Shri Vile Parle Kelavani Mandal's

Dwarkadas J. Sanghvi College of Engineering

(Autonomous College Affiliated to the University of Mumbai)

Scheme and detailed syllabus (DJ19)

Second Year B.Tech

in

Chemical Engineering

(Semester III and IV)

Revision: 1 (2019)
With effect from the Academic Year: 2020-2021

1st July, 2020

SHRI VILEPARLE KELAVANI MANDAL'S
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC ACCREDITED with "A" GRADE (CGPA : 3.18)

Scheme for Second Year B.Tech Program in Chemical Engineering: Semester III (Autonomous)

(Academic Year 2020-2021)

Sr.	Course Code	Course	Teaching Scheme				Semester End Examination (A)						Continuous Assessment (B)							Aggregate Marks(A+B)	Credits Earned	
								Marks								Termwork (Marks)						
			Theory (hrs.)	Practical (hrs.)	Tutorial (hrs.)	Credits	Duration (Hrs)	Theory	Oral	Pract	Oral & Pract	SEE Total	Term Test 1 (TT1) Marks	Term Test 2 (TT2) Marks	Avg (TT1 & TT2) Marks	Laboratory Work	Tutorial / Mini project / Presentation/ Journal	Term Work Total	CA Marks Total			
1	DJ19CHC301	Engineering Mathematics III	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	4
	DJ19CHT301	Engineering Mathematics - III-Tutorial	--	--	1	1	--	--	--	--	--	--	--	--	--	--	25	25	25	25	1	
2	DJ19CHC302	Advanced Chemistry-I	2	--	--	2	3	75	--	--	--	75	25	25	25	--	--	--	25	100	2	3
	DJ19CHL302	Advanced Chemistry-I Laboratory	--	2	--	1	2	--	--	--	25	25	--	--	--	--	25	25	25	50	1	
3	DJ19CHC303	Chemical Engineering Thermodynamics-I -Theory	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	4
	DJ19CHT303	Chemical Engineering Thermodynamics-I - Tutorial	--	1	--	1	--	--	--	--	--	--	--	--	--	--	25	25	25	25	1	
4	DJ19CHC304	Material & Energy Balance Calculations - Theory	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	4
	DJ19CHT304	Material & Energy Balance Calculations - Tutorial	--	--	1	1	--	--	--	--	--	--	--	--	--	--	25	25	25	25	1	
5	DJ19CHC305	Fluid Flow - Theory	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	5
	DJ19CHL305	Fluid Flow - Tutorial and Laboratory	--	2	1	2	2	--	--	--	25	25	--	--	--	--	25	25	25	50	2	
6	DJ19CHC306	Chemical Technology - Theory	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	4
	DJ19CHL306	Chemical Technology - Laboratory	--	2	--	1	2	--	25	--	--	25	--	--	--	--	25	25	25	50	1	
7	DJ19A2	Innovative Product Development-I	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
8	DJ19A3	Constitution of India	1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Total	17	9	3	24	24	450	25	0	50	525	150	150	150	0	150	150	300	825	24	24

Prepared By Checked By HOD Vice-Principal Principal

SHRI VILEPARLE KELAVANI MANDAL'S
DWARKADAS J. SANGHVI COLLEGE OF ENGINEERING
(Autonomous College Affiliated to the University of Mumbai)
NAAC ACCREDITED with "A" GRADE (CGPA : 3.18)

Scheme for Second Year B.Tech Program in Chemical Engineering: Semester IV (Autonomous)

(Academic Year 2020-2021)

Sr.	Course Code	Course	Teaching Scheme				Semester End Examination (A)						Continuous Assessment (B)							Aggregate Marks (A+B)	Credits Earned	
								Marks								Termwork Marks						
			Theory (hrs.)	Practical (hrs.)	Tutorial (hrs.)	Credits	Duration (Hrs)	Theory	Oral	Pract	Oral & Pract	SEE Total	Term Test 1 (TT1) Marks	Term Test 2 (TT2) Marks	Avg (TT1 & TT2) Marks	Laboratory Work	Tutorial / Mini project / Presentation/ Journal	Term Work Total	CA Marks Total			
1	DJ19CHC401	Engineering Mathematics IV	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	4
	DJ19CHT401	Engineering Mathematics - IV-Tutorial	--	--	1	1	--	--	--	--	--	--	--	--	--	--	25	25	25	25	1	
2	DJ19CHC402	Advanced Chemistry-II - Theory	2	--	--	2	3	75	--	--	--	75	25	25	25	--	--	--	25	100	2	3
	DJ19CHL402	Advanced Chemistry-II - Laboratory	--	2	--	1	3	--	--	--	25	25	--	--	--	--	25	25	25	50	1	
3	DJ19CHC403	Solid Fluid Mechanical Operations - Theory	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	4
	DJ19CHL403	Solid Fluid Mechanical Operations - Laboratory	--	2	--	1	3	--	--	--	25	25	--	--	--	--	25	25	25	50	1	
4	DJ19CHC404	Chemical Engineering Thermodynamics-II - Theory	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	4
	DJ19CHT404	Chemical Engineering Thermodynamics-II - Tutorial	--	--	1	1	--	--	--	--	--	--	--	--	--	--	25	25	25	25	1	
5	DJ19CHC405	Chemical Engineering Economics - Theory	3	--	--	3	3	75	--	--	--	75	25	25	25	--	--	--	25	100	3	4
	DJ19CHT405	Chemical Engineering Economics - Tutorial	--	--	1	1	--	--	--	--	--	--	--	--	--	--	25	25	25	25	1	
6	DJ19IHC1	Universal Human Values	2	--	--	2	3	75	--	--	--	75	25	25	25	--	--	--	25	100	2	3
	DJ19IHT1	Universal Human Values - Tutorials	--	--	1	1	--	--	--	--	--	--	--	--	--	--	25	25	25	25	1	
7	DJ19A4	Innovative Product Development-II	--	2	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
		Total	16	6	4	22	24	450	0	0	50	500	150	150	150	0	150	150	300	800	22	22

