DIRECTION

No. 42/2021 Date :- 09/08/2021

Subject :- Examination leading to the Degree of B.E./ B.Text.E. /B.Tech. (Chem.Engg.) (Four Year Degree Course.. Semester Pattern) (C.B.C.S.) in the Faculty of Science & Technology, Direction 2021.

Whereas, Direction No. 29 of 2010 in respect of the Examination leading to the Degree of B.E./ B.Text.E. /B.Tech. (Chem.Engg.) (Four Year Degree Course .. Semester Pattern) (C.B.C.S.) in the Faculty of Engineering & Technology, Direction, 2010 of B.E. /B.Text. E.(Common to all branches) as per Credit Grade System in the Faculty of Engineering & Technology was in existence up to the session 2018-19 and abrogated stage wise vide Direction No. 26 /2019,
AND
Whereas, Direction Nos. 31/2011, 31/2012, 3/2013, 16/2014, 12/2016, 19/2016, 20/2016, 11/2017 and 37/2018 in respect of the Schemes of teaching & examination of Semesters III to VIII in the various branches of B.E. /B.Text.E. /B.Tech. (Chem. Tech.) as per Credit Grade System in the Faculty of Engineering & Technology are in existence,
AND
Whereas, the Hon'ble Vice-Chancellor had constituted a Committee of all the Chairpersons of the Board of Studies of Engineering & Technology under the Chairmanship of the Dean, Faculty of Science & Technology for preparing of the Schemes of teaching & examination of Under Graduated Courses of Semester III to VIII of B.E. /B.Text.E. / B.Tech. (Chem.Engg.) / B.Tech. (Chem.Tech.) as per the guidelines of A.I.C.T.E. Model Curriculum to be implemented from the session 2020-21 & onwards in phase wise manner,
AND
Whereas, the Committee in its series of meetings dtd. 6.6.2020, 22.6.2020 & 23.6.2020 has prepared, finalized and recommended the Schemes of teaching & examination of the branches Civil Engg., Mechanical Engg., Electronics & Telecommunication Engg., Computer Science & Engg. / Computer Engg., Electrical Engg., Electrical Engg. (Electronics & Power), Electrical & Electronics Engg., Information Technology, Textile Engg., Chemical Engg., (C.B.C.S.) of Semester III to VIII as per guidelines of AICTE Model Curriculum to the office to be implemented from the session 2020-21 & onwards in phase wise manner,
AND
Whereas, the Hon'ble Vice-Chancellor had accepted and accorded approval to the schemes of teaching & examination of Semester III to VIII of B.E. /B.Text.E. /B.Tech. (Chem.Engg.) on behalf of Faculty of Science & Technology and Academic Council on 24.7.2020 to be implemented from the session 2020-21 & onwards in phase wise manner,

AND
Whereas, the above Schemes of teaching & examinations of Semesters Semester III to VIII of B.E. /B.Text.E./B.Tech.(Chem.Engg.) in the Faculty of Science & Technology are required to be regulated by the Ordinance /Regulation,

AND

Whereas, at the time of considering the directions issued underSection 12 (8) of 12 of the Maharashtra Public Universities Act, 2016, the Academic Council in its meeting held on 13.1.2020 vide item No. 04 has resoved as under : Hereinafter, afresh Direction shall be issued by superceding earlier Direction if the relative legislation not be made in a stipulated period.
AND

Whereas, earlier Direction Nos. 26/2019 and 8/2020 issued in this regard have already been lapsed, And
Whereas, the existing direction No. 21/2020 regarding Examination leading to the Degree of B.E./ B.Text.E. /B.Tech. (Chem.Engg.) (Four Year Degree Course.. Semester Pattern) (C.B.C.S.) in the Faculty of Science & Technology lapsed as per sub Section (8) of Section 12 of the Maharashtra Public Universities Act, 2016 and could not be converted into Ordinance / Regulation. Hence, now it is imperative to issue a fresh direction,

AND
Whereas, making the Ordinance /Regulation is a time consuming process,

Now, therefore, I, Dr. Vilas M. Bhale, Vice-Chancellor (Acting), Sant Gadge Baba Amravati University, in exercise of powers conferred upon me under sub-section (8) of Section 12 of the Maharashtra Public Universities Act, 2016, do hereby direct as under :-

This Direction shall be called "Examination leading to the Degree of B.E./ B.Text.E. /B.Tech. (Chem.Engg.) (Four Year Degree Course..Semester Pattern) (C.B.C.S.) in the Faculty of Science & Technology, Direction, 2021".

This Direction shall come into force from the date of its issuance.

Subject to the conditions prescribed by the Government from time to time, for admission to First Year B.E./B.Text.E. / B.Tech. (Chem. Engg.) / B.Tech. (Chem. Tech.) Polymer (Plastic) Tech. courses the candidate shall be considered eligible :

Passing 12th Standard examination of the Maharashtra State Board of Secondary and Higher Secondary Education, with subjects :
English (Higher or Lower)
Modern Indian Language (Higher or Lower)
Mathematics and Statistics.
Chemistry.
Physics.
Any other optional subject from out of the list prescribed by the said Secondary and Higher Secondary Education Board.
OR
English (Higher or lower)
Mathematics and Statistics.
Chemistry
Physics
Vocational subject (Defined by the said Board as a Technical Subject)
OR
An Examination recognised by the Sant Gadge Baba Amravati University as an equivalent to the above.

Subject to the conditions prescribed by the Govt. from time to time for direct admission to the second Year B.E. / B.Text.E. / B.Tech. (Chem. Engg.) / B.Tech. (Chem. Tech.) Polymer (Plastic) Tech. the candidates shall be considered eligible :-

Passing Diploma in relevant branch in First Division, awarded by the Board of Technical Examination of Maharashtra State, Mumbai.
OR
Any Diploma equivalent to the corresponding Diploma of the Board of Technical Examination of Maharashtra State, Mumbai.

(a) The Degree of Bachelor of Engineering shall be awarded to examinee who in accordance with the provisions of this Direction qualifies for the award in any of the following branches.

Civil Engineering
Mechanical Engineering
Electrical Engineering (Electronics & Power)
Electrical Engineering
Electrical and Electronics Engineering.
Electronics and Telecommunication Engineering
Computer Science & Engineering
Information Technology
Computer Engineering
Chemical Engineering
Textile Engineering

The Degree of Bachelor of Textile Engineering shall be awarded to examinee, who qualifies in accordance with the provisions of this Direction.

The Degree of Bachelor of Technology (Chemical Engineering) shall be awarded to examinee who qualifies in accordance with the provisions of this Direction.
The Degree of Bachelor of Technology (Chemical Technology) Polymer (Plastic) Tech. shall be awarded to examinee who qualifies in accordance with the provisions of this Direction.

(i) There shall be eight semester examinations leading to the Degree of B.E./B.Text.E./B.Tech. (Chem. Engg.) /B.Tech. (Chem. Tech.) Polymer (Plastic) Tech. (First, Second, Third, Fourth, Fifth, Sixth, Seventh & Eight Semester)
The first & Second Semester Examinations shall be common for all the branches.
The procedure for bifurcation of the students in Group - A & Group - B shall be as given in **Appendix -B**.

The period of Academic Session shall be such as may be notified by the University.

The main examination of first, third, fifth and seventh semester shall be held by the University in winter & supplementary examination in summer every year. And main examination of second, fourth, sixth & eighth semester shall be held in summer & the supplementary examination in winter every year.

The Internal Assessment marks for theory should be based on Class Test and Attendance as follows:-
(a) Class Test Marks will be based upon two Class Tests. - 15

(b) Attendance	-	Mark/s
75% to 80%	-	1
81% to 85%	-	2
86% to 90%	-	3
91% to 95%	-	4
96% to 100%	-	5

Wherever, if internal assessment marks are 'ten (10)' then it should be converted out of "20".

Subject to his/her compliance with the provisions of this Direction & other Ordinances pertaining to Examination in force from time to time, the applicant for admission, at the end of the course of study of a particular semester/session, to an Examination specified in column (1) of the table I below, shall be eligible to appear if,
he/she satisfies with the conditions in the table and the provisions there under.
he/she complies with the provisions of the ordinance pertaining to the Examination in general from time to time.
he/she has prosecuted a regular course of study in a college affiliated to the University.

he/she has in the opinion of the Principal shown satisfactory progress in his/her studies.

TABLE I

Name of Exam B.E./B.Text.E./ B.Tech. (Chem. Engg.)/B.Tech. (Chem.Tech.) Polymer (Plastic)Tech.	The student should have passed Exam. of	The Student should have satisfactorily completed the following semester	The student should have passed the following examination
1.	2.	3.	4.
First Semester Group A/Group B	XII standard Examination or equivalent	....	....
Second Semester	....	I Semester	.....

Group A/Group B		Group A/Group B	
Third Semester	....	II Semester Group A/Group B	2/3rd heads of I & II Sem. combined together
Fourth Semester	.....	III Semester	.....
Fifth Semester	I & II Sem.	IV Semester	2/3rd heads of III & IV Sem. combined together
Sixth Semester	....	V Semester	.....
Seventh Semester	III & IV Sem. combined together	VI Semester	2/3rd heads of V & VI Sem.
Eighth Semester	.....	VII Semester	.....

An examinee who has passed 2/3 rd heads of passing shall be allowed to keep term in the next higher class. Explanation: While calculating 2/3 rd heads of passing, fraction if any shall be ignored
For considering the heads of passing, every theory and every practical shall be considered as separate head of passing.

The schemes of teaching & examinations shall be as provided under "**Appendix-A**" appended with this Direction.

The fees for each B.E./B.Text.E./B.Tech. (Chem. Engg.)/B.Tech. (Chem. Tech.) Polymer (Plastic) Tech. Examinations (Theory & Practical) shall be as prescribed by University from time to time.

The computation of Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) of an examinee shall be done as given below :-

The marks will be given in all examinations which will include college assessment marks and the total marks for each Theory / Practical shall be converted into Grades as per **Table II**.

SGPA shall be calculated based on Grade Points corresponding to Grade as given in Table II and the Credits allotted to respective Theory / Practical shown in the scheme for respective semester.

SGPA shall be computed for every semester and CGPA shall be computed only in VIII semester. The CGPA of VIII semester shall be calculated based on SGPA of VII and SGPA of VIII semester as per following computation :-

$$SGPA = \frac{C_1 \times G_1 + C_2 \times G_2 + \ + C_n G_n}{C_1 + C_2 + \ + C_n}$$

Where, C_1 = Credit of individual Theory / Practical
G_1 = Corresponding Grade Point obtained in the respective Theory / Practical

$$CGPA = \frac{(SGPA)_{VII} \times (Cr)_{VII} + (SGPA)_{VIII} \times (Cr)_{VIII}}{(Cr)_{VII} + (Cr)_{VIII}}$$

Where, $(SGPA)_{VII}$ = SGPA of VII Semester
$(Cr)_{VII}$ = Total Credits for VII Semester $(SGPA)_{VIII}$ = SGPA of VIII Semester
$(Cr)_{VIII}$ = Total Credits for VIII Semester

CGPA equal to 6.00 and above shall be considered as equivalent to First Class which shall be mentioned on Grade Card of VIII Semester as a foot note.

TABLE II THEORY

Grade	Percentage of Marks	Grade Points

AA	80 ≤	Marks ≤ 100	10
AB	70 ≤	Marks < 80	9
BB	60 ≤	Marks < 70	8
BC	55 ≤	Marks < 60	7
CC	50 ≤	Marks < 55	6
CD	45 ≤	Marks < 50	5
DD	40 ≤	Marks < 45	4
FF	00 ≤	Marks < 40	0
ZZ	Absent in Examination	—	

PRACTICAL

Grade	Percentage of Marks	Grade Points
AA	85 ≤ Marks ≤ 10010	
AB	80 ≤	Marks < 85 9
BB	75 ≤	Marks < 80 8
BC	70 ≤	Marks < 75 7
CC	65 ≤	Marks < 70 6
CD	60 ≤	Marks < 65 5
DD	50 ≤	Marks < 60 4
FF	00 ≤	Marks < 50 0
ZZ	Absent in Examination	—

(i) The scope of the subjects shall be as indicated in the syllabi.
(ii) The medium of instruction and examination shall be English.

The Schemes of teaching & examination of Semester I & II (Group A & B) of B.E. /B.Text. E./B.Tech. (Chem.Engg.)/ B.Tech. (Chem. Tech.) (Polymer) (Plastic) Tech. had been already implemented from the session 2019- 2020 which was notified vide Direction No. 26/2019.

As per A.I.C.T.E. Model Curriculum, an Induction Program of three (3) weeks duration is mandatory to the students at the start of the first semester.

The Schemes of teaching & examination of Semester III to VIII of B.E./ B.Text.E./ B.Tech. (Chem.Engg.) (C.B.C.S.) of the branches Civil Engg., Mechanical Engg., Electronics & Telecommunication Engg., Computer Science & Engg., Computer Engg., Electrical Engg., Electrical Engg. (Electronics & Power), Electrical & Electronics Engg., Information Technology, Textile Engg., Chemical Engg., (C.B.C.S.) as per A.I.C.T.E. Model Curriculum shall be implemented in phase wise manner as under :

For Semester III & IV from the session - 2020-2021
For Semester V & VI from the session - 2021-2022
For Semester VII & VIII from the session - 2022-2023

The Schemes of teaching & examination of Semester I & II of B.E. / B.Text.E./ B.Tech. (Chemical Engg.) (common to all branches) and Semester III to VIII of the branches Civil Engg., Mechanical Engg., Electronics & Telecommunication Engg., Computer Science & Engg., Computer Engg., Electrical Engg., Electrical Engg. (Electronics & Power), Electrical & Electronics Engg., Information Technology, Textile Engg., Chemical Engg., (C.B.C.S.) as per A.I.C.T.E. Model Curriculum shall be as per Appendices A,B,C,D,E,F,G,H,I,J,K and L appended with this Direction.

(i) The Semester wise chart regarding the workload and Credits as per A.I.C.T.E. Model Curriculum guidelines for Engineering & Technology Courses for the Schemes of teaching & examination of Sem. III to VIII is as under :

CHART

Sem.	Theory	Pract.	Theory credits	Pract. Credits	Semester Credits	Hours/ week	Remarks
I	4	4	15	5	20	25	Started from session 2019-20
II	4	4	15	5	20	25	
III	5	4	16	4	20	26	ES 2T, 0 credit
IV	5	4	18	4	22	26	ES 2T, 2 credits
V	5	4	16	4	20	24	PE-1,OE-1
VI	5	4	16	4	20	24	PE-1,OE-1
VII	5	3	16	3+4	23	30	PE-2 or 3, Project seminar - 8 hrs, 4 credits
VIII	4	2	12	2+6	20	28	PE-1 or 2, Project seminar 12hrs, 6 credits
Total	**37**	**29**	**124**	**41**	**165**		

The workload for the subject Environment Studies for Semester III & IV (3ES06 & 4ES06) which is common for all branches in all the Faculties as per Ordinance No. 42/2005 is as : 2 theory in III semester with no credits, 2 theory in IV semester with 2 credits and examination at the end of IV semester at college level having distribution as : 80 (Max. marks for Theory) + 20 (Internal) = 100 (Total marks) – 40 (Minimum marks for passing)

Open Electives (OE): Open Elective to be opted from the courses offered by other disciplines of Engineering & Technology of the university / Massive Open learning Courses (MOOC) such as SWAYAM pertaining to the profession.

Students completing foreign language course or completing minimum 4 weeks internship (Full time in Vacations) or participating in sports at National / International level shall be exempted from O.E. in the same / adjacent semester.

An Orientation Program of 15 hours duration /MOOC to be offered to the students during (a)VthSemester : Indian Constitution (b) VIth Semester: Indian Traditional Knowledge.

The Provisions of Ordinance No. 18 of 2001 in respect of an Ordinance to provide grace marks for passing in a Head of passing and improvement of division (Higher Class) and getting distinction in the subject and condonation of deficiency of marks in a subject in all the Faculties prescribed by the Direction No. 15 of 2017 shall be applicable to each examination under this Direction.

An examinee who does not pass; or who fails to present himself/herself for the examination shall be eligible for re-admission to the same examination/semester, on payment of fresh fees and such other fees as may be prescribed from time to time.

A candidate who could not complete a semester satisfactorily or who has failed will be eligible for readmission to the same semester.

However, re-admission to semester should be allowed only when a regular session is running for the particular semester.

One who has passed the Final B.E./B.Text.E./B.Tech. (Chem. Engg.)/B.Tech. (Chem. Tech.) Polymer (Plastic) Tech. examination of the University in one branch and who desires to take B.E./B.Text.E./B.Tech.(Chem. Engg.)/ B.Tech. (Chem. Tech.) Polymer (Plastic) Tech. Degree in another branch shall be admitted to the third Semester of that branch and shall be governed by this Direction for all other purposes.

After examinations the Board of Examination & Evaluation shall publish the result of the examinees as early as possible and the branch wise merit list shall be notified as per Ordinance No.6.

Notwithstanding anything to the contrary in this Direction, no one shall be admitted to any examination under this Direction, if he/she has already passed the said examinations or an equivalent examinations of any statutory University.

