textile, rubber, plastics, metal working, etc.

Design considerations for various process equipment associated with oil processing like extractor, hydrogenator, reaction kettles, distillation equipments, milling equipments, micronizers, etc.

Biotechnology in basic and downstream oleochemicals production for food and industrial applications.

Module II : Advanced Paint Technology

Outline Of The Activities Of The Petrochemical Industries To Manufacture the Raw Materials for Paint, Like Solvents, Monomers, Additives and Production of LDPE, LLDPE, HDPE.
Modern trends in coating systems; waterborne paints;

Powder coatings; electro-deposited paints; high solid coatings

Nano technology and Biotechnology in paint industry for production of polymer materials and protection of coating surfaces.

Module III : Essential Oils and Cosmetic Technology

Chemistry & Technology of Natural Essential oils and of synthetics.

and their uses in food and personal care products

Technology of Production of cosmetics like various creams, shavings, lotions, hair oils, tooth paste, tooth powder, lipstick, face powders, herbal cosmetics.

Recommended Books:

1. Industrial uses of vegetable oils – Sevim Z. Erham
2. Paint and Surface Coatings - R. Lambourne and T.A. Strivens
3. The Essential Oils - Ernest Guenther

4. Perfumes, Cosmetics & Soaps - W.A. Poucher
5. Treaties on Fats, Fatty acids & Oleochemicals – Edited by O P Narula
6. Protective Coatings: Fundamentals of Chemistry and Composition - Clive H Hare
7. Perfumery Materials: Productoionand Applications – D.K. Bhattacharyya

PPR: Petrochemicals & Petroleum Refinery Engineering V

Module I : Management & Process Control of Refinery and Petrochemical Plants

Instrumentation & DCS , Process simulation, LP modeling, Refinery scheduling, Product pricing, Profitability evaluation etc.
Safety Rules, Explosive Rules, OISD guidelines, Factories Act etc.
Energy Audit, Material Audit, Conservation Techniques etc.
HAZOP & HAZAN, Environmental Impact analysis, Disaster management

Module II : Polymerization techniques, characterization & processing

Polymerization reactions – Chain growth polymerization, Step growth polymerization, Copolymerization.
Polymerization practices – Bulk polymerization, Suspension polymerization, Emulsion polymerization etc.
Polymer properties, Polymer Characterization
Polymer Processing – Extrusion, Calendering, Moulding, Casting etc.

Recommended Books:

1. Principle of Polymer Chemistry – P J Flory
2. Textbook of Polymer Science – Fred W Billmeyer, JR
3. Fundamentals of Petroleum Refining, M. A. Fahim, T.A. Alsahhaf, A. Elkilani, Elsevier, 2010
4. Fundamentals of Petroleum and Petrochemical Engineering, U. Ray Chaudhuri, CRC Press, Taylor & Francis group, 2013

PFC: Pharmaceutical and Fine Chemical Technology V

Module I: Medicinal Chemistry III

Medicinal Chemistry of antineoplastic, antiviral agents, fluoroquinolones. Herbals & nutraceuticals formulation
Concepts of drug design and molecular modeling, Quantitative drug design techniques like Hansch analysis, Free Wilson techniques, 2D and 3D approach.
Biostatistics. Principles of drug actions and Receptor concepts, Drug receptor theories.

Module II: Cosmetics and Fine Chemicals

Unit 1: Classification of cosmetics and cosmetic products. Structure of skin, hair, nails, tooth and skin appendages and interactions with cosmetics. Cosmetics common ingredients and processes. Cosmetic formulation and performance. Packaging requirements of cosmetics. Primary and secondary packaging materials types and quality testing.

Unit 2: Chemistry of excipients. Synthesis and application techniques for dyes, dye intermediates, permitted colors, sweetening agents, flavoring agents. Pesticides, trace analysis for pesticides.

Recommended Books:

1. Goodman and Gilman: Pharmacological Basis of Therapeutics, Pregamon Press, New York.
2. Foye's Principles of Medicinal Chemistry, 7th Ed, Thomas L. Lemke, David A. Williams, Victoria F. Roche, S. William Zito, Wolters Kluwer, 2012**.**
3. Wilson and Gisvold's Textbook of Organic Medicinal and Pharmaceutical Chemistry, Charles Owens Wilson, Lippincott Williams & Wilkins, 2004.
4. Basic Concepts in Medicinal Chemistry, Marc W. Harrold and Robin M. Zavod, American Society of Health-System Pharmacists, 2013.
5. Medicinal Chemistry, Ashutosh Kar, New Age International
6. Burger's Medicinal Chemistry, Drug Discovery and Development, 7th Edn, Vol 2, Alfred Burger Ed. Donald J. Abraham and David P. Rotella 2010.
7. Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Loyd Allen and Howard C. Ansel, Lippincott Williams & Wilkins, 2013.
8. Pharmaceutical Preformulation and Formulation: A Practical Guide from Candidate Drug Selection to Commercial Dosage Form, Mark Gibson, CRC Press, 2016
9. Remington: The Science and Practice of Pharmacy, David B. Troy, Paul Bering, Lippincott Williams & Wilkins, 2006
10. The Theory and Practice of Industrial Pharmacy, Herbert Lieberman and Leon Lachman, CBS Publishers, 2013
11. Aulton's Pharmaceutics: The Design and Manufacture of Medicines, Michael E. Aulton, Kevin Taylo, Elsevier Health Sciences, 2013
12. Handbook of Pharmaceutical Excipients, Raymond C. Rowe, Paul J. Sheskey, Marian E. Quinn, Pharmaceutical Press, 2009.
13. The Chemistry of Synthetic Dyes, - Vol 5, K Venkataraman, Academic Press, 2012
14. Industrial Dyes: Chemistry, Properties, Applications, Klaus Hunger, Wiley VCH, 2007.
15. Synthesis of Pesticides Chemical Structure and Biological Activity: Advances in Pesticide Science, H. Geissbühler, G. T. Brooks, P. C. Kearney, Pergamon Press, 2013.

(Practical)

Paper 61
Course CT803 **50 marks /2 Credits**

Grand Viva
Each student shall be required to appear Grand Viva Voce Examination.

Paper 62
Course CT804 **50 marks /3 Credits**
Seminar
Each student shall be required to prepare and submit one typewritten bound copy of seminar paper on selected technological topic related to one's course/subject under the supervision of a faculty member. She/he shall deliver a talk based on his seminar paper through power point presentation in an open seminar in presence of faculty members and external expert. The attendance in the seminar is compulsory for all the students.
Technical report writing skills, basic communication skills, Power point presentation and Group discussions will be in the perspective

Paper 63
Course CT805 **50 marks /4 Credits**
Project Assessment II
Each student shall be required to carry out under the supervision of Faculty member (s) and/or External member as the case may be, an original investigation on an industrial problem to related to one's course/subject. She/he shall submit two typewritten bound copies of a report on Research Work at least 15 days before the commencement of final semester examination and shall defend her/his report in a Viva-voce Examination.