Prepared By Checked By HOD Vice-Principal Principal

Syllabus for Second Year Chemical Engineering - Semester III (Autonomous)
(Academic Year 2020-2021)

<table>
<tr><td colspan="8">Program: Second Year Chemical Engineering</td><td colspan="3">Semester: III</td></tr>
<tr><td colspan="8">Course : Engineering Mathematics-III</td><td colspan="3">Course Code: DJ19CHC301</td></tr>
<tr><td colspan="8">Course: Engineering Mathematics III Tutorial</td><td colspan="3">Course Code: DJ19CHT301</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme
(Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="4">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="4">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
<tr><td colspan="4">Laboratory Examination</td><td colspan="3">Term work</td><td rowspan="3">Total Term work</td><td rowspan="3">25</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">-</td><td rowspan="2">1</td><td rowspan="2">4</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td>Tutorial / Mini project / presentation/ Journal</td></tr>
<tr><td>-</td><td>--</td><td>--</td><td>-</td><td>25</td><td>25</td></tr>
</table>

Pre-requisite: Knowledge of

1. Basics of Complex numbers, Modulus, Argument, Equation of circle, Roots of unity, Euler's formula, Hyperbolic functions
2. Matrices, Symmetric, Orthogonal and Unitary matrices, Rank, Normal form, Solution of system of linear equations, L. I. and L. D. vector
3. First order and second order Linear Differential Equation
4. Basics of Probability and statistics

Objectives:

1. To enable students to solve initial value ODE problems using Laplace-Transforms.
2. To strengthen the knowledge of students in Linear Algebra.
3. To study the basics of statistics and Probability.
4. To study the basics of system of linear equations
5. To study the basics of Complex Variable.

Outcomes: On completion of the course, learner will be able to:

1. Use Laplace and inverse Laplace Transform to solve the Ordinary Differential Equations
2. Use eigenvalues and eigenvectors for diagonalizing a given matrix.
3. Understanding and apply the concept of Probability distribution to Engineering Problems
4. Understand system of Linear equations and its stability to various Engineering Problems
5. Identify the Analytic function and Harmonic function and to apply Bilinear Transformation in Engineering Problems.

Detailed Syllabus: (unit wise)		Total Duration: 42
Unit	**Description**	**Duration**
1	**Laplace transform:** 1.1 Introduction, Definition of Laplace transform, Laplace transform of constant, trigonometrical, exponential functions. 1.2 Important properties of Laplace transform: First shifting theorem, Laplace transform of L{f(at) }, L{ ( ) }, L{ ___ }, L{ ___ }, L{ ∫ ( ) }, (without proof.) 1.3 Unit step function, Heaviside function, Second shifting theorem, Dirac-delta function, Periodic function and their Laplace transforms without proof. 1.4 Inverse Laplace transform with Partial fraction and Convolution theorem. (without proof) 1.5 Application to solve initial and boundary value problem involving ordinary differential equations with at most two dependent variable and constant coefficients.	**10**
2	**Matrices:** 2.1 Eigen values and eigen spaces of 2x2 and 3x3 matrices; existence of a basis and finding the dimension of the eigen space (no proofs); diagonalisable matrices. 2.2 Cayley - Hamilton theorem. (without proof) 2.3 Quadratic forms; orthogonal and congruent reduction of a quadratic form in 2 or 3 variables; rank, index, signature; definite and indefinite forms	**8**
3	**Probability:** 3.1 Random Variables: - Discrete & continuous random variables, expectation, Variance, Probability Density Function & Cumulative Density Function. 3.2 Moments, Moment Generating Function. 3.3 Probability distribution: Binomial, Poisson & Normal Distribution. **Correlation:** 3.4 Karl Pearson's coefficient of correlation, covariance, Spearman's Rank correlation. 3.5 Regression Lines.	**10**
4	**Systems of first Order Linear Differential Equation** 4.1 Theory of Linear Equations 4.2 Homogeneous Linear System (distinct, repeated and complex eigenvalues) 4.3 Non-Homogenous Linear System by variation of parameter method 4.4 Stability of linear systems **Introduction to WX Maxima Software and its application**	**7**
5	**Complex Variable:** 5.1 Functions of a complex variable, Analytic functions, Cauchy-Riemann equations in Cartesian co-ordinates, Polar co-ordinates. (without proof) 5.2 Harmonic functions, Analytic method and Milne Thomson methods to find f(z), Orthogonal trajectories. (without proof) **Mapping** 5.3 Conformal Mapping, Bilinear transformations, Cross ratio, fixed points and standard transformation such as rotation and magnification, inversion, translation.	**7**