(i) The examinees who have passed in all the subjects prescribed for all the examinations of the particular branch shall be eligible for award of the Degree of Bachelor of Engineering / Bachelor of Technology (Chemical Technology) Polymer (Plastic) in the branch concerned, Bachelor of Textile Engineering and Bachelor of Technology (Chemical Engineering).

The Degree certificate in the prescribed form shall be signed by the Vice-Chancellor.

The Guidelines of the A.I.C.T.E. New Delhi and D.T.E., Govt. of Maharashtra, Mumbai shall be applicable from time to time after having noted / approved by the Competent Authority.

(29) The provisions in existing Direction Nos. 31/2011, 31/2012, 3/2013, 16/2014, 12/2016, 11/2017 and 37/2018 shall stand only be applicable to the students of Semester III to VIII of the branches Civil Engg., Mechanical Engg., Production Engg., Electronics & Telecommunication Engg., Electronics Engg., Instrumentation Engg., Computer Science & Engg., Computer Engg., Electrical Engg., Electrical Engg. (Electronics & Power), Electrical Engg. (Electrical & Power), Electrical & Electronics Engg., Information Technology, Textile Technology, Chemical Engg., Chemical Technology (Polymer) (Plastic) and Biomedical Engg. who have already sought their admissions as per its provisions and shall stand abrogated after exhausting the chances given to the failure students of Old Course by the University.

Sd/-
Date :- 08/08/2021 (Dr.Vilas M. Bhale)
Vice-Chancellor (Acting)

L : Theory Lecture T : Tutorial P : Practical D : Drawing / Design	FOUR YEAR DEGREE COURSE IN BACHELOR OF TECHNOLOGY BRANCH: CHEMICAL ENGINEERING CBCS SYSTEM SEMESTER PATTERN **SEMESTER : THIRD**

Sr. No.	Category	Subject Code	Subject	Teaching Scheme					Examination Scheme								
				L	T	P/D	Total Hours/ week	Credits	Duration of Papers (Hrs.)	Maximum Marks		Total	Min. Pass Marks	Max. Marks Practical		Total Marks	Maximum Passing Marks
										Theory Paper	College Assessment			External	Internal		
1	Basic Science Course	3CH01	Applied Maths-III	3	1	-	4	**4**	3	80	20	100	40	---	---	---	---
2	Professional Core Course	3CH02	Process Instrumentation	3	-	-	3	**3**	3	80	20	100	40	---	---	---	---
3	Professional Core Course	3 CH 03	Strength of Material	3	-	-	3	**3**	3	80	20	100	40	---	---	---	---
4	Professional Core Course	3 CH04	Chemical Engg. Thermodynamics -I	3	-	-	3	**3**	3	80	20	100	40	---	---	---	---
5	Professional Core Course	3CH05	Process Calculation	3	1	-	4	**4**	3	80	20	100	40	---	---	---	---
6	Humanities & Social Science	3ES06	Environmental Studies	2	-	-	2	**0**	---	---	---	---	---	---	---	---	---
7	Professional Core Course	3CH07	Process Instrumentation- Lab	-	-	2	2	**1**	---	---	---	---	---	25	25	50	25
8	Professional Core Course	3CH08	Strength of Material-Lab	-	-	2	2	**1**	---	---	---	---	---	25	25	50	25
9	Professional Core Course	3CH09	Chem. Engg. Thermo-I .-Lab	-	-	2	2	**1**	---	---	---	---	---	25	25	50	25
Total				**17**	**2**	**6**	**25**	**20**				500				150	
Note – Environmental Science as per Direction No. 20/2021.									**Grand Total**			500				150	**650**

SYLLABI PRESCRIBED FOR FOUR YEAR DEGREE COURSE BACHELOR OF ENGINEERING (CHEMICAL) SEMESTER PATTERN (CHOICE BASED CREDIT GRADE SYSTEM)

SEMESTER : THIRD

3 CH 01/3 PE 01 APPLIED MATHEMATICS-III / MATHEMATICS-III

1. **Pre-requisite of Subject** : Engineering Mathematics I and Engineering Mathematics II 2 **Course Objectives of Applied mathematics III** :

On Completion of the students are expected

To understand Fourier transform & Z-transform, Laplace transform & their application to engineering problems.
To know probability and probability distribution.
To understand Numerical analysis.
To know vector Clarks &their application.

SECTION A

UNIT –I: Ordinary differential equations:- Complete solution, Operator D, Rules for finding complementary function, the inverse operator, Rules for finding the particular integral, Method of variations of parameters, Cauchy's and Legendre's linear differential equations. (7 Hrs.)

UNIT-II: Laplace transforms: Definition, standard forms, properties of Laplace transform, Inverse Laplace transform, Laplace convolution theorem, Laplace transforms and Unit step function, Solution of Linear differential equations. (7 Hrs.)

UNIT-III: Probability & Probability Distribution Probability: definition, axioms of mathematical probability, complementation rule, Theorem of total probability, Theorem of compound probability, Independent Events, subjective probability, Baye's Theorem, Probability Distribution:– Binomial distribution, Poisson and normal Distribution. (7 Hrs.)

SECTION B

UNIT-IV: Complex Analysis :- Functions of complex variables, Analytic function, Cauchy- Reimann conditions, Harmonic conjugate functions, Milne's method, singular points, expansion of function in Taylor's and Laurent's series, Cauchy's integral theorem and formula, Residue theorem. (7Hrs.)

UNIT-V: Numerical Analysis: Solution of algebric and transcendental equations by method& method of false position, Newton-Raphson method Solution of system of linear equations by Gauss Seidal method, Relaxation method. Solution of first order ordinary differential equations by modified Euler's, method Runge - Kutta method. (7Hrs.)

UNIT-VI: Vector Calculus :- Scalar and vector point functions, Differentiation of vectors, Gradient of a scalar point function, Directional derivatives, Divergence and curl of a vector point function and their physical meaning, line, surface, volume integrals, irrotational and solenoidal vector fields, Stoke's and Divergence theorem(without proof). (7Hrs.)

Course Outcomes :

Students are expected to expertise in

Solving numerical methods, Laplace transform, Fourier Transform & Z-transform Probability & Probability Distribution and statistics are very useful to them in future curriculum/student.

Complex functions and vector calculus are backbone of future academic curriculum and hence should be in touch with contents in syllabus. Design of syllabus is more than sufficient for academic curriculum of student.

Text Books:

Higher Engineering. Mathematics by B.S. Grewal, Khanna Publication.
A Text Book of Applied Mathematics, Volume-II by P. N. Wartikar and

J.N. Wartikar, Pune Vidyarthi Griha Prakashan, Pune.
Applied Mathematics, Vol. III, J.N. Wartikar and P.N. Wartikar, Vidyarthi Griha Prakashan, Pune.

Reference Books:
Numerical Analysis- S.S. Sastry.
Advancing Engg. Mathematics by E.K.Kreyzig.
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3 CH 02 PROCESS INSTRUMENTAION

Monitoring and control of processes is an important activity of Chemical Engineer. This subject deals with measurement principles of process parameters like temperature, pressure, level flow.

Course Objectives:
The students will be able:
To learn the operating principles, construction and working of temperature, pressure, level and flow measuring devices.
To select the most suitable measuring device based on its performance characteristics for specific measuring task.
To test, Calibrate, Maintain measuring devices elements.

SECTION A
UNIT-I : Basic method of measurements –Errors in measurements – Types of Errors. Transducers – definition – classification – Static characteristics of instruments Dynamic characteristic. Transmitter –definition different types. (8)

UNIT-II : Temperature measurements: Introduction – Temperature scale Conventional methods of temperature sensing. Resistance Thermometer Detector (RTD) – Unbalanced Wheatstone Bridge Direct conversion. Thermistors
Temperature sensing using thermistor – Semiconductor temperature sensor. Thermocouple – Basics of thermocouple – Thermocouple types – Cold junction compensation. Infrared thermometry – Basics of radiation – Emissivity – Methods of sensing –Direct detection – Indirect detection. (8)

UNIT-III: Pressure measurements: Introduction – Units of pressure – Types of pressure measurement- –Bourdon tube and bellows – SG based pressure sensors – Capacitance type pressure transducers. Low pressure measurements
pirani gauge – Thermocouple gauge – Ionization gauge. (8)

SECTION B
UNIT-IV: Basics of fluid flow – Flow meters – Quantum flow measurements, Differential pressure measurement
Principle of the differential pressure flow meter, Orifice plate, Venturimeter, Flow nozzle, Dall tube, Pitot tube. Variable area flow meter,Magnet Flowmeters – DC Magnetic Flow meter, Pulsed Magnetic Flow meter, Permanent Magnet Type Magnetic Flow meter, AC Magnetic Flow meter. Positive displacement Flowmeters – Different type of ultrasonic Flow meter. (7)

UNIT-V : Level Measurements – Level transducer with differential pressure sensing –Capacitance based level sensors – Capacitance sensors for conducting liquids – Capacitance sensors for Non – conducting liquids, other liquid sensors – Displacement type level sensor – Ultrasonic type level sensor, Gamma ray level sensor. (7)

UNIT-VI : pH measurements – Basic ideas of pH value – Measurement of electrode potentials – Glass electrode – Reference electrode – Calomel electrode – Silver- Silver chloride electrode, Humidity Sensing – Basic ideas of humidity sensing – Humidity measurement by dew point sensing – Humidity measurement using Lithium Chloride. **Measurement for Concentration**: Obtaining concentration of solution by conductivity and conductivity titration, determination of concentration by density meter, hydrometer, refractometer, measurement of concentration of ion and coloured solution.. (7)

Text Books:
Tattamangalam R. Padmanaban “Industrial Instrumentation Principles and Design” Springer, 2000.
Donald P. Eckman, “ Industrial Instrumentation”, CBS Publishers, New Delhi,2002.

Reference Books:

R.K.Jain, "Mechanical and Industrial Measurements" Khanna Publishers, New Delhi, 1999
D.Patranabis, "Principles of Industrial Instrumentation", Tata McGraw Hill Publishing Ltd, New Delhi, 1999
C.D. Johnsons, "Process Control Instrumentation Technology", Prentice Hall Inc,
A.K.Sawhney, "A Course In Electrical and Electronics Measurement and Instrumentation", Dhanpat Rai and Sons, New Delhi, 1999

3 CH 03 /3CT03 STRENGTH OF MATERIALS

Learning Objectives of Subject:

TodeterminetheMechanicalbehaviorofthebodyandconstructionmaterialsbydetermining the stresses, strains produced by the application of loads.
To apply the fundamentals of simple stresses and strains.
To make one understand the concept of bending and its theoretical analysis.
To apply fundamental concepts related to deformation, moment of inertia, load carrying capacity, shear forces, bending moments, torsional moments, principal stresses and strains, slopes and deflection.

Course outcomes:

At the end of the subject the students will be able -
To understand the basics of material properties, stress and strain.
To apply knowledge of mathematics, science, for engineering applications
To identify, formulate, and solve engineering & real life problems
To design and conduct experiments, as well as to analyze and interpret action and reaction data.
To understand specific requirement from the component to meet desired needs within realistic constraints of safety.

SECTION – A

Unit I: Mechanical properties: Concept of direct and shear stresses and strains, stress-strain relations, Biaxial and triaxial loading, elastic constants and their relationship, stress-strain diagrams and their characteristics for mild steel, tor steel, Generalized Hook's law, factor of safety. Uniaxial stresses and strains: Stresses and strains in compound bars in uniaxial tension and compression, temperature stresses in simple restrained bars and compound bars of two metals only.

Unit II: Axial force, shear force & bending moment diagrams: Beams, loading and support conditions, bending moment, shear force and axial load diagrams for all types of loadings for simply supported beams, cantilevers and beams with overhangs, relation between shear forces, bending moment and loading intensity.

Unit III: Stresses in beams (Bending, Shear), i) Bending: Theory of simple bending, section modulus, moment of resistance, bending stresses in solid, hollow and built up section. ii) Shear: Distribution of shear stresses on beam cross sections, impact loads and instantaneous stresses.

SECTION – B

Unit IV: Torsion: Theory of torsion & assumptions, derivation of torsion equation, polar modulus, stresses in solid & hollow circular shaft, power transmitted by shaft, closed coiled helical spring with axial load. Thin cylinders subjected to internal pressures.

Unit V: Principal stresses: Biaxial stress system, principal stresses, principal planes, Mohr's circle of stresses, principal strains. Combined direct & bending stresses.

Unit VI: Slope & deflection of beams: Slope & deflection in statically determinate beams subjected to point loads, uniformly distributed loads, moments by Macauley's method. Theory of long columns, Euler, Rankin's formula.

Books Recommended:

E. P. Popov, "Mechanics of Materials", Prentice Hall of India, New Delhi.
S.Timoshenko and O. H. Young, 'Elements of Strength of Materials', East West Press Private Ltd., New Delhi.
Ferdinard L. Singer, 'Strength of Materials', Harper and Row, New York.

Shames, I. H., 'Introduction to Solid Mechanics', Prentice Hall of India, New Delhi.
R. K. Bansal, Strength of materials, Laxmi Publications Pvt Ltd.
Junnarkar, S. B., Mechanics of materials.
Mubeen, A., Mechanics of solids, Pearson education (Singapore) Pvt. Ltd.
Beer and Johston, Mechanics of materials, Mc-Graw Hill.
S. Ramamrutham, Strength of Materials, Dhanpat Rai Publishing Co Pvt Ltd.

3 CH 04 : CHEMICAL ENGINEERING THERMODYNAMICS-I

Chemical Engineering Thermodynamics is primarily concerned with the application of thermodynamics to phase equilibria and reaction equilibria. It is concerned with the application of Thermodynamics to heat-to-work and work- to-heat conversion devices. Chemical engineers are seriously concerned with the calculation of work in separation and in mixing processes. Its applications are obvious in the design of Chemical engineering equipments in processes.

Course Objectives:

After studying this subject the student will have:
The mathematical abilities required for applying thermodynamics to practical problems.
Its applications in the design of Chemical engineering equipments in processes.
SECTION A
UNIT-I:BASIC CONCEPTS: The terminologies of thermodynamics, the variables and quantities of thermodynamics, categorization of systems and processes. Energy classifications, point and path properties, energy in transition, heat and work, reversible and irreversible processes, phase rule. (8)

UNIT-II: FIRST LAW OF THERMODYNAMICS: First law of thermodynamics – heat and energy changes, enthalpy and heat capacity limitations of the first law, application of first law to different processes. (8)
UNIT-III: SECOND LAW THERMODYNAMICS: Second law of thermodynamics and its applications - Entropy, reversible and irreversible processes, Carnot cycle, T-S diagrams, enthalpy of mixing and disorder, refrigeration and liquefaction. (8)
SECTION B
UNIT-IV: REFRIGERATION AND LIQUEFACTION: The carnot refrigerator, the vapour- compression cycle, comparison of refrigeration cycles, liquefaction processes, heat pump. Rankine power cycle. (7)

UNIT-V: THERMODYNAMIC PROPERTIES OF FLUIDS: Property relations for homogeneous phases, thermodynamic diagram, generalized property correlation for gases. (7)

UNIT-VI: THERMODYNAMICS OF FLOW PROCESSES: flow of compressible fluids through ducts, compression processes, steam turbines and nozzles, condensers. (7)

Text Books:
J.M. Smith and H.C. Van Ness, "Introduction to Chemical Engineering Thermodynamics", McGraw Hill, 1998.

K.V.Narayanan, ."A textbook of Chemical Engineering Thermodynamics", Prentice Hall of India Ltd., 2001.

Reference Books:

Sadler S. I., J, "Chemical and Engineering Thermodynamics" John Wiley and Sons, Inc. New York, 3rd Ed., 1999.
Elliot J. R. and Lira C.T., "Introductory Chemical Engineering Thermodynamics", Prentice Hall, 1999.

Eastop T. D. and McConkey A.," Applied Thermodynamics for Engineering Technologists', Addison Wesley Longman Ltd., England, 5th Ed., 1999.

3 CH 05 PROCESS CALCULATION

Course objectiveS :

Students will learn the basic and fundamentals of chemical engineering operations and processes.
Students will understand the material balance and energy balance of various unit operations and unit processes.
Students will learn how to formulate and solve the problems related to material and energy balance with or without chemical reaction.

Course Outcomes:

After successful completion of this course student will be able to :

Understand the concept of basic chemical calculations
Understand the concept and application of theory of proportions
Determine the humidity with/without using a psychrometric chart.
Make the material balance over unit operations and processes.
Make the energy balance over unit operations and processes.
Solve the problem of fuels and combustion.

Course Contents :

Unit I. Introduction to unit operations and unit processes, Units and dimensions, Atoms, moles and molecular weight, mole and mass fraction, Composition of solids, liquids and gases, Concept of Normality, Molarity and Molality, PPM (Parts Per Million), Ideal Gas Law, Dalton's Law, Partial Pressure, Amagat's Law, Average Molecular Weight,Density of Gas Mixture, Raoult's Law, Henry's Law, Vapour Pressure, Clausius Clapeyron equation, Cox Chart,.Humidity and saturation, Humidity Chart, and their application.