Books Recommended:

Text books:

1. Higher Engineering Mathematics by Dr. B. S. Grewal,44th Edition, Khanna Publication, 2020
2. Advanced Engineering Mathematics , Dennis G Zill and Michael R Cullen ,4th Edition, Narosa Publication, 2015

Reference Books:

1. Advanced Engineering Mathematics by Kreyszig E. 10th edition, JOHN WILEY and SONS, INC., 2011
2. Advanced Engineering. Mathematics by C. Ray Wylie and Louis Barrett.TMH International Edition, 1995
3. Mathematical Methods of Science and Engineering: Aided with MATLAB by Kanti B. Datta, Cengage Learning , 2012
4. Laplace Transforms by Murry R. Spiegel, Schaum's outline series-McGraw Hill Publication, 1965
5. Fundamentals of Mathematical Statistics by S. C. Gupta, V. K. Kapoor, Sultan Chand and Sons - 2017

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Tutorial: (Term work)

Term work shall consist of minimum 8 Tutorials covering the entire modules.

The Tutorials could be conducted as follows:

Tutorial No	Topics
1	Laplace Transform
2	Inverse Laplace Transform
3	Eigenvalues and Eigenvectors
4	Quadratic Forms
5	Random Variables
6	Probability distribution
7	Correlation and regression
8	Systems of first Order Linear Differential Equation
9	Complex Analysis-Problems related to analytic functions
10	Bilinear Transformation

The distribution of marks for term work shall be as follows:

Tutorial– 25 marks

The final certification and acceptance of term work will be subject to satisfactory performance of tutorial work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Second Year Chemical Engineering - Semester III (Autonomous)
(Academic Year 2020-2021)

Program: Second Year Chemical Engineering	**Semester : III**
Course : Advanced Chemistry-I Theory	**Course Code: DJ19CHC302**
Course : Advanced Chemistry-I Laboratory	**Course Code: DJ19CHL302**

Teaching Scheme (Hours / week)				**Evaluation Scheme**						
				Semester End Examination Marks (A)			**Continuous Assessment Marks (B)**			**Total marks (A+ B)**
Lectures	**Practical**	**Tutorial**	**Total Credits**	**Theory**			**Term Test 1**	**Term Test 2**	**Avg.**	
				75			**25**	**25**	**25**	**100**
				Laboratory Examination			**Term work**		**Total Term work**	**50**
2	**2**	**--**	**3**	**Oral**	**Practical**	**Oral & Practical**	**Term Work**	**Tutorial / Mini project / presentation/ Journal**		
				--	**25**	**--**	**25**	**--**	**25**	

Pre-requisite:

- Syllabus of First Year Engineering, Semester I and Semester II (DISCOE – Autonomous).

Objectives:

- To understand chemical bonding.
- To understand different concepts of organic reactions.
- To understand the basic of organic reactions including bond cleavage and formation of reactive species.
- To study the effect of temperature and time on chemical reactions.
- To become aware of different concepts and laws of photochemistry.
- To understand the importance of catalysis in various reactions.
- To understand the principles of different chromatographic techniques.

Outcomes: After completion of the course, students would be able to:

- Study advances in bonding in different molecules.
- Capable of defining stability of co-ordination compounds.
- Predict and synthesize different products through reaction mechanism.
- Study the kinetics and energy profile diagrams of reaction.
- Understand the effect of light on reactions.
- Understand the role and involvement of catalyst in various types of reactions.
- Predict the utility of particular chromatographic technique for separation of molecules.