Unit II. Material balance without chemical reaction stoichiometry and unit operations Distillation, Absorption, Extraction, Crystallization, Drying, Mixing, Evaporation. Recycle, purge and Bypass calculations.
Unit III.: Material balance involves chemical reaction, Principle of stoichiometry, simple oxidation reaction, multiple chemical reaction, percentage Conversion, percentage Yield, and selectivity, calculation involving combustion of gases, liquid and solid fuel. Recycle, purge and bypass calculations.
Introduction to unsteady state material balance
Unit IV.: Energy balance: open and closed system, heat capacity, calculations of enthalpy changes, enthalpy changes for phases transitions, evaporation, Solution and mixing, clausius clapeyron equation.
Unit V.: Energy balance with chemical reaction, calculation of standard heat of reaction, heat of formation, heat of combustion, Hess law, Effect of temperature on heat of reaction; adiabatic flame temperature calculations.
Unit VI.: Heating value of fuels, calculations involving theoretical and excess air, heat and material balance of combustion processes.

References :

Bhatt, B. I., Vora, S. M., "Stoichiometry", Fourth Edition, Tata McGraw Hill Publishing Company Ltd, 2004.
Narayanan K V and Lakshmikutty B, Stoichiometry and Process Calculations, Prentice Hall of India Pvt Ltd, New Delhi 2006.
Sikdar, D. C., "Chemical Process Calculations", Prentice Hall of India.
Himmelblau, D. M., Riggs, J. B. "Basic Principles and Calculations in Chemical Engineering", Eighth Ed., Pearson India Education Services, 2015.
Hougen. O. A, Watson K.M. and Ragatz R.A. "Chemical Process Principles, Part -I, Material and Energy Balance".

3CH07 PROCESS INSTRUMENTATION - LAB

List of experiments:

Measurement of temperature using thermocouple or RTD or Thermistor and to find their characteristics.
Measurement of high temperature using radiation or Optical pyrometer.
Measurement of pressure using LVDT or Strain gauge transducer.
Calibration of pressure gauge using Dead Weight Tester.
Measurement of level using air purge or capacitance type level detector.
Measurement of flow using magnetic flow meter or Ultrasonic flow meter.
Calibration of thermocouple/Bimetallic thermocouple/Resistance thermocouple.
Calibration of Pressure gauge/ Pnuematic pressure recorder/ Differential pressure recorder.
Calibration of Orificemeter/ Venturimeter / Rotameter/ Gas flow meter.
Estimation of viscosity by Redwood/ Saybolt/ Ostwald viscometer.
Calibration of pH meter.
Calibration of Conductivity meter.

All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

3CH08 / 3CE06 – STRENGTH OF MATERIALS – LAB

List of Practical's in Strength of Material Lab (Minimum any eight practical from the list should be performed)

Tension test on metals.
Compression test on metals.
Shear test on metals.
Impact test on metals.
Hardness test on metals.
Torsion test on metals.
Deflection of beams.
Modulus of rupture test.
Buckling of columns.
Deflection of springs.

3CH09 CHEMICAL ENGINEERING THERMODYNAMICS-I–LAB

L : Theory Lecture T : Tutorial P : Practical D : Drawing / Design	FOUR YEAR DEGREE COURSE IN BACHELOR OF TECHNOLOGY BRANCH: CHEMICAL ENGINEERING CBCS SYSTEM SEMESTER PATTERN **SEMESTER : FOURTH**

Sr. No	Category	Subject Code	Subject	Teaching Scheme					Examination Scheme								
				L	T	P/D	Total Hours/week	Credits	Duration of Papers (Hrs.)	Maximum Marks		Total	Min. Pass Marks	Max. Marks Practical		Total Marks	Maximum Passing Marks
										Theory Paper	College Assessment			External	Internal		
1	Engineering Science Course	4CH01	Applied Physical Chemistry	3	-	-	3	3	3	80	20	100	40	---	---	---	---
2	Engineering Science Course	4CH02	Machine Design & Drawing	3	-	-	3	3	3	80	20	100	40	---	---	---	---
3	Professional Core Course	4CH03	Fluid Flow Operation	3	-	-	3	3	3	80	20	100	40	---	---	---	---
4	Professional Core Course	4CH04	Chemical Engg. Thermodynamics-II	3	-	-	3	3	3	80	20	100	40	---	---	---	---
5	Professional Core Course	4CH05	Chem. Engg. Operation –I (Mech. Operation)	3	-	-	3	3	3	80	20	100	40	---	---	---	---
6	Humanities & Social Science	4ES06	Environmental Studies	2	-	-	2	2	3	80	20	100	40	---	---	---	---
7	Engineering Science Course	4CH07	Applied Physical Chemistry-Lab	-	-	2	2	1	---	---	---	---	---	25	25	50	25
8	Professional Core Course	4CH08	Fluid Flow Operation-Lab	-	-	2	2	1	---	---	---	---	---	25	25	50	25
9	Professional Core Course	4CH09	Chem. Engg. Thermo.-II – Lab.	-	-	2	2	1	---	---	---	---	---	25	25	50	25
10	Professional Core Course	4CH10	Chem. Engg. Operation –I (Mech. Operation)-Lab	-	-	2	2	1	---	---	---	---	---	25	25	50	25
Total				**17**	**-**	**08**	**25**	**21**				600				200	
Grand Total												**600**				**200**	**800**

Note – (**i**) Environmental Science as per Direction No. 20/2021. **(ii)** For subject 4CH02 Machine Design & Drawing, Students are expected to submit minimum 5 drawing sheets.

SEMESTER: FOURTH

4 CH01 APPLIED PHYSICAL CHEMISTRY

Teaching Scheme: Examination Scheme:
Lecture: 03 Hours / week Theory
Tutorial: 01 Hour /week T (E) : 80 Marks T (I) : 20 Marks
(Total credit: 04) Duration of University Exam : 03 Hours

Learning Objectives**:**
To understand the transport phenomenon, internal forces and molecular speed in gases.
To understand the electrical properties of fluid.
To know the rate, order, energy of activation of chemical reactions and their determination.
To know the use of kinetics and thermodynamics to elucidate mechanisms of reactions.
To understand the basic concepts, the Ist and IInd Laws of Thermodynamics, Thermodynamic functions and their applications.
To predict the high and low quantum yield photochemical reactions and to know about advanced spectroscopic analysis techniques.
To know the basic concepts and industrial examples of catalysis and adsorption on surface.

Contents:
Unit-I : Advanced Gas Concepts : Equation of state for real and ideal gases, Van-der-waal's equation, critical phenomenon, calculation of critical constants, Principle of corresponding states, compressibility factor, Principle of equipartition of energy, Maxwell-Boltzmann's law of distribution of molecular speed, Root mean square speed, Average speed and Most probable speed. Numerical. (6 Hrs)

Unit- II : Kinetics & Reaction mechanism: Introduction, Rate of reaction, concept of molecularity and order in elementary and complex reactions, differential and integral methods to formulate rate equations of zero, first and second order reactions. experimental methods in kinetic studies, effect of temperature on reaction rate, energy of activation and its determination, steady state approximation and rate determining step, Mechanism of complex reactions, photochemical chain reactions, polymerization reactions. Fast reactions **–** experimental techniques. Numerical (10 Hrs.)

Unit-III : Surface, interfacial chemistry and catalysis: Adsorption , types of adsorption, Adsorption isotherms , Langmuir theory of adsorption, BET adsorption isotherm and it's application for determination of surface area of fine powder. Homogeneous and Heterogeneous catalysis, Criteria of catalyst, Theory of heterogeneous catalysis, Homogeneous, Lewis acid-base catalysts, organometallic catalysts and industrially examples, Auto and enzyme catalysis. kinetics of reactions on surfaces. (8 Hrs.)

Unit – IV : Ion transport and electrical phenomenon at interface: Specific, Equivalent and Molar conductivity, Kohlraush's law and its applications ,Transport number and their determination ,Relation between electrical work done and free energy, Nernst equation for electrode potential ,Electrolytic concentration cell with and without transference, Debye- Huckel's theory of strong electrolyte, Determination of pH, solubility and solubility product of sparingly soluble salts, dissociation constant by emf measurement, Numerical. (8 Hrs.)

Unit – V : **Thermodynamics and Equilibrium :** Statements of the second law; Heat engines, Carnot's theorem, and Carnot cycle, Mathematical statement of the second law, Introduction of Entropy under the IInd Law to define spontaneity of a process, Temperature- entropy diagram, Introduction of the state functions A & G to determine conditions of Material Equilibrium. Condition of reversibility, Transformation at constant temperature and pressure, Gibbs- Helmholtz equation, pressure – volume and volume – Temperature relationship under isothermal condition for ideal gas. Partialmolar properties, chemical potential, Numerical (8 Hrs.)

Unit VI: **Spectroscopic techniques and applications :** Principles of spectroscopy and selection rules. Electronic spectroscopy. Vibrational and rotational spectroscopy of diatomic molecules. Principle and Applications of Nuclear magnetic resonance and magnetic resonance imaging.

Photochemistry and Modern Analytical techniques: Lows of photochemistry, quantum efficiency and its determination, low & high quantum yield reactions, Mass spectrometry. Chromatography. (8 Hrs.)

Course Outcomes :

The course will enable the student to:

Evaluate the properties of non-ideal gases, Intermolecular forces in gas, critical phenomenon & probability consideration of molecular speed.

Solve problems involving root mean square, average and most probable speeds & critical constants.

Evaluate the specific rate, order and energy of activation of chemical reactions.

Know the fundamental concepts related to homogeneous and heterogeneous catalysis, mechanisms of industrially important reactions, surface phenomenon and adsorption isotherms.

Apply mass and energy balances to closed and open systems ,Rationalize bulk properties and processes using thermodynamic considerations

Distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques and spectroscopic methods for identification of compounds.

Know the ion transport & electrical properties of solutions, solve problems involving transport no, electrode potential and emf of different types of cell.

Books Recommended :

Physical Chemistry , P.W. Atkins and J.D. Paula, Oxford University Press.
Physical Chemistry , K.J. Laidler and J.M. Meiser, CBS Publisher
Chemical kinetics and catalysis , R. J. Masel, John Wiley publications
Handbook of conducting polymers, Skotheim, Elsenbaumer and Reynolds, Marce Dekker.
Fundamentals of spectroscopy ,Banwell, Tata McGraw-Hill
Physical chemistry of surfaces, Arthur W. Adamsons, Alice P. Gast, John Wiley publications
Principle of Heterogeneous catalysis, J.M.Thomas, W.J. Thomas, John Wiley publications
Thermodynamics for students of chemistry, Dr. J. Rajaram & Dr. J. C. Kuriacose, Chand & comp.

4 CH02 MACHINE DESIGN & DRAWING

SECTION - A

Unit I- (a) Sectional Views Conversion of pictorial view in to sectional orthographic projections, Sectional views with different types of projections, Missing views (12 Hrs)

Unit II- a) Development of surfaces 31 32 Development of surfaces of cubes, prisms, cylinders, pyramids, cones & their cut sections

b) Intersection of solids-prism and prism, cylinder and cylinder, cylinder and prism, cone and cylin-der, cone and prism. (12 Hrs)

SECTION B

Unit III- (a) Meaning of Design, Phases of Design, Design considerations.

Simple stresses, Thermal stresses, Torsional Stress, stresses in straight & curved beams and its application- hooks, cclamps

Design & drawing of riveted joints- Caulking & fullering, failures, strength & efficiency of riveted joints.

Welded joints- Symbolic representation, Strength of transverse & parallel fillet welded section e) Design & drawing of Knuckle Joints (12 hrs)

Unit IV :(a) Design of Helical springs- Types of springs, stresses in helical springs, Wahl's stress factor, Buckling & surge, tension spring (b) spiral & leaf springs c) Design of power screw-Torque required to raise loads, efficiency & helix angle, overhauling & self locking of screw, acme threads, stresses in power screw. (12 hrs)

Books Recommended :

Text Books :
Machine Drawing by N. D. Bhatt, Charator Publication
Machine Design by R. S. Khurmi & J. K. Gupta , S. Chand Publication .

Reference Books :
Machine Design by Dr. P. C. Sharma & Dr. D. K. Agrawal, Katsons Books publication
Design of Machine elements by C. S. Sharma, Kamlesh Purohit, PHI publication
Design of Machine elements by V. B. Bhandari, Tata McGraw Hill Publication
Machine Design, Jindal, Pearson publications
Design Data Book by- P.S.G. Koimbatore
Design Data Book by Mahadevan.

(Use of any data book from the above will be permitted during the examination).

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4CH03 FLUID FLOW OPERATIONS
Course Objectives:
This basic course introduces concepts of momentum transfer to students. Various concepts such as pressure, momentum, energy are introduced. Laws related to conservation of momentum, energy are taught. Applications of these laws to various engineering situations and process equipment is explained with the help of several problems

SECTION A
Unit I: Properties of fluids and their classification. Fluid statics: Forces on fluids, pressure depth relationship for compressible and incompressible fluids. Forces on submerged bodies. Rigid body motion, pressure measurements, Euler's equation. (8)

Unit II: Kinematics of flow, Description of velocity field, Stream functions, Angular velocity, Fluids in circulation, Fluid flow: Laminar and turbulent flows, Equations of Continuity and Motion in laminar flows and its applications for the calculation of velocity profiles, shear stresses, power, etc. in various engineering applications. Dimensional analysis; Buckingham's Pi Theorem ; Dimensionless numbers and their physical significance; Vortex flow (8)

Unit III Dynamics of flow , Bernoulli's Equation and engineering applications, Conservation of mass, momentum and energy; Mechanical energy balance ,Basics of Turbulent flows, equations of continuity and motion for turbulent flows: Prandtl mixing length theory,. Turbulent pipe flow, basis of Universal velocity profile and its use. Von- Karman integral equations . Pressure drop in pipes and Fittings, Piping systems. (10)
SECTION B

Unit IV: Flow measuring devices for chemical plants: Orifice meter, Venturi meters, Rotameter, Pitot tube and Notches.

(7)

Unit V : Fluid moving machinery such as pumps like reciprocating pumps, rotary pumps, Centrifugal pumps, blowers, compressors, vacuum systems, etc. . (8)

Unit VI: Flow past immersed bodies, Particle Dynamics, flow through packed bed and fluidized Bed. Introductory concepts of two-phase flow. (6)

Books Recommended:

Unit Operations in Chemical Engineering, McCabe Smith: McGraw Hill.
Chemical Engineering, Vol. 1, Coulson J. M. and Richardson J. F. Butterworth Heinemann.
Fluid Mechanics, F. W. White.
A Text book of Fluid Mechanics and Hydraulic Machines ; Dr. R.K.Bansal
Fluid Mechanics , R. P. Vyas.

Subject Outcomes :

1 Students should be able to calculate velocity profiles by simplification of equations of motion in simple 1-D flows
2 Students should be able to calculate friction factor, losses in pipe fittings
3 Students will be able to calculate pressure drop, power requirements for single phase flow in pipes 4 Students should be able to calculate two phase gas/liquid pressure drop
Students should be able to calculate power requirements, NPSH requirements of pumps
Students should be able to calculate drag force and terminal settling velocity for single particles 7 Students will be able to calculate pressure drop in fixed and fluidized beds.

4CH04 CHEMICAL ENGINEERING THERMODYNAMICS-II

Chemical Engineering Thermodynamics is primarily concerned with the application of thermodynamics to phase equilibria and reaction equilibria. It is concerned with the application of Thermodynamics to heat-to-work and work- to-heat conversion devices. Chemical engineers are seriously concerned with the calculation of work in separation and in mixing processes. Its applications are obvious in the design of Chemical engineering equipments in processes.

Course Objectives:
After studying this subject the student will have:

The mathematical abilities required for applying thermodynamics to practical problems.
Its applications in the design of Chemical engineering equipments in processes.

SECTION A

UNIT-I: First law of thermodynamics, equation of state, critical properties, Vander Wall's constants, Virial expansions, Redlich-Kwong equation, Beattle-Bridgeman equation.
First law applied to thermodynamic processes and calculations of work, free energy and heat changes. Maxwell relation equation, second law and third law of thermodynamics. Thermodynamics relations based on second law. Relation between Cp and Cv, compressibility factor and coefficient of thermal expansion, concept of residual entropy and entropy of equilibrium. (8)

UNIT-II: Partial molar and apparent molar properties, Gibbs Duhem equation, chemical potential, effect of temperature and pressure fugacity, excess thermodynamic properties of mixing. Gibbs- Duhem-Morgules equation, Konovalov laws.

UNIT-III: Colligative properties, Ebulliometric constant. Determination of molecular weight of unknown chemical substances. Solubility
law. Vapour liquid equilibrium, T-X-Y diagrams and X-Y diagram for ideal and non ideal system . Raoult's law and Henry's law, Deviations from Raoult's law. Comparison of ideal and non- ideal systems. (8)

SECTION B

UNIT-IV: Phase equilibria in non reacting multi-components, binary and ternary systems. Graphical representation of L/L, L/S and G/S systems. Right angled triangular diagrams. Equilateral triangular diagrams, Janecke diagram, Phenol-water systems, Aniline-water-chlorobenzene systems. (7)

UNIT-V: Statistical thermodynamics, thermodynamics probability, its relation with entropy, partition function and its relation with thermodynamic functions, the Boltzman distribution law, Distribution law for chemically reactive system Thermodynamics charts and their uses. Searching of thermodynamics data. (7)

UNIT-VI: Chemical equilibrium, feasibility of chemical reaction, free energy change, Reaction co-ordinate, equilibrium constant, effect of temperature and pressure, Relation between Kp, Kc and Kv, Le-Chatelier's principle. Endo-exothermic reactions. Heterogeneous equilibria, various methods of calculating free enegy charge, equilibrium conversions, case study of feasibility report for manufacture of industrial chemicals. (7)

Text Books:

An Introduction of Chemical Thermodynamics: R.P.Rastogi and R.R. Mishra
Chemical Engineering Process: Houghen and Watson

Reference Books:
Introduction to Chemical Engineering Thermodynamics: J. M. Smith and H. C. Vauhess.
Thermodynamics for Chemical Engineering: H. C. Weber and J. P. Meissner.
Engineering Thermodynamics: P.K. Nag.

4CH05 CHEMICAL ENGINEERING OPERATIONS–I (MECH. OPERATIONS)

This subject intends to equip the students with concepts and principles as well as construction of equipments used for handling Mechanical Operations in a chemical plant. This subject gives idea about principles of handling mixtures of solids, liquid and gases. This subject will help students for understanding principles for separation and purification techniques of solid, liquids and gases mixtures.

Course Objective: After studying this subject's student will be able to:

Explain methods of size reduction and equipments working on those principles.
Describe various equipments used for size separation.

Identify various other physical properties used for purification solid-solid mixtures and equipments working on this principle.
Describe various method of purification of heterogeneous mixture of solid liquid, & equipments like filters, settlers, used for separation of solid liquid mixtures.
Identify various types of agitators used for mixing solids-liquids mixtures, power calculation of a mixer.

SECTION - A

UNIT-I: Size reduction, stages of reduction, equipment operating variables, laws of energies, energy requirements. Screening: Screen analysis, particle size distribution. (7)

UNIT-II: Classification: Equal falling particles, equipment, jigging, tabling. Gravity settling, drag force, terminal settling velocity Sedimentation: Continuous thickners. (8)

UNIT-III: 1. Storage and handling of solids, transportation.
2. Mixing, mixers, agitation, type of equipments. (7)

SECTION - B

UNIT-IV: Filtration: Theory, operation, types, flotation agents, flotation cells Filter calculations, filtration equation for compressible and non- compressible cakes , specific cake resistance. Filtration- constant pressure and constant rate and their equipments. (8)

UNIT-V: Centrifuges: Theory, equipments, types and calculations. Cyclones: Hydro cyclones, liquid scrubbers and electronic precipitators (7)

UNIT-VI: Adsorption, theory, type and application, Langmuir's Freund Lich;s equation nature of adsorbents, industrial adsorbents. Adsorption on fixed bed, fluidized beds Recent developments in mechanical operations. **(8)**

Text Books:

Bedger and Bencharo, "Introduction to Chemical Engineering". Tata McGraw Hill.
Narayanan C.M. & Bhattacharya B.C. "Mechanical operations for chemical engineers", Khanna Publishers, 3 rd Ed.1999.

Reference Books:

Coulson and Richardson: Chemical Engineering, Vol. 2

Brown,G.G. and Associates "Unit operations" Wiley , New York

4CH07 APPLIED PHYSICAL CHEMISTRY- LAB

Total credits: 2 Examination Scheme: (I): 25 (Ext): 25 Marks

Objectives: To provide the practical knowledge of analysis techniques by classical and instrumental methods for developing experimental skill to built technical competence.

List of Experiments:

Determination of critical temperature of phenol-water system
Determination of order of reaction and specific rate constant of hydrolysis of methyl acetate.
Study of kinetics of second order reaction.
Determination of relative strength of two acids by kinetic study of reaction
Determination of energy of activation of reaction
Determination of equivalent conductivity of strong electrolytes at infinite dilution.
Determination of transport number
Determination of equivalence point of titration by conductance measurement.
Potentiometric titration between strong acid and strong base.
Verification of Beer- Lambert's law and determination of concentration of unknown solution.
Verification of Freundlich and Langmuir isotherm.
Determination of refractive index.
Determination of solubility of sparingly soluble salts by EMF measurement.
Determination of heat of neutralization & ionization of acetic acid
Determination of ΔH and ΔS of monobasic acid by measuring its solubility at different temperatures.
Determination of specific rotation of cane sugar by polarimetry.

Course outcomes: After completion of this course the students shall be able to ;

Understand the objectives of their experiments.
Follow the proper and safe procedure to get the accurate results.
Record and analyze the results.
Interpret the results through proper writing in laboratory journal

Books Recommended :

Experiments in Physical Chemistry, David P. Shoemaker, Carl W. Garland, Jeffrey I. Steinfeld
Experiments in Chemistry, Dr. D. V. Jahagirdar, Himalaya Publishing House, New Delhi
A Text Book of on experiments and calculations- Engg. Chemistry, S.S. Dara, S. Chand & Comp. ltd.

All above experiments are to be arranged in the laboratory. Minimum 08 experiments are required to be performed by the student to complete the term work.

4CH08 FLUID FLOW OPERATION-LAB

Experiments:
To obtain the coefficient of discharge for the given Venturimeter and obtain its relationship with Reynolds' no.
To calibrate the given Rotameter.

To obtain the coefficient of discharge for the given orifice meter and obtain its relationship with Reynolds' no.
To study the flow and determine critical Reynolds no.

To determine the discharge co-efficient of the given v-notch.

To verify the Bernoulli's theorem.

To determine the viscosity of the given liquids using Stoke's law.

To determine the viscosity of a given liquid by measuring efflux time of a given tank. Also determine the diameter of a given capillary and compare.

To determine relation between friction factor and Reynolds number for the given flowing fluid through circular pipe.
To obtain relation between friction factor and Reynolds number for flow of water through annulus.
To determine the resistance offered by various pipe fittings and express them in terms of equipment straight pipe length.
To study characteristics curves for a centrifugal pump.

All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

4CH09 CHEMICAL ENGINEERING THERMODYNAMICS –II -LAB

List of experiments:
Critical solution temperature of phenol water system.

Critical solution temperature of phenol water system in presence of impurity like NaCl.

Critical solution temperature of phenol water system in presence of impurity like succnic acid.

Determination of boiling point elevation in presence of impurity.

Determination of freezing point depression in presence of impurity.

Study of T-X-Y Diagram.

Lowering of vapour pressure.

Study of boiling point diagram.

Study of ternary diagram.

All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

4CH10 CHEMICAL ENGINEERING OPERATIONS-I LAB (MECH. OPERATIONS) -LAB

- To study the performance of Ball Mill and find out it's crushing efficiency.

To study the performance of Jaw Crusher and find out it's crushing efficiency.
To study the performance of Crushing Rolls and find out it's crushing efficiency.

To study the settling characteristics (Free & Hindered settling) of a given suspension of particles.

To study the filtration characteristics of rotary vacuum filter.

To study the filtration characteristics of Plate and frame filter press.

To study the filtration characteristics of Leaf and sparkle filter.

To carry out differential and cumulative screen analysis of given sample of solid particles.
To determine energy consumption and crushing law constants for jaw crusher.

To determine Critical speed of Ball mill & Average particle size of the

product obtained in ball mill, **OR** Average particle size of product obtained in Bhrustone mill.

To determine area of batch thickener by conducting batch sedimentation test.

To determine efficiency of Cyclone separator.

To Determine Variation of size reduction in ball Mill by changing the residence time, size of grinding medium and material of grinding medium.

All above experiments are to be arranged in the laboratory. Minimum 8 experiments are required to be performed by the student to complete the term work.

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L : Theory Lecture	FOUR YEAR DEGREE COURSE IN BACHELOR OF TECHNOLOGY
T : Tutorial	BRANCH: CHEMICAL ENGINEERING
P : Practical	CBCS SYSTEM
D : Drawing / Design	SEMESTER PATTERN
	SEMESTER : FIFTH

Sr No.	Category	Subject Code	Subject	Teaching Scheme					Examination Scheme								
				L	T	P/D	Total Hour/ week	Credits	Duration of Papers (Hrs.)	Maximum Marks		Total	Min. Pass Marks	Max. Marks Practical		Total Marks	Maximum Passing Marks
										Theory Paper	College Assessment			External	Internal		
1	Professional Core Course	5 CH 01	Heat Transfer	3	1	-	4	4	3	80	20	100	40	---	---	---	---
2	Professional Core Course	5 CH 02	Chem. Engg. Process-I (Inorganic Chemical Technology)	3	1	-	4	4	3	80	20	100	40	---	---	---	---
3	Professional Core Course	5 CH 03	Material Science & Engineering	4	-	-	4	4	3	80	20	100	40	---	---	---	---
4	Professional Core Course	5 CH 04	Professional Elective-I	3	-	-	3	3	3	80	20	100	40	---	---	---	---
5	Professional Elective Course	5 CH 05	Open Elective- I	3	-	-	3	3	3	80	20	100	40	---	---	---	---
6	Professional Core Course	5 CH 06	Heat Transfer- Lab	-	-	2	2	1	---	---	---	---	---	25	25	50	25
7	Professional Core Course	5 CH 07	Material Science & Engineering Lab	-	-	2	2	1	---	---	---	---	---	25	25	50	25
Total				**16**	**2**	**4**	**22**	**20**				500				100	
Grand Total												500				100	**600**

5CH01 HEAT TRANSFER

To introduce the concepts of heat transfer to enable the students to design components subjected to thermal loading.

SECTION-A

UNITI: Importance of heat transfer in chemical process industries. Modes of heat transfer, steady state conduction in one dimension. Fourier's law. Heat transfer through plane, cylindrical and spherical walls, compound resistance in series, thermal insulation, critical and economic thickness. Extended surface equipments, types, their design and operation. **(7)**

UNIT II: Heat transfer by convection, film concept, individual and overall coefficients and factors affecting them. Natural and forced convection. Dimensional analysis applied to heat transfer. Dittus-Boelter equation, Limitations and application. Theories of heat& Mass transfer & analogy between momentum & heat transfer.. **(7)**

UNIT III: Heat transfer by parallel and counter current flow, concept of log mean temperature difference, rate of heat transfer. Heat transfer by film wise and drop wise condensation in horizontal & vertical tube. Process design of condenser **(7)**

SECTION-B

UNIT IV: Heat exchange equipments and their design, double pipe, parallel, counter current, shell and tube heat exchangers, fouling factors, concepts of transfer units in heat exchangers, NTU concept for heat exchangers. Compact Exchangers, plate, plate fin, Spirals etc construction, features advantages, limitation & their process design aspects. **(8)**

UNIT V: Boiling and Evaporators: Theory of boiling. Classification, types and field applications of evaporators. Single and multiple effect evaporators. Heat transfer in agitated vessels, jackets, coils etc. **(8)**

UNIT VI: Heat transfer by radiation, concept of black body, Kirchhoff's law, Stefan's law, Black and gray body radiation, view factors luminous and non-luminous gases. Heat transfer in packed and fluidized beds. Recent developments and technological forecasting in heat transfer. **(8)**

Text Books:

Heat Transfer by Sukhatme
Heat Trasnfer by Mc Adams
Process Heat Transfer By Kern D. Q.
Process Heat transfer By G Hewitt

Reference Books:

Unit Operations of Chemical Engineering by McCab and Smith
Chemical Engineering by Coulson & Richardson, Vol. I
Heat Transfer byR.C.Sachdeva

5CH02 CHEMICAL ENGINEERING PROCESS-I

(Inorganic Chemical Technology)

Chemical Engineers are trained primarily to work in chemical industries. Its basic purpose is to start from one ore or other chemical raw material and end up with a consumer product through series of chemical and physical changes, and here it differs from other manufacturing industries which are assembly industries not creative industries. It will be shown in the study of a number of types of chemical industrial process that the fundamentals chemistry, thermodynamics, kinetics, engineering and economics are always valid.

Objective:

After studying this subject the chemical engineering student will have a comprehensive picture of the chemical industry, particularly as to the reasons and the basis for many and diverse operations which are carried out in process.

SECTION A

UNIT-I : 1. Sugar and Starch Industries: Sugar, Starches and related products.
2. Soap and Detergents: Detergents, Soap and Glycerin. **(7)**

UNIT-II: 1. Pulp and Paper Industries: Types, raw materials, manufacture of pulp and paper.
2. Cement and Lime Industries: Portland Cement, types, raw materials, setting and hardening of cement, manufacturing processes of Portland cement; Manufacture, use of lime and gypsum. **(8)**

UNIT-III: 1. Industrial Gases: Manufacture and application of carbon dioxide, hydrogen, oxygen, nitrogen.
2. Fuel Gases: Manufacture and uses of producer gas, water gas, natural gas, synthesis gas. **(8)**

SECTION B

UNIT-IV: 1. Acids: Sulfuric acid, nitric acid, hydrochloric acid.
2. Fertilizer Industry: Manufacture of ammonia, urea, diammonium phosphate, super phosphates (SSP and TSP)
(8)

UNIT-V: Principles of electro-chemical technological process; Electrolytic process in igneous and molten system; caustic soda, chlorine.
(7)
UNIT-VI: Electro-thermal Industries: aluminum, lithium, titanium. Electro-chemical sources of energy and storage. **(7)**
Note: The students are expected to visit the various industries to have a thorough understanding of the subject.
Text Books:
Austin, G.T., "Shreve's Chemical Process Industries ", Fifth Edition, McGraw-Hill International Book Co, Singapore, 1984.
Dryden, C.E., "Outlines of Chemical Technology ", Edited and Revised by Gopala Rao M.and M. Sittig, Third edition, Affiliated East-West press, 1997

Reference Books:
Kent, J.A., "Riggel's Hand Book of Industrial Chemistry ", 7th Edition, Van Nostrant Reinhold, 1974.
CHEMTECH 1-4, "Chemical Engineering Education Development Centre ", I.I.T., Madras 1975-78.

5CH03 MATERIAL SCIENCE & ENGINEERING
Materials Science & Engineering is the study of mechanical, physical, and chemical properties of engineering materials, such as metals, ceramics, polymers, and composites.
Objectives: The objective of a Materials Engineer is to predict and control material properties through an understanding of atomic, molecular, crystalline, and microscopic structures of engineering materials.
SECTIONA
UNIT I: Introduction to materials and their principle properties, Simple stresses and strains, Concept of stress, strain, shear stress, shear strain, Hooks law, Elastic limit, stress-strain curve for mild steel and elastomeric materials, factor of safety, Poisson's ratio, Strain energy due to axial load and impact. Introduction to determination of mechanical properties of materials ASTM methods. **(7)**
UNITII: Basic principles in their selection for fabrication and erection of chemical plant. Testing of materials, destructive and nondestructive tests, structure of atom and chemical bonds, crystal structures and their influence on material properties, Deformation and slip processes. **(7)**
UNIT III: Metals and their alloys: Iron – carbon diagram, Ferrous and nonferrous alloys, mild steel, special steels, stainless steels, brasses, brasses, aluminum alloys and titanium alloys, high and low temperature material, insulation, refractories. Methods for fabrication, rolling, bending, central punching, revetting, welding. Nickel and its alloys: aluminum and its alloys. **(8)**

SECTION B
UNITIV: Corrosion and its control: Corrosion attack methods, Different types of corrosion: chemical, biochemical, and electrochemical; Internal and external factors affecting corrosion of chemical equipments, Methods to minimize corrosion, corrosion charts for process equipments.
Polyaniline and anticorrossive surface coatings electrochemical corrosion prevention corrosion case studies from the chemical industry. **(8)**
UNIT V: Polymers, natural and synthetic: Selection of polymetric materials for equipment linings, fiber reinforced plastic, application of special polymers like Nylon 66, Teflon in engineering. Polymer
Composites. **(7)**
UNIT VI: Ceramic and glasses: Definition of ceramics and glasses; interaction between structure, processing, and properties; Applications of ceramic and glass materials; Crystalline and noncrystalline ceramics, silicates, refractories, clays, cements, glass vitreous silica, and borosilicate.**(7)**
Text Books:
James F. Shacketford, Introduction to Material Science, McMillan publishing company, New York ISBN 1990
D.Z. Jestrazebaski, Properties of Engineering Materials, 3rd Ed. Toppers. Co. Ltd.