Detailed Syllabus: (Unit wise)		
Unit	**Description**	**Duration (Hours)**
1	**Basic Concepts of Chemistry, Molecular Structures and Co-ordination chemistry:** VSEPR theory. Structure of BeF_2, BF_3, NH_3, PCl_5, SF_6, SF_4, XeF_4, ClF_3 and IF_7. Definitions: Co-ordination number or ligancy, Ligand, Complex ion, Co-ordination or dative bond. Nomenclature and isomerism (Only Geometrical and Structural) in co-ordination compounds with respect to co-ordination number 4 and 6. Theories of coordination compounds: Werner's Co-ordination theory, Effective Atomic Number (EAN), Valence bond-Theory, Crystal field theory (CFT). Application of CFT to tetrahedral and octahedral complexes, drawbacks of CFT. Measurement of CFSE (10Dq) and Numericals based on EAN and 10Dq measurement. Applications of coordination compounds.	**08**
2	**Reactive intermediates:** • Carbocation, carbanion, carbon free radicals and carbenes – their formation, structure and stability. • Name reactions with mechanism w.r.t. each reactive intermediate. Carbocation – Pinacol - Pinacolone reaction. Carbanion – Michael reaction. Free radical – Wohl-Ziegler bromaination reaction. Carbene – Reimer-Tiemann reaction for aldehyde.	**08**
3	**Kinetically and Thermodynamically controlled reactions:** Transition state (T.S.), Intermediate. Difference between T.S. and intermediate. Rate (Kinetically) controlled and Equilibrium (Thermodynamically) controlled reactions. Explain w.r.t. Nitration of chlorobenzene, Methylation of toluene by Friedel-Crafts reaction, Sulphonation of naphthalene.	**02**
4	**Photochemistry:** Introduction, difference between photochemical and thermochemical reactions. Laws of Photochemistry (i) Grothus Draper Law (ii) Stark Einstein Law. Quantum yield, reasons for high quantum yield and low quantum yield. Numericals based on quantum yield. Photochemical reactions of carbonyl compounds-(i) Norrish type-I cleavage (ii) Norrish type-II cleavage with mechanism.	**04**
5	**Catalysis:** Definition. Criteria of catalysis. Types (Homogeneous and Heterogeneous). Catalytic promoters, poisons. Negative catalysis and inhibition. Autocatalysis and Induced catalysis. Activation energy and catalysis. Intermediate compound formation theory. Adsorption theory. Acid-Base catalysis and mechanism. Enzyme catalysis. Characteristics and mechanism of enzyme catalysis.	**04**
6	**Chromatography:** Adsorption and partition. Study of Paper Chromatography, Thin Layer Chromatography, High Performance Liquid Chromatography (HPLC), Gas (Liquid and solid) Chromatography – Principle and their applications. Ion exchange resins, cation and anion exchangers. Desalination by ion exchange and separation of lanthanides.	**04**

Books Recommended:

Reference Books:

1. B.R. Puri, L.R. Sharma & K.C. Kalia., "Principles of Inorganic Chemistry", 33rd edition. Milestone/Vishal Publishers, New Delhi (2017).
2. J. D. Lee, "Concise Inorganic Chemistry", 5th edition. Wiley India Pvt. Ltd., New Delhi, (2014).
3. Michael B. Smith, Jerry March, "March's Advanced Organic Chemistry – Reactions, Mechanisms, and Structure", Sixth Edition. John Wiley & Sons, Inc., New Jersey, (2007).
4. V.K. Ahluwalia, Rakesh K. Parashar, "Organic Reaction Mechanisms", Fourth Edition. Narosa Publishing House, New Delhi, (2018).
5. Peter Skyes, "A Guidebook To Mechanisms In Organic Chemistry", Sixth Edition. PEARSON INDIA, New Delhi, (2003).
6. Glasstone Samuel, "Textbook of Physical Chemistry", 2nd edition. Macmillan India Ltd., London, (1962).
7. B.R. Puri, L.R. Sharma, M.S. Pathania, "Principles of Physical Chemistry", 47th edition. Vishal Publishing Co., Punjab, (2016).
8. S.S. Dara, S.S. Umare, "A Textbook of Engineering Chemistry", 25th edition. S. Chand & Company Pvt. Ltd. New Delhi, (2010).
9. Gurdeep R. Chatwal, Sham Anand, "Instrumental methods of Chemical Analysis", Fifth Edition, Himalaya Publishing House, Mumbai, (2019).
10. A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford, P.W.G. Smith, "Vogel's Textbook of Practical Organic Chemistry", Fifth Edition, Longman Scientific & Technical, England, (1989).

List of Experiments Suggested:

A] Volumetric analysis:
Preparation of standard solutions and to find normality and deviation factor. [Any 2]

B] Titrimetric analysis: [Any 3]

(1) Analysis of talcum powder for Mg content by EDTA method
(2) Analysis of Aspirin as per I.P. or USP
(3) Determination of fluoride content in the toothpaste spectrophotometrically
(4) Estimation of CaO in cement
(5) Estimation of Vitamin C using Ceric ammonium sulphate

C] Organic estimation: [Any 2]

(1) Estimation of Aniline
(2) Estimation of Phenol
(3) Estimation of Acetamide

D] Gravimetric estimation: [Any 2]

(1) Barium as $BaCl_2$
(2) Tin as $SnCl_2$
(3) Nickel as Ni-DMG.
(4) Zinc as $ZnSO_4$

E] Preparation: [Any 2]

(1) Preparation of m-Dinitrobenzene
(2) Preparation of 5-nitrosalicylic acid from salicylic acid
(3) Preparation of β-naphthyl benzoate from β-naphthol
(4) Preparation of glucosazone from dextrose or fructose
(5) Preparation of cyclohexanone oxime from cyclohexanone

Students have to perform at least 10 practicals from the above during the semester.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Practical Examination:

1. A student become eligible for practical examination after completing a minimum of eight experiments out of ten experiments.
2. Practical examination: 25 Marks.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Term work:

1. Batch wise laboratory work is to be conducted to develop a rational temperament for scientific observations which lead to constructive inferences essential for technology studies. Students must be encouraged to perform minimum ten experiments and submit the Laboratory Journal.
2. Total Marks: 25

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Second Year Chemical Engineering - Semester IV (Autonomous)
(Academic Year 2020-2021)

Program: Second Year Chemical Engineering	**Semester : III**
Course : Chemical Engineering Thermodynamics -I	**Course Code: DJ19CHC303**
Course : Chemical Engineering Thermodynamics -I Tutorial	**Course Code: DJ19CHT303**

Teaching Scheme (Hours / week)				**Evaluation Scheme**						
				Semester End Examination Marks (A)			**Continuous Assessment Marks (B)**			**Total marks (A+ B)**
Lectures	**Practical**	**Tutorial**	**Total Credits**	**Theory**			**Term Test 1**	**Term Test 2**	**Avg.**	
				75			**25**	**25**	**25**	**100**
				Laboratory Examination			**Term work**		**Total Term work**	**25**
3	**--**	**1**	**4**	**Oral**	**Practical**	**Oral & Practical**	**Laboratory Work**	**Tutorial / Mini project / presentation/ Journal**		
				--	--	--	--	**25**	**25**	

Pre-requisite:

Basic thermodynamic properties, laws and equations.
Engineering Mathematics: Differential Equations, Linear Algebraic Equations.

Objectives:

To make students understand the Laws of Thermodynamics and Basics of Chemical Engineering Thermodynamics
To make students learn to apply the concepts of Chemical Engineering Thermodynamics to various Chemical Engineering Processes

Outcomes:

The students will be able to apply thermodynamic laws and equations to various Chemical Engineering processes.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration (Hours)**
1.	A review of systems, state variables.,First law of thermodynamics for opens systems,Application of first law to cycles.	**03**
2	Second Law of Thermodynamics**,** Concepts of heat engine, heat pump and refrigerator, Carnot Cycle and Carnot Principle, Clausius Inequality, Concept of Entropy and estimation of Entropy change for processes, Third Law of Thermodynamics, Exergy	**10**
3	Equations of State, Non-ideal gases: Virial equation of state, Van Der Waals, Redlich-Kwong-Soave, Peng-Robinson equation of state.	**10**
4	Maxwell Equation, Joule Thomson effect, Enthalpy and Entropy departure functions, Thermodynamic Charts, Diagrams and their applications , Fugacity and fugacity coefficient	**14**
5	Ideal gas mixtures, An introduction to ideal liquids, Properties of ideal mixtures.	**5**

Books Recommended:

Text books:

1. Chemical, Biochemical and Engineering Thermodynamics, by Stanley I Sandler, John Wiley & Sons, 4th Edition.

Reference Books:

1. Introduction to Chemical Engineering Thermodynamic by J.M. Smith, H.C. Van Ness, M.M. Abbott, 8th Edition McGraw Hill Publishing Company Limited, 2018
2. Fundamentals of Engineering Thermodynamics by Micheal J Moran , Howard N Shaprio, 9th Edition, Wiley publication.
3. Phase Equilibria in Chemical Engineering by Stanley Walas, Butterworth-Heinemann (Published on 22 October 2013).

Evaluation Scheme:

Semester End Examination (A):

Theory:

Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.

Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

Two term tests of 25 marks each will be conducted during the semester.

Total duration allotted for writing each of the paper is 1 hr.

Average of the marks scored in both the two tests will be considered for final grading.

Tutorial: (Term work)

1. Term work shall consist of minimum ten tutorials from entire syllabus which are to be given at regular intervals batch wise. Total Marks: 25
2. The tutorials could be conducted as per the following topics: -
3. The students should note that they will have to use MS Excel to solve the tutorials. The students are advised to read, A Guide to Microsoft Excel 2013 by Bernard Liengme. The students are strongly advised to do some self learning from the web. Suggested site, https://www.excel-easy.com/

Tutorial No 1	First law
Tutorial No 2	First law for flow systems
Tutorial No 3	Second Law, Entropy
Tutorial No 4	Entropy balance for closed system
Tutorial No 5	Entropy balance for open system.
Tutorial No 6	Exergy
Tutorial No 7	Exergy Balance.
Tutorial No 8	Calculation of Enthalpy of a fluid using EOS
Tutorial No 9	Calculatin of Entropy using EOS
Tutorial No 10	Calculation of Fugacity using EOS

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Second Year Chemical Engineering - Semester III (Autonomous)
(Academic Year 2020-2021)

Program: Second Year Chemical Engineering	**Semester : III**
Course : Material & Energy Balance Calculations	**Course Code: DJ19CHC304**
Course : Material & Energy Balance Calculations - Tutorial	**Course Code: DJ19CHT304**

Teaching Scheme (Hours / week)				**Evaluation Scheme**						
				Semester End Examination Marks (A)			**Continuous Assessment Marks (B)**			**Total marks (A+ B)**
Lectures	**Practical**	**Tutorial**	**Total Credits**	**Theory**			**Term Test 1**	**Term Test 2**	**Avg.**	
				75			**25**	**25**	**25**	**100**
				Laboratory Examination			**Term work**		**Total Term work**	**25**
3	**--**	**1**	**4**	**Oral**	**Practical**	**Oral & Practical**	**Laboratory Work**	**Tutorial / Mini project / presentation/ Journal**		
				--	--	--	--	25	25	

Pre-requisite:

- The concepts of basic mathematics as well as a few concepts of higher mathematics.