Reference Books:
J.L. Lee and Evans, Selecting Engineering materials for chemical and process plants, Business Works 1978
Design of machine elements, Spott M.M. Prentice Hall
A text book of machine design, Khurmi R.S. and Gupta J.K.
Material Science & Metallurgy for Engineers, Dr.V.D.Kodgire, Everest Publishing House.
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PROFESSIONAL ELECTIVE-I

5CH04 (1) AIR POLLUTION CONTROL
Objective:
This subject covers the sources, characteristics and effects of air pollution and the methods of controlling the same. The student is expected to know about source inventory and control mechanism.
SECTION A

UNIT I: Sources of air pollution: Classification of air pollutants – Particulates and gaseous pollutants – Sources of air pollution
–Source inventory. **(7)**

UNIT II: Effects of air pollution: Effects of air pollution on human beings, materials, vegetation, animals – global warming-ozone layer depletion, Sampling and Analysis – Basic Principles of Sampling – Source and ambient sampling – Analysis of pollutants – Principles. **(8)**

UNIT III: Dispersion of pollutants: Elements of atmosphere – Meteorological factors – Wind roses – Lapse rate – Atmospheric stability and turbulence – Plume rise – Dispersion of pollutants – Dispersion models–Applications. **(7)**

SECTION B

UNITIV: Air Pollution Control: Concepts of control – Principles and design of control measures – Particulates control by gravitational, centrifugal, filtration, scrubbing, electrostatic precipitation – Selection criteria for equipment - gaseous pollutant control by adsorption, absorption, condensation, combustion –Pollution control for specific major industries. **(8)**

UNITV: Air Quality Management: Air quality standards – Air quality monitoring– Preventive measures - Air pollution control efforts– Zoning – Town planning regulation of new industries – Legislation and enforcement – Environmental Impact Assessment and Air quality. **(8)**

UNITVI: Sampling and Analysis: Basic principle of sampling – Statistical Techniques - Source and ambient sampling – Analysis of Gaseous and Particulate pollutants - Standards. **(7)**

Text Books:

Anjaneyulu, D., "Air Pollution and Control Technologies", Allied Publishers, Mumbai, 2002
Rao, C.S. Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Delhi,1996

Reference Books:

Rao M.N., and Rao H.V.N., Air Pollution Control, Tata-McGraw-Hill, New Delhi,1996
W.L.Heumann, Industrial Air Pollution Control Systems, McGraw- Hill, New Yark,1997
Mahajan S.P., Pollution Control in Process Industries, Tata McGraw- Hill Publishing Company, New Delhi, 1991
Peavy S.W., Rowe D.R. and Tchobanoglous G. Environmental Engineering, McGraw Hill, New Delhi, 1985
Garg, S.K., "Environmental Engineering Vol. II", Khanna Publishers, New Delhi
Mahajan, S.P., "Pollution Control in Process Industries", Tata McGraw-Hill, New Delhi,1991

(2) ECONOMICS & MANAGEMENT

Engineers are trained primarily to work in industries, market as managers. They should have knowledge about the basic concepts of economics, latest developments in the field, foreign trades, banking, etc. As a manger they should have basic knowledge about management from production to marketing.

Objective:

After studying this subject the engineering student will have understanding of the happenings in the field of economics and preliminary idea about management.

SECTION A

UNIT-I: Nature and scope of economics, Demand and Supply, Demand: concepts, specification, types of demand. Demand Analysis: significance of demand analysis, law of diminishing utility, consumer surplus. Demand Forecasting: concept of forecasting, types of forecast, steps in demand forecasting, techniques of demand forecasting. **(8)**

UNIT-II: Market: Meaning, types of market – Perfect Competition, Monopoly, Oligopoly, Monopolistic Competition. Inflation: Causes, measurement, effects, controlling of inflation. **(7)**

UNIT-III: Nature and characteristics of Indian economy, Privatization – meaning, merits and demerits. Globalisation of Indian economy – merits and demerits. Concepts of VAT, WTO, GATT & TRIPS agreement, Banking, Foreign exchange.
(8)

SECTION B

UNIT-IV: Basic concepts and functions of Management, Personal Management. Production Management: Definition, Objectives, Functions and Scope, Production Planning and Control; its significance, stages in production planning and control. Concepts of material management, inventory control; its importance and various methods. **(8)**

UNIT-V: Marketing Management: Definition of marketing, marketing concept, objectives and functions of marketing. Marketing Research – Meaning; Definition; objectives; Importance; Limitations; Process.
Advertising – meaning of advertising, objectives, functions, criticism. **(7)**

UNIT-VI: Financial Management: Introduction, Objectives of Financial Management, Functions and Importance of Financial Management. Concept of capital structure and various sources of finance. **(7)**

Text Books:

Modern Economic Theory – K.K. Dewett, S.Chand

Principles and Practice of Management: R.S. Gupta, B.D.Sharma,

N.S. Bhalla Kalyani Publishers

Reference Books:

Principles of Economics: P.N. Chopra (Kalyani Publishers).

Micro Economic Theory – H.L. Ahuja (S.Chand)

Indian Economy: Rudar Dutt & K.P.M. Sundhram

Principles & Practices of Management – L.M. Prasad (Sultan Chand & Sons)

Marketing Management – S.A. Sherlikar (Himalaya Publishing House, Bombay).

Financial Management – I.M. Pandey (Vikas Publishing House, New Delhi)

OPEN ELECTIVE-I

5CH05 RISK AND SAFETY MANAGEMENT

Public awareness of hazards and risks has enhanced the importance of safety assessment andmanagement in today's increasingly litigious society. Worldwide the burden of responsibility for safety is shifting towards those who own, manage and work in industrial and commercial organizations. The management of safety and risk needs to be integrated into the overall

management of the organization. It should be appropriate and cost- effective without dampening the innovative entrepreneurial spirit of employees with inflexible bureaucratic rules and procedures. An organization's exposure to potential hazards needs to be managed so as to reduce the chance of loss and mitigate any effects. Risk and safety issues need to be evaluated in a structured and calculated manner but in the light of an overall organizational strategy.

SECTIONA

UNIT-I: Hazard identification methodologies, risk assessment methods - PHA, HAZOP, MCA, ETA, FTA, consequence analysis, probit analysis. **(8)**

UNIT II : Hazards in work places - nature and type of work places, types of hazards, hazards due to improper house-keeping, hazards due to fire in multi-floor industries and buildings, guidelines and safe methods in the above situations. **(7)**

UNIT- III: Workers' exposures to hazardous chemicals, TLVs of chemicals, physical and chemical properties of chemicals leading to accidents like fire explosions, ingestion and inhalation, pollution in work places due to dangerous dusts, fumes and vapours, guidelines and safe methods in chemicals handling, storage and entry into confined spaces. **(8)**

SECTION B

UNIT- IV: Hazards peculiar to industries like fertilizer, heavy chemicals, petroleum, pulp and paper, tanneries, dyes, paints, pesticides, glass and ceramics, dairy and sugar industries, guidelines for safeguarding personnel and safeguarding against water, land and air pollution in the above industries. **(8)**

UNIT- V: Safety education and training - safety management, fundamentals of safety tenets, measuring safety performance, motivating safety performance. **(7)**

UNIT VI: Legal aspects of industrial safety, safety audit. **(7) Text Books:**

F. P. Lees, "Loss prevention in process industries", 2nd, Butterworth-Heinemann, 1996.

W. Handley, "Industrial safety handbook", 2nd ed., McGraw-Hill, 1977.

Reference Books:

S. P. Levine, "Protecting personnel at hazardous waste sites", Martin- Butterworth, 1971.

R. P. Blake, "Industrial safety", Prentice Hall, 1953.

D. Patterson, "Techniques of safety management", McGraw-Hill, 1978.

5CH06 HEAT TRANSFER - LAB

List of Experiments:

Heat conduction

Natural convection

Thermal radiation-determination of emissivity

Double pipe heat exchanger

Shell and tube heat exchanger

Plate Heat exchanger

Heat transfer in agitated vessels

Double effect evaporator

Open pan evaporator

Heat pipe demonstrator

Fluidized bed heat transfer

Note: The students should perform minimum EIGHT experiments from the list to complete the term. All experiments in this list shall be available in the laboratory. Additional experiments relevant to the syllabus may be added to the main list.

5CH07 MATERIAL SCIENCE & ENGINEERING-LAB

List of Experiments:

Microstructure observation and study of metals and alloys. (Minimum five) low carbon steel, medium carbon steel, high carbon Steel, tin, bronze, brass, phosphor bronze.

Study of properties of polymeric materials; impact test and polymeric Tests.

Corrosion testing (salt spray test for different samples such as plain carbon steel, chrome plate steel, galvanized steel.)

Different types of hardness test on metals, i.e. Rockwell hardness test, Brinell hardness test, Shore scleroscope tests.

Izod and Charpy impact test on mild steel, copper, brass and aluminium.

Chemical analysis of metals and alloys (Any one element to be analysed e.g. molybdenum from stainless steel, carbon from steel, copper from brass etc.

Macrostructure observation: (flow lines observation in forging by macro etching sulphur printing of steel.)

Study experiments based in, i) Dye penetration ii) Rubber lining,

iii) Ultrasonic test, iv) Heat treatments.

Note: The students should perform minimum 8 experiments from the list to complete the term. All experiments in this list shall be available in the laboratory. Additional experiments relevant to the syllabus may be added to the main list.

Note – An orientation programme/Mooc courses of 15 hr duration on **Indian Constitution** to be offered to the students during fifth semester

List of open Elective offered by chemical engineering department
Risk & Safety Management

List of Professional Elective
Air Pollution Control
Economics & Managment

NOTES:

An Orientation Program / MOOC Courses of 15 hours duration on '**Indian Constitution'** to be offered to the students during the Fifth Semester.

Students have to select the **Open elective**-I from the other disciplines, offered by other departments or specialize expertise available in the institute.

List of **Open Elective-I** offered by Chemical Engineering Department**:**

Risk & Safety Management

List of **Professional Elective-I** :

Air Pollution Control

Economics and Management

Polymer Science and Technology Subject can be opt by students from chemical engineering and all other engineering descipline – **Offered by expertise from Polymer Technology**

L : Theory Lecture T : Tutorial P : Practical D : Drawing / Design	FOUR YEAR DEGREE COURSE IN BACHELOR OF TECHNOLOGY BRANCH: CHEMICAL ENGINEERING CREDIT GRADE SYSTEM SEMESTER PATTERN **SEMESTER : SIXTH**

Sr. No.	Category	Subject Code	Subject	Teaching Scheme					Examination Scheme								
				L	T	P/ D	Total Hours /week	Credits	Duration of Papers (Hrs.)	Maximum Marks		Total	Min. Pass Marks	Max. Marks Practical		Total Marks	Maximum Passing Marks
										Theory Paper	College Assessment			External	Internal		
1	Professional Core Course	6 CH 01	Chemical Engg. Operation-II (Mass Transfer-I)	3	1	-	4	4	3	80	20	100	40	---	---	---	---
2	Professional Core Course	6 CH 02	Chemical Engg Process –II (Organic Chemical Technology)	3	-	-	3	3	3	80	20	100	40	---	---	---	---
3	Professional Core Course	6 CH 03	Computer Programming & Application	3	1	-	4	4	3	80	20	100	40	---	---	---	---
4	Professional Core Course	6 CH 04	Professional Elective- II	3	-	-	3	3	3	80	20	100	40	---	---	---	---
5	Professional Elective Course	6 CH 05	Open Elective - II	3	-	-	3	3	3	80	20	100	40	---	---	---	---
6	Professional Core Course	6 CH 06	Chemical Engg. Operation-II (Mass Transfer)- I Lab	-	-	2	2	1	---	---	---	---	---	25	25	50	25
7	Professional Core Course	6 CH 07	Computer Programming & Application-Lab	-	-	2	2	1	---	---	---	---	---	25	25	50	25
8	Project	6 CH 08	Minor Project /Skill Laboratory /Innov. Lab.	-	-	2	2	1	---	---	---	---	---	25	25	50	25
Total				**15**	**2**	**6**	**23**	**20**				500				150	
Grand Total												**500**				**150**	**650**

6CH01 CHEMICALENGINEERING OPERATION-II (MASS TRANSFER-I)

SECTION-A

UNITI: Importance of Mass Transfer Operation. Classification of mass transfer, operations based on gasliquid-solid contacts. Concepts of flux, resistance, driving force, equilibrium, direction of mass transfer, Dimensionless numbers in mass transfer. Diffusion, Fick's law I and II,
Dependence of diffusivity on physical properties, Schmidt's no. calculation, Determination of diffusivity in liquid-liquid, gas-gas, gas-liquid diffusion. **(7)**

UNITII: Interphase mass transfer, various coefficient of mass transfer and their determination, resistance concept, controlling phase concept, Mass transfer in turbulent flow, Analogies of mass transfer, Empirical equations. Theories of mass transfer, two film theory, Higbies penetration theory, Derivation of flux equation, surface renewal theory, Applications and problems.
(7)

UNIT III: Absorptions, stagewise absorption, material balance overall, stepwise minimum irrigation rate, Absorption and stripping factor calculation of number of stages, McCabe-Thiele graphical method, Kremsor-Brown-Sounder's equation. Equipments of absorption, tray towers, packed towers. Continuous absorption, concept of HTU, NTU, HETP, comparison with stepwise columns, design concepts, determination of height and diameter of packed absorption column. **(8)**

SECTION-B

UNIT IV: Adsorption: Adsorption equilibria, types of adsorption, properties of adsorbents, single and multi-stage adsorption, adsorption isotherms, principles of adsorption, Break through curves, adsorption of liquids, basic equations, adsorber design, adsorption equipments. Ion Exchange: Principles of ion exchange, techniques and applications, Ion exchange equilibria, rate of ion exchange. **(7)**

UNIT V: Drying and humidification: Principles of drying, phase equilibrium, cross circulation drying, through circulation drying, drying of suspended particles, rate of drying curve, dryers for solids and pastes, dryers for solutions and slurries,
i.e. various types of dryers, Humidification: Terms, definitions, wet bulb temp., dry bulb temperature and measurement of humidity, adiabatic saturation temperature, study of

temperature humidity chart, Enthalpy-humidity charts, determination of humidity, and concept of dehumidification, equipments for humidification operations. **(8)**

UNIT VI: Crystallisation: Principles of crystallisation, equilibria, calculation of yield, heat effects, crystal growth, properties of crystals nucleation, fractional crystallisation, caking of crystals, Various types of crystallise's and their applications. Membrane separation process, Types of membrane, separation of gases, separation of liquids, Dialysis, Reverse Osmosis, pervaporisation, desalination. Recent developments in mass transfer operation. **(8)**

Text Books:

Unit Operation in Chemical Engineering: W.L. McCabe & J.C. Smith, McGraw Hill

Mass Transfer Operation: R.E. Treybal

Reference Books:

Mass Transfer: T.K. Sherwood, R.I. Pigford, McGraw Hill

Chemical Engineering: Coulson & Richardson

6CH02 CHEMICAL ENGINEERING PROCESS-II

(Organic Chemical Technology)

Chemical Engineers are trained primarily to work in chemical industries. Its basic purpose is to start from one ore or other chemical raw material and end up with a consumer product through series of chemical and physical changes, and here it differs from other manufacturing industries which are assembly industries not creative industries. It will be shown in the study of a number of types of chemical industrial process that the fundamentals chemistry, thermodynamics, kinetics, engineering and economics are always valid.

Objective:

After studying this subject the chemical engineering student will have a comprehensive picture of the chemical industry, particularly as to the reasons and the basis for many and diverse operations which are carried out in process.

SECTIONA

UNITI: 1. Fermentation Industries: Industrial alcohol, absolute alcohol, wine.

2. Organic acid production: Acetic acid, lactic acid, citric acid.

(7)

UNITII: 1. Polymerization Industries: Polyethylene, polypropylene, PVC, polyester synthetic fibers.

2. Rubber Industries: Natural rubber, synthetic rubber, SBR.

(8)

UNIT III: 1. Petroleum Refinery: Refining of crude oil, products of refining.
2. Petrochemicals: Significant petrochemicals and their derivatives. **(8)**
SECTION B
UNITIV: 1. Nitration: Nitration agents, kinetics, mechanism, industrial preparation of nitrobenzene, nitronaphthalene, chloro- nitronaphthalene, nitroacetanilide.
2. Sulphonation and Sulfation: agents, kinetics, mechanism, technical preparation of aliphatic sulphonates, sulphonation of lauryl alcohol, dimethyl ether. **(8)**
UNITV: 1. Hydrogenation: Catalytic hydrogenation, kinetics, mechanism, hydrogenation of fatty oils, synthesis of methanol.
2. Hydrolysis: Hydrolysis of fat, carbohydrate, starch: Manufacture of ethanol from ethylene, manufacture of phenol. **(7)**
UNITVI: 1. Halogenation: Technical preparation of halogen compounds- allyal chloride, DDT, BHC, chlorobenzene, vinyl chloride.
2. Oxidation: Liquid and vapour phase oxidation, technical oxidation of isopropyl benzene, naphthalene, benzene, ethyl benzene, naphthalene sulfonic acid. **(7)**
Note: The students are expected to visit the various industries to have a thorough understanding of the subject.
Text Books:
P.H. Groggins, "Unit Processes in Organic Synthesis", McGraw Hill Book Co., Kogakusha (1984)
J.A. Kent, "Riegel's Hand book of Industrial Chemistry", 7th Edition, Van Nostrand Reinhold Co., New York (1974)

Reference Books:
Peter Wiseman, "An Introduction to Industrial Organic Chemistry", 2nd Edition, Applied Science Publishers Ltd., London (1979)
CHEMTECH 1-4, "Chemical Engineering Education Development Centre ", I.I.T., Madras 1975-78

6CH03 COMPUTER PROGRAMMING & APPLICATIONS

Application of the following techniques is for problems of interest in chemical engineering, writing and testing of programs in C Language.

SECTION-A

UNIT I: Numerical solution of first order differential equations with initial condition, Euler's method,Runge-Kutta method. **(7)**

UNIT II: Systems of linear equations, solution by the method of determinants, matrix inversion for the solution of linear equations, Gauss elimination method. **(7)**

UNIT III: Roots of algebraic and transcendental equation, iteration methods, Regula-Falsi method, Newton-Raphson method, roots of simultaneous and solution set of transcendental and algebricequations. Development of equations for heat transfer, fluid mechanics and reaction engineering problems. **(8)**

SECTION-B

UNITIV: Regression analysis - Least Square, error approach, approximation by Chebychev orthogonal polynomial. **(7)**

UNIT V: Elements of optimization techniques, single variable function, optimization-direct search, with and without acceleration, method of regular intervals and fibonacci search method, gradient methods. **(8)**

UNIT VI: Computer programming in modular form, use of subroutine libraries, Block diagrams of preliminary aids in programming, capacity optimization. **(8)**

Text Books:

1. Digital Computation for Chemical Engineering by Leon Lapidas, McGraw Hill.

PROFESSIONAL ELECTIVE-II

6CH04 (1) PROCESS EQUIPMENT - DESIGN & DRAWING

SECTION - A

UNITI: Material behaviour under stresses, theories of failures. **(7)**

UNITII: Fabrication methods and their effects: Design method for atmospheric storage vessels, unfired pressure vessel subjected to internal and external pressure. **(7)**

UNIT III: Vessels for high pressure operations, Agitated vessels. Tail columns, internals of the reactors. **(8)**

SECTION - B

UNITIV: Design of process equipment accessories and support systems.(7)

UNITV: Complete design and preparation of working drawing for typical process equipment, such as large storage vessels, thick wall pressure vessels. Self supported tall columns, agitated pressurevessels with heat transfer requirements etc. **(8)**

UNITVI: Design and layout of piping system and preparation of piping diagram for a typical process. Material selection and piping coding. **(8)**

Note: Drawings of minimum eight design problems are expected.

Text Books:

Process Design of Equipments: S. D. Dawande

Process Equipment Design: M.V. Joshi, McMillan

Reference Books:

Introduction to Chemical Engineering Design, Mechanical Aspects

I.S. Code for Unfired Pressure: IS No. 2825 - 1969 pressure vessel

Process Equipment Design: I.E.Brownell, E.H.Young, John Wiley

International & Indian Standard codes for Piping

(2) Fuel Technology

COURSE OUTLINE

Fuels and combustion technology course is required at various Indian universities and IITsas a part of the degree courses. This course is also useful to post graduate students researchers, teachers and technical personnel. It may become a useful guide to industry The course introduces basic knowledge about solid, liquid and gaseous fuels, their origin classification, preparation procedure and characterization in terms of physico-chemica properties. In Solid fossil fuels coal is the main fuel which is focused here. Coal mining cleaning and its combustion processes are the main feature of discussion in the section of Solid fuel. In Liquid fuel section, petroleum is the liquid fuel which is elaborated in terms of exploration, evaluation, distillation and secondary processing. Different important gaseous fuels are included in Gaseous fuel section. Emphasis is given to combustion of various fuels in the light of thermodynamics and various combustion appliances are discussed in Combustion technology section. Requisite mathematical examples with their step-wise solutions are also included in the course. Where ever required, concepts are illustrated with schematic and block diagrams..

SECTION A

UNIT-I

History of Fuels, History of solid fuel, History of liquid fuels and gaseous fuels, Production, present scenario and consumption , pattern of fuels, Fundamental definitions, properties and various measurements,

UNIT-II

Definitions and properties of solid fuels, Definitions and properties of liquid and gaseous fuels, Various measurement techniques,

UNIT-III

Coal classification, composition and basis, Coal mining, Coal preparation and washing
Combustion of coal and coke making, Action of heat on different coal samples, Different types of coal combustion techniques, Coal tar distillation, Coal liquefaction, Direct liquefaction, Indirect liquefaction,Coal gasification,

SECTION -B

UNIT-IV

Exploration of crude petroleum,Evaluation of crude Distillation, Atmospheric distillation, Vacuum distillationSecondary processing, Cracking, Thermal cracking, Visbreaking,Coking,Catalytic cracking

UNIT-V

Reforming of naphtha Refinery equipments,Natural gas and LPG,Producer gas,Water gas,Hydrogen, Acetylene, Other fuel gases,Fundamentals of thermochemistry,

UNIT-VI

Combustion air calculation, Calculation of calorific value of fuels, Adiabatic flame temperature calculation, Mechanism and kinetics of combustion, Flame properties, Combustion burners , Combustion furnaces,Internal combustion engines

References:

Modern Petroleum Technology, Vol 1, Upstream, Ed. by Richard A. Dave, IP, 6th ed., John Wiley & Sons. Ltd.
Modern Petroleum Technology, Vol 2, Downstream, Ed. by Alan G. Lucas, IP, 6th ed., John Wiley & Sons. Ltd.
Combustion, Irvin Glassman, 2nd ed., Academic Press.
Modern Petroleum Refining Processes, B.K. Bhaskar Rao, 4th ed., Oxford & IBH Publishing Co. Pvt. Ltd.
Report on the project "Coal Combustion Study", sponsored by Tata Tron and Steel Company Ltd., Jamshedpur.
Fuels Combustion and Furnaces, John Griswold, Mc-Graw Hill Book Company Inc. Fuels and Combustion, Samir Sarkar, 3rd. ed Universities Press.
Petroleum Refinery Engineering, W.L. Nelson, 4th ed. Mc-Graw Hill Book Company

OPEN ELECTIVE-II

6CH05 (1) RENEWABLE ENERGY SOURCES

Objectives:

To explain concept of various forms of renewable energy
To outline division aspects and utilization of renewable energy sources for both domestics and industrial applications
To analysis the environmental and cost economics of using renewable energy sources compared to fossil fuels.

Course-Outcome:

At the end of the semester the student will have knowledge about various renewable energy sources and be able to choose the appropriate renewable energy as an alternate for conventional power in any application.

SECTION A

UNIT I : Solar-Energy : Solar radiation its measurements and prediction - solar thermal flat plate collectors concentrating collectors - applications - heating, cooling, desalination, power generation, drying, cooking etc - principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications: battery charger, domestic lighting, street lighting, and water pumping, power generation schemes.(7)

UNITII: Wind-Energy : Atmospheric circulations - classification - factors influencing wind - wind shear - turbulence - wind speed monitoring - Betz limit - Aerodynamics of wind turbine rotor- site selection - wind resource assessment - wind energy conversion devices - classification, characteristics, and applications. Hybrid systems - safety and environmental aspects.
(8)

UNIT III: Bio-Energy : Biomass resources and their classification - chemical constituents and physicochemical characteristics of biomass - Biomass conversion processes - Thermo chemical conversion: direct combustion, gasification, hydrolysis and liquefaction - biochemical conversion: anaerobic digestion, alcohol production from biomass - chemical conversion process: hydrolysis and hydrogenation. Biogas - generation - types of biogas Plants- applications. **(7)**

SECTION B

UNIT IV : Hydrogen and Fuel Cells: Thermodynamics and electrochemical principles - basic design, types, and applications, production methods, Biophotolysis: Hydrogen generation from algae biological pathways, Storage gaseous, cryogenic and metal hydride and transportation. Fuel cell: principle of working, various types, construction and applications. **(8)**

UNIT V: Other Types of Energy : Ocean energy resources, principles of ocean thermal energy conversion systems, ocean thermal power plants, principles of ocean wave energy conversion and tidal energy conversion, hydropower, site selection, construction, environmental issues, geothermal energy, types of geothermal energy sites, site selection, and geothermal power plants. **(8)**

UNIT V: Analysis of the cost effectiveness of renewable energy sources, present status, comparison, forecast. **(7)**

Text Books:

Rai G. D., Non-conventional Energy Sources, Khanna Publishers, New Delhi,2007
John Twidell, Tony Wier, 'Renewable Energy Sources', Taylor & Francis Publishers, New York, 2005

Reference Books:

Sukhatme, S.P., Solar Energy, Tata McGraw - Hill Publishing Company Limited, 2006
Khandelwal K.C, Mahdi S.S., Biogas Technology - A Practical Handbook, Tata McGraw Hill, 1986
Thomas .b. Johansson, Henry Kelly, Amulya K.N .Reddy, Robert
.H. Williams, 'Renewable Energy Sources for Fuels and Electricity', Island Press, Washington DC, 2009
Anthony San Pietro, Biochemical and Photosynthetic aspects of Energy Production, Academic Press, 1980

(2) WATER TECHNOLOGY

Objectives: To make the students aware about the issues involved in water and water quality aspects and also to learn about physical, chemical and biological techniques available for managing water quality.

SECTION A

UNIT I: Conventional water and waste water treatment methods, their capabilities and limitations, Need for advanced treatment of water and waste water. **(7)**

UNITII: Advanced water treatment- Iron and manganese removal, colour and odour removal, activated carbon treatment, carbonate balance for corrosion control, ion exchange, electro-dialysis, reverse osmosis and modern methods and flouride management. **(8)**

UNIT III: Advanced waste water treatment- Nutrient control in effluents, Nitrogen and phosphorus removal methods including biological methods, Methods for the removal of heavy metals, oil and refractory organics. **(7)**

SECTION B

UNITIV: Microsreening, ultra-filtration, centrifugation and other advanced physical methods- aerobic digestion, anaerobic filtration, rotating biological contractor, novel methods of aeration etc. **(7)**

UNITV: Combined physico-chemical and biological processes, Activated carbon treatment, chlorination of waste water, Pure oxygen systems. **(8)**

UNITVI: Filtration for high quality effluents, multistage treatment systems, Land treatment and other resources recovery systems. **(8)**

Text Books:

Introduction to Environmental Engineering, By P.A. Veslind, PWS Publishing Company, Boston, 1997

Activated Sludge Process: Theory and Practices, By N.F Grey, Oxford University Press, 1990.
Reference Books:
Wastewater Treatment and disposal, By S.J. Arceivalla, Marcel Dekker, 1981.
Wastewater Treatment Plant Planning, Design and Operation, By
S.R. Quasim, Holt, Rinehart & Winston N.Y.

6CH06 CHEMICALENGINEERING OPERATION-II LAB (MASS TRANSFER-I)

List of Experiments:

To calculate the diffusivity of vapors of volatile liquid into air by Stefan's tube. (Winklemann's Experiment)
To find coefficient of mass transfer of naphthalene ball in stagnant air.
To find yield of crystallization with and without seeding.
To establish Freundlich and Langmuir isotherm.
To determine liquid diffusion coefficient of solute diffusing in water.
To determine the critical moisture content of given material.
To measure humidity of air from humidifier.
To study unsteady state adsorption.
To compare the mass transfer in stagnant infinite medium in laminar and turbulent flow.
To determine gas film mass transfer coefficient by wetted column for G/L system.
Use of humidity or psychometric chart.
To compare the mass transfer coefficient for different liquids from free surface by evaporation.
Separation of $NaNO_3$ by fractional crystallization.
To study the efficiency of tray drier.

Note: The students should perform minimum EIGHT experiments from the list to complete the term. All experiments in this list shall be available in the laboratory. Additional experiments relevant to the syllabus may be added to the main list.

6CH07 COMPUTER PROGRAMMING & APPLICATIONS - LAB

List of Experiments:

Design an algorithm, draw a flow chart and write program to perform addition, subtraction, multiplication and division of two numbers by taking two values from users.
Algorithm quadratic equation (for root of).
Program for solving ordinary differential equation with initial value of Euler's method.
To find value of unknown of simultaneous by Gauss elimination method.
To find roots of equation using Bisection method.
Algorithm for Regula-Falsi method.
Find the roots of equation by Newton-Raphsons method.
Program for modified Newton-Raphson method.
Design algorithm for regression.
Algorithm for print the grades of students using if-else-if statement.
Design algorithm and flow chart for Runga-Kutta method.
Design algorithm and flow chart to find greatest and smallest element.

Note: The students should perform minimum EIGHT experiments from the list to complete the term. All experiments in this list shall be available in the laboratory. Additional experiments relevant to the syllabus may be added to the main list.

6CH08 MINOR PROJECT/SKILL LABORATORIES/INNOVATION LABORATORIES

The students in a group of not more than four members have to work on a topic which is experimental and analytical in the area of **Chemical Engineering**. Each project shall have a guide. On completion of the work, a project report should be prepared and submitted to the Department. The project work and the report will be evaluated by an internal assessment committee for 25 marks. The university examination for 25 marks will be a Viva-Voce examination conducted by a committee of one external examiner and one internal examiner /Guide appointed by the University.

NOTE-

1. An orientation programme/Mooc courses of 15 hr duration on **Indian traditional knowledge** to be offered to the students during Sixth semester

2. List of open Elective-II offered by chemical engineering department
   a. Renewable energy Sources
   b. Water Technology

List of Professional Elective-II

a. Process Equipment Design & Drawing

b. Fuel Technology

Semester – VII CBCS B.Tech (Chemical Engg.)

Sr. No.	Category	Subject Code	Subject	Teaching Scheme					Emamination Scheme								
				L	T	P/D	Total Hours/ Week	Credits	Duration of Papers (Hrs.)	Maximum Marks		Total	Min. Pass Marks	Max.Marks Practical		Total Marks	Maximum Passing Marks
										Theory Paper	College Assessment			External	Internal		
1	Professional Core Course	7 CH 01	Chemical Engg Operation – III (Mass Transfer-II)	3	-	-	3	3	3	80	20	100	40	---	---	---	---
2	Professional Core Course	7 CH 02	Chem. Reaction Engineering – I	3	-	-	3	3	3	80	20	100	40	---	---	---	---
3	Professional Core Course	7 CH 03	Process Dynamics & Control	3	-	-	3	3	3	80	20	100	40	---	---	---	---
4	Professional Core Course	7 CH 04	Plant Design & Process Engg.	3	-	-	3	3	3	80	20	100	40	---	---	---	---
5	Professional Elective Course	7 CH 05	Professional Elective – 3	3	-	-	3	3	3	80	20	100	40	---	---	---	---
6	Professional Core Course	7 CH 06	Chemical Engg Operation – III (Mass Transfer-II)-Lab	-	-	2	2	1	---	---	---	---	---	25	25	50	25
7	Professional Core Course	7 CH 07	Chem. Reaction Engineering – I-Lab	-	-	2	2	1	---	---	---	---	---	25	25	50	25
8	Professional Core Course	7 CH 08	Process Dynamics & Control	-	-	2	2	1	---	---	---	---	---	25	25	50	25
9	Professional Elective	7 CH 09	Professional Elective-III Lab	-	-	2	2	1	---	---	---	---	---	25	25	50	25
10	Project	7 CH 10	Project & Seminar			8	8	4	---	---	---	---	---	-	50	50	25
Total				**15**	**-**	**16**	**31**	**23**				**500**				**250**	
Grand Total												**500**				**250**	**750**

SYLLABUS OF B.TECH. (CHEMICAL ENGINEERING) SEMESTERVII & VIII (CBCS)

SEMESTER: SEVEN

7CH01 CHEMICAL ENGINEERING OPERATION – III

SECTION - A

UNIT I: Liquid-liquid extraction: Liquid equilibria, Representation in equilateral triangular and rectangular coordinates, choice of solvent: Selectivity Distribution coefficient, Recoverability, Density, Determination of plait point liver rule, single and multistage extraction:
1) Cross current extraction
2) Counter current extraction, fractional extraction. Applications in petrochemical industries, extraction of nuclear fuels and recent advancements inapplications. **(8)**

UNIT II: Continuous or differential extraction, Calculation of NTU & HTU, Classification of extraction equipments, stagewise:
i) The mixer settle, Baffle plate columns, Scheibel columns.
Differential
ii) Spray column, Sieve Iray column, packed columns, pulsed columns, centrifugal extractors, and their applications, Design of continuous-contact towers. **(7)**

UNIT III: Principles of leaching, Types of equilibrium, Multistage cross- current, counter current leaching and their graphical and RAT representation. Continuous counter current decantation verify types of solid-liquid extractors, shank system, Rotocel, Ballmamn extractor, Extractor for cellular material, extraction of oil from cellular material, agricultural material and seeds. **(7)**

SECTION - B

UNIT IV: Distillation: Thermodynamics of vapour-liquid equilibrium, Relative volatility, partial pressures, Dalton's, Raoult's and Henry's laws Methods of distillations: - Differential, Flash or equilibrium, Rectification and Batch distillations No. of plates by McCabe Thiele method. **(8)**

UNIT V: Panchon savarit, Lewis method, Reflux ratio, minimum reflux ratio, and Azeotroes, Antonic,Vanlaar. Consistency of system, Generation of Vapour-liq equilibria for unknown system Herington's consistency test. **(7)**

UNIT VI: Introduction to multi component distillation Azeotroic distillation, extractive distillation, steam distillation of plate columns, Sieve trays, valve trays, plate efficiency, factors determining column performance, Bubble cap trays, Packed column : Packings, calculation of enrichment in packed column and design of distillation column. **(8)**

Text Books:

1) UnitOperation in Chemical Engineering:W.L.McCabe&J.C. Smith, Mc-Graw Hill.
2) Mass Transfer Operation: R.E. Treybal.
3) Mass Transfer by Pranav Datta.