Objectives:

- Students will learn to write mass balances on various process equipments with and without recycle.
- Students will learn to write energy balances on various process equipments with and without recycle.
- Students will learn to write mass and energy balances for chemical reactions with and without recycle.
- Students will learn to flow sheeting calculations.

Outcomes:

- Students will learn to calculate mass and energy flow rates into and out of various process equipments.
- Students will learn to calculate conversion, selectivity etc for various reactions with and without recycle.
- Students will learn to carry out degrees of freedom analysis for various units.

Detailed Syllabus: (unit wise)

Unit	**Description**	**Duration (Hours)**
1	Introduction. Basic Chemical Calculations. Units and Dimensions: Various systems of units, conversion of units. Density, specific volume, specific gravity, Concentration & composition of mixtures and solutions. Ideal Gas law, Dalton's la w, Amagat,s law, Raoult's law, Henry's law. Introduction to real gas	**07**
2	Material Balance without chemical reactions. Introduction to first law of thermodynamics, General material balance equation, degree of freedom analysis for individual units, solving material balance problems for various unit operations using steady state equation, Recycle, Bypass and Purge Calculations	**08**
3	Material Balance with chemical reactions. Concept of limiting and excess reactants, conversion and yield, selectivity and degree of completion of reaction,	**08**

	material balance problems related to chemical reactions including recycle, bypass and purge Calculations.	
4	Energy Balance. Heat capacity, sensible heat, latent heat, calculation of enthalpy changes. General energy balance equation. Energy balances for process involving chemical reaction including adiabatic reactions & combustion processes, Orsat Analysis & Net, Gross Calorific Value determination. Combined Material and Energy balance: Material and Energy balance for binary distillation, combustion and evaporation. Material Balance for Unsteady operations/Processes.	**14**
5	Humidity and saturation: Molal humidity, absolute molal humidity, relative humidity, saturation humidity, psychrometric chart.	**05**

Books Recommended:

Text books:

1. Narayan, K. V. and Lakshmikutty, B. "Stioichiometry and Process Calculations", 1st edition, Prentice Hall of India Pvt. Ltd., New Delhi (2006)
2. Himmelblau, D. M. and Riggs, J. B., "Basic Principles and Calculations in Chemical Engineering, 7th, Prentice Hall of India Pvt. Ltd., New Delhi (2009)
3. Ch. Durga Prasad Rao and D. V. S. Murthy, " Process Calculations for Chemical Engineers", McMilan India Ltd. (2010)

Reference Books:

1. Bhatt, B. I. and Thakore, S. B., "Stoichimetry, 5th editionTata McGraw Hill Education Private Limited, New Delhi(2017)
2. O. A. Hougen, K. M. Watson, and R. A. Ragatz., "Chemical process principles-part 1, Material and Energy Balances". Second Edition. John Wiley & Sons, Inc., New York (1954).

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading. *Tutorial: (Term work)*

1. Term work shall consist of minimum ten tutorials from entire syllabus which are to be given at regular intervals batch wise. Total Marks: 25
2. The tutorials could be conducted as per the following topics: -

Tutorial No 1	Basic chemical calculations
Tutorial No 2	Material balance without chemical reaction
Tutorial No 3	Material balance without chemical reaction
Tutorial No 4	Material balance without chemical reaction: Bypass, recycle and unsteady state operations.
Tutorial No 5	Material balance with chemical reaction
Tutorial No 6	Material balance with chemical reaction: Recycle and Purge operations.
Tutorial No 7	Energy balance based on heat capacity, enthalpy change
Tutorial No 8	Energy balance based on Hess's law, temperature of reaction
Tutorial No 9	Combined material and energy balance: Combustion and distillation
Tutorial No 10	Humidity and Saturation

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Second Year Chemical Engineering - Semester III (Autonomous)
(Academic Year 2020-2021)

Program: Second Year Chemical Engineering	**Semester : III**
Course :Fluid Flow - Theory	**Course Code:DJ19CHC305**
Course :Fluid Flow -Tutorial	**Course Code:DJ19CHT305**
Course :Fluid Flow - Laboratory	**Course Code:DJ19CHL305**

Teaching Scheme (Hours / week)				**Evaluation Scheme**						
				Semester End Examination Marks (A)			**Continuous Assessment Marks (B)**			**Total marks (A+ B)**
Lectures	**Practical**	**Tutorial**	**Total Credits**	**Theory**			**Term Test 1**	**Term Test 2**	**Avg.**	
				75			**25**	**25**	**25**	**100**
				Laboratory Examination			**Term work**		**Total Term work**	**50**
3	**2**	**1**	**5**	**Oral**	**Practical**	**Oral & Practical**	**Laboratory Work**	**Tutorial / Mini project / presentation/ Journal**		
				--	--	25	--	**25**	**25**	

Pre-requisite:

- The concepts of basic mathematics as well as a few concepts of higher mathematics.
- The concepts of Basic Physical quantities, Units and Dimensions.

Objectives:

- To introduce students to the mechanics of fluids (fluid statics and fluid dynamics), relevant to Chemical Engineering operations.
- To introduce students to hydrostatic pressure, pressure drop measurement, types of fluids and their flow, viscous flows, turbulence and turbulent flows, potential flows and boundary layer theory, continuity equation, Bernoulli equation, flow measurement and instruments, skin and form friction, flow through pipes and ducts, compressible flow, forces on submerged solids, flow transportation - pumps, blowers and compressors, important types of valves and power required in agitation.

Outcomes:

After completion of the course students will be able to:

- Calculate surface Tension, static pressure and pressure drop with manometers.
- Identify and calculate the energy of flow, rate of flow.
- Calculate major and minor pressure losses and flow rate using measuring devices.
- Analyze compressible fluid flow.
- Calculate drag force and pressure drop in flow past immersed bodies.
- Calculate NPSH and power rating for pumps, Power required for agitation and Understand working principles of various types of valves.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration(Hrs)**
1	**Introduction:** Nature of fluids, Scope and application of Fluid Flow, Properties of fluids- Density, Surface Tension, Capillary Effect.	**02**
2	**Fluid Statics:** Pressure concept, Hydrostatic equilibrium, U tube manometers, Differential U tube manometers, Inverted U tube manometers, Inclined U tube manometers, continuous gravity decanter.	**04**
3	**Fluid Kinematics:** Types of Fluid Flow, The Velocity field, Velocity gradient and rate of shear, The shear stress field, Newton's law of viscosity, Rheological behavior of fluids, Viscosity and its measurement, Kinematic viscosity, Reynolds Number, Laminar and Turbulent flow, Reynolds experiment, Nature of turbulence, Deviating velocities in turbulent flow, Statistical nature of turbulence, Intensity and scale of turbulence, Isotropic turbulence, Reynolds stresses, Eddy viscosity, Boundary layer theory, Boundary layer separation.	**04**
4	**Equations of Fluid Flow:** Streamline and stream tubes, Average velocity, Mass velocity, Continuity equation, Euler's equation, Bernoulli's equation, Modifications in Bernoulli's equation, Applications of Bernoulli's equation (Venturi meter, Orifice meter, Rotameter, Pitot tube, Square Notch, V-Notch).	**08**
5	**Flow of Incompressible fluids in conduits: -** Shear stress distribution in a cylindrical tube, Relation between Skin friction and wall shear, The friction factor, Relations between skin friction parameters (Darcy-Weisbach equation). **Laminar Flow in pipes:** Laminar flow of Newtonian fluids, Average velocity, Kinetic Energy Correction factor, Momentum correction factor of Newtonian fluids, Hagen – Poiseullie equation. **Turbulent Flow:** Velocity distribution for turbulent flow, Universal velocity distribution equations, Limitations of universal velocity distribution laws, Flow quantities for turbulent flows in smooth round pipes, Average velocity, The Reynolds's Number – Friction factor law for smooth tubes, The kinetic energy and momentum correction factors, Relations between maximum velocity and average velocity, Effect of roughness, The friction factor chart, Friction factor in flow through non-circular ducts. Pipes in series and parallel. Major and minor pressure losses in pipe networks and pipe fittings.	**08**
6	**Flow of Compressible Fluids:** - Introduction, Mach no, Sonic, supersonic and subsonic flow, continuity equation and Bernoulli's equation, stagnation properties, Acoustic velocity. Adiabatic Flow. Isothermal Flow. Isentropic Flow.	**04**
7	**Flow Past Immersed Bodies:** Drag forces, Coefficient of drag, Particle Reynold's number, Terminal settling velocity, Stoke's law, Friction in flow through bed of solids, Fluidization, Minimum fluidization velocity, types of fluidization.	**05**
8	**Pumps, Valves and Agitators:** Classification and types, Centrifugal pumps – Construction and working, Power required, Definitions of heads and efficiency, NPSH, Priming, Cavitation's, characteristic curves. Specific speed, minimum speed, Introduction to Reciprocating Pumps, Compressors, Fans and Blowers. **Types of Valves:** Globe valves, Gate valves, butterfly valves and non – Return valves.	**08**

	Power Consumption in Agitation: Power curves, Power Number, types of impellers.	

Books Recommended:

Textbooks:

1. W. L. McCabe, J. C. Smith and P. Harriot, Unit Operations of Chemical Engineering, McGraw-Hill International, 7th Edition, 2005.
2. Yunus A. Cengel, John M. Cimbala, Adapted by S. Bhattacharya, Fluid Mechanics Fundamentals and Applications, 4th edition, The McGraw Hill Companies.