Reference Books:

1) MassTransfer: T K Sherwood, R.I.Pigford, McGrawHill
2) Chemical EngineeringVol. II: Coulson &Richardson
3) Transport Phenomena and Unit Operations: Geankoplis.

7CH02 CHEMICAL REACTION ENGINEERING - I

SECTION - A

UNIT I: Classification of chemical reactions. Variables affecting the rates of reaction. Kinetics & Thermodynamics. Thermodynamics of chemical reactions. Classification of reactors. Order ofreaction & rate constant. **(7)**

UNIT II: Rates of Homogeneous Reactions. Fundamentals of rate equation. Rate equations from proposed mechanism Analysis of simple& complex rate equation. Evaluation of rate equation from Laboratorydata. (8)

UNIT III: Interpretation of rate data, Scale up and Design. Constant volume batch reactor. Variable volume Batch reactor. Temperature and reaction rate. **(7)**

SECTION – B

UNIT IV: Single ideal reactors. Ideal Batch Reactor. space time and space velocity, steady state mixed flow reactors, steady state plug flow reactor, Holding-time & space time for flow system. (**7)**

UNIT V: Design for single reactions Size comparison of single reactors Batch reactor, Mixed verses plug flow reactors Variation of reactant rates. General Graphical comparison. Autocatalytic reactions. **(8)**

UNIT VI: Design for multiple reactor system. Reactions in parallel & in series, series-parallel reactions. Batch recycle reactor, Flow recycle reactor. Temperature & pressure effects in single and multiple reactions. Optimum temperature profile. **(8)**

Text Books:

1) Chemical Reaction Engineering: Octane Levenspiel, Wiley Eastern Ltd.
2) ChemicalEngineeringKinetics: Smith J.M.McGrawHill.

Reference Books:

1) Reaction Kinetics for Chemical Engineers,WalasMcGrawHill
2) Elements of Chemical Reaction Engineering, H. Scott Fogler, Prentice Hall.

7CH03 PROCESS DYNAMICS AND CONTROL

SECTION - A

UNIT I : Transmit response of control systems, optimization. (7)

UNIT II: Stability, Root locus, Transient response. Application of root locus to control system. Frequency response

methods. Design ofNyquist criteria. (8)
UNIT III: Process applications,Controller mechanisms. (7)
SECTION - B
UNIT IV: Development and control systems for various chemical industries case studies. (7)
UNIT V: Introduction on advanced control techniques as feed forward, control, cascade control, ratio control, adaquative control and digital computer control. (8)
UNIT VI: Dynamics and control of chemical equipments such as heat exchangers, distillation columns, absorption column, etc. (8)
Text Books:
1) ProcessControl: Pater Harriott,McGrawHill, NewYork.
2) Process SystemAnalysis and Control: Koppel Conghawoner McGraw Hill.
Reference Books:
1) Automatic Process Control: D.P. Eckman,Wiley
2) Chemical Process Control: George Stephanopoulos - Prentice Hall of India Pvt. Ltd.
3) Process SystemsAnalysis &Control: Donald R. Coughanour,McGraw Hill.
7CH04 PLANT DESIGN & PROJECT ENGINEERING
Objectives:
Learning fundamentals and applications of chemical engineering plant design, value engineering, optimization with emphasis on chemical engineering applications, fundamentals of engineering economics and the management decision making processes that are used in engineering problem solving. Understanding the concept of interest and equivalence, learning the methods of engineering economic analysis like present worth, rate of return, annual cash flow and benefitcost ratio, depreciation, etc.
SECTION - A
UNIT I: Basic considerations in chemical engineering plant design, project identification, project identification, preliminary techno- economic feasibility, process selection, laboratory developments and its importance, pilot plant, scale-up methods, flow diagrams. Selection of process equipments: standard vs. Special equipments, materials of construction of process equipments, specification sheets. **(7)**
UNIT II: Plant Location: Objectives, levels of location problems, factors influencing location of a plant, locational analysis, selection criteria, significance, theories of plant location.
Plant Layout: Meaning of plant layout, design importance and scope, essentials, types of layout, factors influencing layout, dynamics of plant layout, planning for plant design. **(7)**

UNIT III: Cost estimation: equipment costs, cost indices, William's point sixth rule, methods of estimation of fixed capital, product cost estimation. Interest formulae and their applications, time value of money, simple and compound interest, discrete, nominal and continuous rate of return and their relationships, issue and evaluation of bonds, concept of equivalence. **(8)**
SECTION - B
UNIT IV: Depreciation: Introduction, straight line method of depreciation, declining balance method of depreciation, sum of the years- digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation. **(8)**
UNIT V: Replacement and Maintenance analysis: Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset, capital recovery with return and concept of challenger and defender, Simple probabilistic model for items which fail completely, practical factors in alternative and replacement investment. (8)
UNIT VI: Inventory control, scheduling a project using CPM/PERT, projectmanagement, optimum conditions, optimum production rates in plant operations, optimum conditions in cyclic operations, design reports. **(7)**
Text Books:
1. Max Peters, Plant design and economics for chemical engineers, McGrawHill
2. Panneer Selvam, R, Engineering Economics, Prentice Hall of India Ltd,NewDelhi, 2001.
Reference Books:
1. Chan S.Park, "ContemporaryEngineering Economics", Prentice Hall of India, 2002
2. Donald G. Newman, Jerome.P.Lavelle, "Engineering Economics and analysis" Engg. Press,Texas, 2002
7CH05 PROFESSIONAL ELECTIVE - III
(i) INDUSTRIAL WASTE TREATMENT
Objectives:
i) To impart the knowledge about disposal of effluents and the standards for disposal.
ii) To impart the knowledge about biological treatment methods and advanced treatment methods.
SECTION - A
UNIT I: Disposal Effects on Environment:
Effects of industrial wastes on streams, land, air - wastewater treatment plants - water quality criteria. Effluent standards - Process modification - Bioassay studies - Environmental legislation Pollutants Reduction: Waste minimization - House keeping - Volume and strength reduction - Material and process modifications - recycle, reuse and by-product recovery – Environmental audit. **(7)**
UNIT II: Effluent Treatment:
Conventional methods of treatment and disposal of industrial wastes - Equalization and Neutralization -

Separation of solids - Sedimentation and filtration - Coagulation and flocculation, absorption, chemical precipitation, chemical oxidation, Physiochemical treatment methods - Removal of dissolved impurities - Residue management - Combined treatment of industrial and municipal wastes. **(8)**

UNIT III: Biological Treatment Methods:

Principles and methods for removal of suspended impurities and organics - aerobic and anaerobic decomposition of organic matter, Stabilization ponds, activated sludge process,Oxidation ditch. **(7)**

SECTION - B

UNIT IV: Advanced Waste Water Treatment:

Nitrogen removal - Phosphorous removal - Removal of refractory Organics - Removal of dissolved inorganic substances - Chemical precipitation - ion exchange - ReverseOsmosis - Electrodialysis. **(8)**

UNIT V: Industrial Process and Waste Treatment – I:

Manufacturing process, waste water characteristics, composition, effects and appropriate treatment - flow sheets for chemical industries - Petro-chemical industries, Refineries, Pharmaceutical, Textiles - Apparel industries - Metallurgical industries - Steel plants, mines - Power industries - Fertilizer plants - Cement industry. **(8)**

UNIT VI: Industrial Process and Waste Treatment – II:

Manufacturing process, waste water characteristics, composition effects and appropriate treatment flow sheets for Pulp and paper industry - Agro-industries, Sugar - Distilleries, Food processing industry - meat packing, pickles, poultrydairy - Leather tanning. **(7)**

Text Books:

1. Rao.M.N. and Dutta, Waste Water Treatment, Oxford and IBH Publishing Ltd., Calcutta,2008.
2. Eckenfelder,W.W., IndustrialWaste Pollution Control, McGrawHill BookCo.,NewDelhi, 2003.
3. S C Bhatia Managing Industrial Pollution.

Reference BookS:

1. Nemerow, N.L., Theory and Principles of IndustrialWasteTreatment, Addison Wesley, Reading Mass, 1993.
2. Wastewater Engineering Treatment & Reuse Metcalf & Eddy Inc.

7CH05 PROFESSIONAL ELECTIVE - III

(ii) NEW SEPARATION TECHNIQUES

SECTION - A

UNIT I: Adsorption separations - Review of fundamentals, mathematical modelling of column contactors, pressure swing adsorption, ion chromatography, affinity chromatography, gradient chromatography, parametric pumping, counter-current, simulated counter-current and multidimensional chromatography. **(7)**

UNIT II: Membrane separation processes – basic concepts, membrane modules, structure and characteristics of membranes. **(7)**

UNIT III: Design considerations of Reverse Osmosis, Ultra Filtration, Electro Dialysis, Gas permeation membranes, Pervaporation, Nanofiltration andmicrofiltration. **(8)**

SECTION – B

UNIT IV: Detailed theories for membrane separations – concentration polarization, gel formation and fouling, mathematical models for membrane systems with and without concentration polarization, Transport inside the membranes, solution diffusion membranes, porous membranes. **(8)**

UNIT V: Surfactant based separations - fundamentals of surfactants at surfaces and in solution, liquid membrane permeation, and foam separations, micellar separations. **(7)**

UNIT VI: Supercritical fluid extraction - Physicochemical principles, thermodynamic modelling, process synthesis and energy analysis. **(8)**

Text Books:

1. P. C. Wankat, “Large scale adsorption and chromatography”, CRC Press, 1986
2. R.T.Yang, “Gas Separation byAdsorption Processes”, Imperial College Press, 1997.

Reference Books:

1. P.C.Wankat, “RateControlled Processes”, Springer Publications, 2005.
2. Seader, “Separation Process Principles”, Wiley Publication, Second Edition, 2008.
3. R. W. Rousseau, “Handbook of separation process technology”, John Wileyand Sons, 1987.
4. M. C. Porter, “Handbook of industrial membrane technology”, Noyes Publication, ParkRidge, NewJersey, 1990.
5. J. F. Scamehorn and J. H. Harwell, “Surfactant based separation processes, T. A. Hatton in Vol. 23 of Surfactant science series”,Marcel- Dekker.,1989
6. M. A. McHugh and V. J. Krukonis, “Supercritical fluid extraction”, Butterworth, 1985.

7CH05 PROFESSIONAL ELECTIVE - III

(iii) OPTIMIZATION OF CHEMICAL PROCESSESS

SECTION - A

UNIT I: Nature and organization of optimization problems, fitting models to data, method of least squares, factorial experimental designs, formulation of objective functions. **(7)**

UNIT II: Optimization theory and methods - basic concepts of optimization, optimization of unconstrained functions, one dimensional search,multivariable optimization. **(8)**

UNIT III: Linear programming and applications, nonlinear programming with constraints, optimization of staged and discrete processes. (7)

SECTION – B

UNIT IV: Optimum recovery of waste heat, optimum shell and tube heat exchanger design, optimization of heat exchanger networks. **(7)**

UNIT V: Optimization of multistage evaporators, optimization of liquid- liquid extraction processes, optimal design and operation of staged distillation columns. **(8)**

UNIT VI: 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. **(8)**

Text Books:

1. T.F.Edger and D.M.Himmelblau, "Optimization of Chemical Processes", Mc.GrawHill, 2001
2. G.S.Beveridge and R.S.Schechter, "Optimization Theory and Practice", Mc.GrawHill, 1970.

Reference Books:

1. Kalyanmoy Deb, "Optimization for Engineering Design", John Wiley, 1995
2. V.Kafarov, "Cybernetic Methods in Chemistry and Chemical Engineering",MIRPublishers, 1976.

7CH05 PROFESSIONAL ELECTIVE - III

(iv) SMART MATERIALS

SECTION - A

UNIT- I: **Introduction:** Closed loop and Open loop Smart Structures. Applications of Smart structures, Piezoelectric properties. Inchworm Linear motor, Shape memory alloys, Shape memory effect-Application, Processing and characteristics. **(7)**

UNIT- II:**Shape Memory Alloys:** Introduction, Phenomenology, Influence of stress on characteristic temperatures, Modelling of shape memory effect. Vibration control through shape memory alloys. Design considerations, multiplexing embedded NiTiNOL actuators. **(7)**

UNIT- III: **Electro rheological and Magneto rheological Fluids:** Mechanisms and Properties, Characteristics, Fluid composition and behaviour, Discovery and Early developments, Summary of material properties. Applications of ER and MR fluids (Clutches, Dampers, others). **(7)**

SECTION – B

UNIT- IV: Fibre Optics: Introduction, Physical Phenomenon, Characteristics, Fibre optic strain sensors, Twisted and Braided Fibre Optic sensors, Optical fibres as load bearing elements, Crack detection applications, Integration of Fibre optic sensors and shape memory elements. **(8)**

UNIT- V:Vibration Absorbers: Introduction, Parallel Damped Vibration Absorber, Analysis, Gyroscopic Vibration absorbers, analysis & experimental set up and observations, Active Vibration absorbers. Control of Structures: Introduction, Structures as control plants, Modelling structures for control, Control strategies and Limitations. **(8)**

UNIT-VI: Case Studies: MEMS Magnetic actuators, BP sensors, Microphone, Acceleration sensors, Gyro, MEMS Product development: Performance, Accuracy, Repeatability, Reliability, Managing cost, Market uncertainties, Investment and competition **(8)**

Text Books:

1. "Smart Structures –Analysis and Design", A.V.Srin ivasan, Cambridge University Press, New York, 2001, (ISBN:0521650267).
2. "Smart Materials and Structures", M.V.Gandhi and B.S.Thompson Chapmen & Hall, London, 1992 (ISBN:0412370107)
3. "Foundation of MEMS, by Chang Liu. Pearson Educa tion. (ISBN:9788131764756)

Reference Books:

1. Banks HT, RC Smith, Y Wang ,Smart Materials and Structures', , Massow S A, Paris 1996.
2. Clark R L, W R Saunolers ,G P Gibss,'Adaptive Structres', Jhon Wiles and Sons, New York, 1998.
3. Esic Udd, An introduction for scientists and Engineers', Optic Sensors : Jhon Wiley & Sons, New York, 1991 (ISBN : 0471830070.

7CH06 CHEMICAL ENGINEERING OPERATION–III (MASS TRANSFER-II) - LAB.

List of Experiments:

1. To prepare boiling point (B.P.) diagram and plot x-y data on the equilibriumdiagram.
2. Verification of Rayleigh's equation for differential (Batch)distillation.
3. Toconstruct equilibrium curve from vapour liquid equilibrium (VLE) data.
4. To find the composition of distillate and residue after distilling n- butanol-methyl alcohol mixture bysimple distillation.
5. To determine vaporization efficiency and thermal efficiency in case of steamdistillation.
6. Toconstruct a ternarydiagram for acetic acid –water-benzene system.
7. Tostudythe performance of sieve trayextraction column and compare it with packed column (or spraycolumn).
8. To find out number of stages in multistage continuous counter current operation and in single stage multiple contact of operation for solid liquid extraction (Leaching).
9. To compare single stage with two stage cross current liquid-liquid extraction with partiallymiscible solvent.
10. Tocompare single stagewith two stage cross current extraction for a system in which solvents are immiscible.

Note: The students should perform minimum EIGHT experiments from the list to complete the term. All experiments in this list shall be available in the laboratory. Additional experiments relevant to the syllabus may be added to the main list.

7CH07 CHEMICALREACTIONENGINEERING-I - LAB.

List of Experiments:

1. To determine the rate constant of saponification of ethyl acetate characterized byan acid likeHCL.
2. To determine the activation energy of hydrolysis of an ester such as ethyl acetate.
3. Todetermine the kinetic of reaction between ethyl acetate and sodium hydroxide at room temperature using differential method of analysis.
4. Todetermine the kinetics of reaction between ethyl acetate and sodium hydroxide at room temperature byintegral method.
5. Show that the decomposition of H2O2 in aqueous solution as first order reaction and determine value of rate constant.
6. To determine void volume porosity of catalyst particle.
7. To determine the RTDcurve for packed bed reactor.
8. Todetermine the RTDcurve for PFR.
9. Todetermine the RTDcurve for mixed flowreactor.
10. Verification of performance equation of batch reactor.

Note: The students should perform minimum EIGHT (8) experiments from the list to complete the term. All experiments in this list shall be available in the laboratory. Additional experiments relevant to the syllabusmay be addedto themain list**.**

7CH08 PROCESS DYNAMICS AND CONTROL – LAB.

List of Experiments:

1. Sketch the response of the first order system for impulse change.
2. To find the response of a bare measuring thermometer. c) +ve step change d)-ve step change.
3. To find the response ofmercury thermometer (kept in a thermal cell) for bare thermometer) +ve step change d)-ve step change.
4. To study under-damped response of manometer fluid with pressure change function.
5. To study the response of non-interacting system use in two tank for step change in flowrate.
6. To study the response level in one tank c) step change d) impulse change.
7. To verify efficiency of transportation lag when coupled with first order system.
8. To study a liquid level on-off controller.
9. To study the temperature control system.
10. To study the temperature control system.
11. To measure liquid level by bubbler system.

Note: The students should perform minimum EIGHT experiments from the list to complete the term. All experiments in this list shall be available in the laboratory.Additional experiments relevant to the syllabus may be added to the main list.

7CH09 PROFESSIONAL ELECTIVE - III - LAB.

Minimum EIGHT experiments based on the syllabus are to be performed.

7CH10 INDUSTRIAL TRAINING

During the course of study from III toVII semester each student is expected to undertake a minimum of two industrial visits and undertake a minimum of two weeks of industry/field training. The students are expected to submit a report, which shall be evaluated by an internal assessment committee at the end ofVII semester for 50marks.

07CH 11 PROJECT & SEMINAR

SEMINAR:

Each one of the students will be assigned a Seminar Topic in the current and frontier areas. The student has to conduct a detailed study/ survey on the assigned topic and prepare a report. The student will make an oral presentation followed by a brief question and answer session. The Seminar (presentation and report) will be evaluated by an internal assessment committee for 50 marks. The Seminar Report will be evaluated by external examiner appointed by the University along with the Project - VivaVoceexamination at the end ofVIII Semester.

PROJECT:

The objective of the project is to enable the students to work in groups of not more than four members in each group on a project involving analytical, experimental , design or combination of these in the area of Chemical Engineering. Each project shall have a guide. The student is required to do literature survey, formulate the problem and form a methodology of arriving at the solution of the problem. On completion of the work, a project report should be prepared and submitted to the department.

The evaluation is based on continuous internal assessment by an internal assessment committee for 75 marks bywayof oral presentations. The university examination at the end of VIII Semester carries 75 marks will be a Viva Voce examination conducted by a committee of one external examiner appointed bytheUniversityand one internal examiner/Guide.

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NOTE 1: For Professional Elective -III

The Elective course will be offered as per the availability of the faculty with College /institute & only if the number of students opting for such elective arehigher.

7CH05: PROFESSIONAL ELECTIVE –III :

Industrial Waste Treatment

New Separation Techniques

Optimization of chemical Process

Smart Materials.

NOTE 2: For Industrial Training/ Internship :

During the course of study from III to VII semester each student is expected to undertake a minimum of two industrial visits and undertake a minimum of two weeks of industry/ field training/Internship. The students are expected to submit a report, which shall be evaluated by an internal assessment committee at the end of VII semester.

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L : Theory Lecture T : Tutorial P : Practical D : Drawing / Design	FOUR YEAR DEGREE COURSE IN BACHELOR OF TECHNOLOGY BRANCH: CHEMICAL ENGINEERING CBCS SYSTEM SEMESTER PATTERN **SEMESTER : EIGHTH**

Sr. No.	Category	Subject Code	Subject	Teaching Scheme					Examination Scheme								
				L	T	P/D	Total Hours/ week	Credits	Duration of Papers (Hrs.)	Maximum Marks		Total	Min. Pass Marks	Max. Marks Practical		Total Marks	Maximum Passing Marks
										Theory Paper	College Assessment			External	Internal		
1	Professional Core Course	8 CH 01	Transport Phenomenon	3	-	-	3	3	3	80	20	100	40	---	---	---	---
2	Professional Core Course	8 CH 02	Chem. Reaction Engineering - II	3	-	-	3	3	3	80	20	100	40	---	---	---	---
3	Professional Core e Course	8 CH 03	System Modelling	3	-	-	3	3	3	80	20	100	40	---	---	---	---
4	Professional Elective Course-II	8 CH 04	Professional Elective – IV	3	-	-	3	3	3	80	20	100	40	---	---	---	---
5	Professional Elective Course	8 CH 05	Professional Elective – IV Lab.	-	-	2	2	1	---	---	---	---	---	25	25	50	25
6	Professional core Course	8CH06	Chem.. Reaction Engineering-II lab	-	-	2	2	1	---	---	---	---	---	25	25	50	25
7	Professional Elective Course	8 CH 07	Project & Seminar	-	-	12	12	6	---	---	---	---	---	75	75	150	75
Total				**12**	**-**	**16**	**28**	**20**				**400**				**250**	
Grand Total												400				250	**650**

Note: The Elective will be offered as per the availability of the faculty with the college /Institute & only if the number of student opting for such elective are minimum thirty.

SEMESTER: EIGHT

8CH01 TRANSPORT PHENOMENON

SECTION-A

UNIT-I : Transport properties and mechanism, Rate process, flux, types of fluids, phenomenological laws, Rheology of non-Newtonian fluids, flow through circular pipes, Mathematical foundation, types of time derivatives, Divergence, Operators. **(7)**
UNIT-II : Control Volume, Overall mass, momentum and energy balances, Extended Bernoulli's equation, Reynold's transport equation, mass balance withchemical reaction. **(7)**
UNIT-III : Equation of change based on differential balance, equation of continuity, Navier-Stokes equation, energy equation, application of Narier-Stokes equations to various flows through different geometric shapes, applications of energy equation, potential streamline, creeping andideal flow. **(8)**

SECTION-B

UNIT-IV: Flow around submerged solids, flow past flat plate, boundary layer, Prandtl equation, expressions for viscous drag, thermal boundary layer. Von Karmon's integral momentum equation, analysis of integral equation, displacement thickness. **(8)**
UNIT-V: Turbulent flow mechanism, intensity of turbulence, Reynold's sitresses, Prandtl mixing length, turbulent flow through circular pipes. Analogies of transfer processes, profiles of gradients, Reynold's Prandtl, Von Karmon, Chilton-Coulburn analogies, J factors, Dittus-Boelter's equation. **(8)**
UNIT-VI : Review of classical mass transfer problems, mass transfer in binary systems with or without chemical reactions. Theoriesof interphase mass transfer. Mass transfer analogies. **(7)**
Text Books:
1) Transport Phenomenon: Bird, Stayward, Light Foot, John Wiley.
2) Momentum, Heat and Mass Transport: Benett and Mayers,McGraw Hill.

Reference Books:
1) Principles of Unit Operations: A.S. Foust, et-al, Wiley Toppan Int. Ed., LatestEdition
2) Fluid Dynamics and HeatTransfer: J.G.Kundsen and Katz, McGraw Hill, LatestEdition
3) Transport Phenomenon and Unit Operations: Geankoplis.

8CH02 CHEMICAL REACTION ENGINEERING-II

SECTION – A

UNIT-I: Residence time distribution. Models for non-ideal flow. (7)
UNIT-II: Mixing concept and models: Rate equation for Heterogeneous reactions, fluid particle Reactions. Determination of rate controlling step. Application to Design. **(8)**
UNIT-III: Fluid-Fluid reaction: The rate equation for different cases and application to design. **(7)**

SECTION – B

UNIT-IV: Heterogeneous processes, catalysis and adsorptional determination of surface area, void volume. Pore volume distribution catalyst preparation, promoters and inhabitation catalyst reactivation. **(8)**
UNIT-V: Rate equation for third solid catalytic, reactions. Internal External transport process in Heterogeneous Reactions. **(7)**
UNIT-VI: Design of Heterogeneous catalytic reactors, fixed broad reactors, isothermal and adiabatic fixed bed reactor, non- isothermal&non-adiabatic fixed bedrector. Fluidized bed,Drickle bed, slurry reactor. **(8)**
Text Books:
1. Chemical Reaction Engineering,OctaveLevenspil,WileyEastern Ltd.
2. ChemicalEngineering Kinetics, Smith J.M.,McGrawHill.
Reference Books:
1. Elements ofChemical Reaction Engineering - H. Scott Fogler, Prentice Hall.
2. Chemical Reactor Analysis &Design, Gilberth F. Froment &Kenneth B. Bischoof, John Wiley &Sons.
3. Chemical Reactor Design,Vol. I&II,M.W.Rase.

8CH03 SYSTEM MODELLING

SECTION – A

UNIT-I: Introduction: Models and model building, principles of model formulation, fundamental laws - continuity equation, energy equation, equations of motion, transport equations, equations of state, equilibrium and kinetics, classification ofmathematical 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 variable. **(8)**
UNIT-II: Lumped Parameter Models: Formulation and solution techniques to be discussed for Vapour liquid equilibrium models, dewpoint and flash calculations for multi-component systems, boiling operations, batch and continuous distillation models, tank models, mixing tank, stirred tank with heating. **(7)**
UNIT-III: CSTR with multiple reactions. Non-isothermal CSTR - multiplicity and stability, control at the unsteady state. Non-ideal CSTR models - multi-parameter models with dead space and bypassing, staged operations (**7)**

SECTION – B

UNIT-IV: 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. **(8)**
UNIT-V: 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. **(8)**
UNIT-VI: 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. **(7)**
Text Books:
1. Roger E. Franks, “Modelling and Simulation in ChemicalEngineering”, JohnWileyand Sons, 1972.
2. W.F. Ramirez, “Computational Methods in Process Simulation”, Butterworth Publishers, 1989.
Reference Books:
1. Seinfeld and Lapidus, “Mathematical Methods in Chemical Engineering”, PrenticeHall, 1974.
2. W.L.Luyben,” Process Modelling, simulation and Control for Chemical Engineers”,1990.
3. Santosh Kumar Gupta, “Numerical Methods for Engineers”, Tata McGrawHill, 1995.

8CH04 PROFESSIONAL ELECTIVE – IV

(i) PETRO CHEMICAL TECHNOLOGY

SECTION –A

UNIT- I: General Introduction - History, economics and future of petrochemicals, energy crisis and petrochemical industry, sources and classification of petrochemicals, different feedstock,Types of cracking Process **(7)**
UNIT- II: First generation petrochemicals - alkanes - C1, C2, C3, C4 petrochemicals, alkenes -C2, C3, C4, petrochemicals, alkynes - C2, C3, C4 petrochemicals, B-T-X aromatics, diene based petrochemicals. **(7)**
UNIT- III: Second generation petrochemicals - synthesis gas, methanol, formaldehyde chloromethanes, ethanol, acetaldehyde, acetic acid, acetic anhydride, isopropyl alcohol, ethylene oxide, propylene oxide, acetone, vinyl chloride, phenol, aniline and styrene. **(8)**

SECTION – B

UNIT- IV: Third generation petrochemicals - plastics, rubbers and fibres, olefinic polymers, polyethylene, polypropylene, polyisobutylene, diene polymers - polybutadiene, neoprene, polyisoprene, SBR, synthetic fibres. **(7)**
UNIT- V: Miscellaneous petrochemicals - petroleum proteins, synthetic detergents, resin and rubber chemicals, explosives - TNT and RDX. **(8)**
UNIT- VI: Various technological forecasting of the petroleum and petrochemicals. **(8)**

Text Books:

1. S.Maiti, “Introduction to petrochemicals”, Oxford and IBH publishing Co.,1992.
2. H.Steines, “Introduction to petrochemical Industry”, Pergamon,1961.
3. I D Mall Petrochemical Process Technology.

Reference Books:

1. G.D.Hobson and W.Pohl, “Modern Petroleum Technology”, Applied Science Publishers, IV Edition, 1975
2. Richard frank Goldsten andA.LawrenceWaddams, “The Petroleum Chemical Industry”, E&FNSpon Ltd., 1967
3. G.T.Austin, “Shreves Chemical Process Industries”, McGrawHill, V Edition, 1986

8CH04 PROFESSIONAL ELECTIVE – IV

(ii) INDUS1RIAL PIPING

SECTION - A

UNIT-I: Importance of piping in chemical industry. Classification of pipes: - Pipe codes and specification, Schedule numbers, BWG,NPS. **(7)**
UNIT-II: Material of construction of pipes. Pipe sizing: - Calculation of pipe diameter, thickness. Pipe fittings, advantages, calculation of frictional losses, and empirical correlations for flow of oil. Gasoline, hydrocarbons. **(8)**
UNIT-III: Criteria for selection of pipe joints, pipe joints for similar and dissimilar material, expansion effects and methods for reducing them. **(7)**

SECTION – B

UNIT-IV: Piping lay-out consideration, piping diagrams, types of pipe support, erection and maintenances of supporting, restraining and braing systems. Complex pipelines in series and in parallel. **(8)**
UNIT-V: Calculation of equivalent lengths. Pipeline storage capacity. Fundamental considerations in piping vibrations, types of vibrations, their prevention and control. Cryogenic piping. **(8)**
UNIT-VI: Single phase and two-phase flow. Piping for slurries.Insulation for piping systems. **(7)**
Text Books:
l. Piping Design for Process Plants by H. F. Rase, JohnWiley.
2. Process Piping Systems, D. J. Deutsch, Chemical Engineering Magazine, McGrawHill.
Reference Book: Industrial Piping,C.T. Littleton,McGrawHill.

8CH04 PROFESSIONAL ELECTIVE – IV

(iii) ENERGY & ENVIRONMENT ENGINEERING

SECTION – A

UNIT-I: INTRODUCTION TO ENERGY SOURCES: Global Energy, Environmental Resources, Energy necessity and energy crisis. Indian Energy Scenario: EnergyConsumption, needs and crisis, energy sources and availability. **(7)**
UNIT-II: RENEWABLE SOURCES OF ENERGYAND ENVIRONMENT:
Biomass – introduction, energy plantation, bio-mass conversion technologies (wet and dry process), photosynthesis, agricultural waste derived energy, urban waste derived energy.
BIOGAS: Generation, factors affecting bio-digestion, advantages of anaerobic digestion, classification of biogas plants. **(7)**
UNIT-III: HYDROPOWER: Site selection for hydroelectric power plants, classification of hydroelectric power plants, submergence, ecological imbalance, catchment area treatment, advantages and disadvantages of hydroelectric power plants. Submergence, Ecological Imbalance, CatchmentAreaTreatment (**8)**

SECTION – B

UNIT-IV: SOLAR ENERGY: Solar constants, solar radiation at earth surface, physical principles of conversion of solar radiation into heat. Concentrating collectors (focusing and non-focusing). **(7)**
UNIT-V: TIDAL ENERGY: OTEC (Ocean Thermal Electric Conversion), methods of ocean thermal electric power generation, site selection. Energy from tides – basic principles of tidal power, components of tidal power plant.
WIND ENERGY: Introduction, basic principles of wind energy conversion. Site selection considerations. Basic components of wind energy conversion system. Wind energy collectors. Natural gas – classification and comparison of different gas turbine power plants, Associated Environmental Effects. **(8)**
UNIT-VI: NUCLEAR ENERGY: necessity, general components of nuclear reactors, different types of reactors, breeding reactors, location of nuclear power plants, disposal of nuclear wastes, Associated Environmental Effects.
GEO-THERMALENERGY: introduction, nature of geothermal fields, geo-thermal sources, binary fluid geothermal power system and arrangement for hybrid plants. **(8)**
Text Books:
1. Rai, G.D, “Non-conventional EnergySources”, Khanna Publications.
2. Rao and Parulekar B.B., (1977), Energy Technology–Non- conventional, Renewable and Conventional”, 2nd Edition, Khanna Publishers.

Reference Books:

1. Mathur, A.N., and Rathore, N.S., "Renewable Energy and Environment" –Proceedings of the National Solar Energy, Himanshu Publications, Udaipur
2. Saha, H., Saha, S.K., and Mukherjee, M.K., (1990), "Integrated Renewable Energy for Rural Development", Proceedings of the National Solar EnergyConvention, Calcutta, India,
3. Wilber, L.C., (1989), "Handbook of Energy Systems Engineering", Wiley and Sons
4. The EnergyResearch Institute (TERI), NewDelhi, Publications
5. Ministry of Environment and Forests, Government of India,Annual Reports.

8CH05 PROFESSIONAL ELECTIVE-IV - LAB.

Minimum EIGHT experiments based on the syllabus are to be performed by the students.

8CH06 CHEMICALREACTIONENGINEERING- II - LAB.

List of Experiments:

1. To determine the RTD in CSTR - pulse input.
2. To determine the RTD in PFR - pulse input.
3. To determine the RTD in Packed Bed Reactor - pulse input.
4. To determine the RTD in CSTR - step input.
5. To determine the RTD in PFR - step input.
6. To determine void volume porosity & solid density of catalyst .
7. To determine the Semi batch reactor.
8. Todetermine the solid fluid heterogeneous Catalytic reaction.
9. Todetermine theAdiabatic Batch Reactor.
10. To determine Study of adsorption isotherm of calculation of specific surface area of catalyst.

Note: The students should perform minimum EIGHT (8) experiments from the above list to complete the term. All experiments in this list shall be available in the laboratory. Additional experiments relevant to the syllabusmay be addedto themain list.

8CH07 PROJECT & SEMINAR:

The Seminar Report submitted by the student at the end ofVII Semester will be evaluated byexternal examiner appointed by theUniversity along with the Project -VivaVoce examination at the end ofVIII Semester.

PROJECT:

The objective of the project is to enable the students to work in groups of not more than four members in each group on a project involving analytical, experimental , design or combination of these in the area of Chemical Technology. Each project shall have a guide. The student is required to do literature survey, formulate the problem and form a methodology of arriving at the solution of the problem. On completion of the work, a project report should be prepared and submitted to the department.

The evaluation is based on continuous internal assessment by an internal assessment committee for 75 marks by way of oral presentations. The university examination, which carries a **total of 150 marks**, will be a VivaVoce examination conducted by

a committee of one external examiner appointed bytheUniversityand one internal examiner/Guide.

8CH04 PROF. ELECTIVE –IV

Petrochemical Technology
Industrial Piping
Energy & Environment Enginneing