Reference Books:

1. Coulson and Richardson's Chemical Engineering, 7th edition, Volume 1A: Fluid Flow: Fundamentals and Applications.
2. Dr. R. K. Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publications Pvt. Ltd, 10th edition,(2010).
3. R. Welty, C. E. Wicks, R. E. Wilson, G. Rorrer, Fundamentals of Momentum, Heat and Mass Transfer, 4th edition, Wiley (2007).

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Practical Examination:

1. A student becomes eligible for practical examination after completing a minimum of eight experiments out of the list given.
2. Practical examination: 25Marks.

List of Experiments suggested: -

1	Viscosity by efflux time.
2	Reynolds's Experiment.
3	Bernoulli's Apparatus.
4	Venturi Meter.
5	Orifice Meter.
6	Pitot Tube.
7	Rota meter calibration.
8	V Notch/ Rectangular Notch.
9	Flow through circular Pipe.
10	Flow through annulus.
11	Pipe fittings.
12	Viscosity by Stokes Law.
13	Pressure drop in Fixed Bed.
14	Characteristics of Centrifugal pump.
15	Power consumption in Agitated Vessel.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Tutorial: (Term work)

1. Term work shall consist of minimum ten tutorials from entire syllabus which are to be given at regular intervals batch wise.Total Marks: 25
2. The tutorials could be conducted as per the following topics: -

Tutorial No 1	Basic calculations
Tutorial No 2	Static pressure and Manometer
Tutorial No 3	Fluid Kinematics
Tutorial No 4	Continuity and Bernoulli's equation
Tutorial No 5	Bernoulli's equation
Tutorial No 6	Flow meter calculations
Tutorial No 7	Losses in piping networks.
Tutorial No 8	Compressible fluids and stokes law.
Tutorial No 9	Centrifugal pump calculations
Tutorial No 10	Power in Agitation

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

<table>
<tr><td colspan="5">Program: Second Year Chemical Engineering</td><td colspan="5">Semester : III</td></tr>
<tr><td colspan="5">Course : Chemical Technology</td><td colspan="5">Course Code: DCHC306</td></tr>
<tr><td colspan="5">Course : Chemical Engineering Laboratory</td><td colspan="5">Course Code: DCHL306</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="9">Evaluation Scheme</td></tr>
<tr><td colspan="3">Semester End Examination Marks (A)</td><td colspan="4">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="3">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="3">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
<tr><td colspan="3">Laboratory Examination</td><td colspan="3">Term work</td><td rowspan="2">Total Term work</td><td rowspan="3">50</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">2</td><td rowspan="2">--</td><td rowspan="2">4</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td colspan="2">Tutorial / Mini project / presentation/ Journal</td></tr>
<tr><td>25</td><td>--</td><td>--</td><td>15</td><td colspan="2">10</td><td>25</td></tr>
</table>

Prerequisites

- Knowledge of Inorganic, Organic and Physical Chemistry, Thermodynamics and Basic Mathematics.

Course Objectives

- To give students an insight of different chemical processes.
- To understand the development of a process from its chemistry.
- To understand different engineering problems in process industries.

Course Outcomes

- At the end of the course the student will be able to Describe various manufacturing processes used in the chemical process industries.
- Explain industrial processing and overall performance of any chemical process including the major engineering problems encountered in the process.
- Determine the overall process aspects including yield, formation of by-products and generation of waste, etc.
- Draw and illustrate the process flow diagram for a given process.

Module	Contents	Contact Hours
1	**Introduction :** Chemical industries in India present and future trends Concepts of Unit Operations and Unit Processes used in Chemical Industries. General principals of thermodynamics and kinetics used in chemical processes.	3
2	**Inorganic Chemical industries** Manufacture of sulphuric acid Ammonia , Nitric acid, Urea Phosphoric acid by wet process , Single Superphosphates, Triple superphosphate Manufacture of Caustic Soda Manufacture of Hydrochloric Acid by combustion of chlorine and Hydrogen Manufacture of Soda Ash (Solvay and Dual Processes)	16
3	**Basic Building Blocks of Petrochemical Industry :** Introduction to Petroleum Refining Catalytic Cracking by Fluidized Catalytic Cracking Unit (FCCU) Naphtha Cracking for manufacture of ethylene and propylene Naphtha Reforming Separation of BTX (Benzene-Toluene-Xylene) Isomerization of Xylenes Separation of Xylene isomers	10
4	**Synthesis of Important Heavy Organic Chemicals and Intermediates :** Manufacture of Styrene by dehydrogenation of ethylbenzene Manufacture of Cumene from benzene and propylene Manufacture of Phenol from cumene by peroxidation-hydrolysis Process	7
5	**Natural Product Industries :** Hydrogenation of Vegetable Oils Manufacture of Sugar from Sugarcane, By-products obtained in manufacture of sugar, Inversion of sugar Manufacture of ethanol by fermentation of molasses	6

LIST OF EXPERIMENTS

Sr. No.	PREPARATION	Chemicals required	Apparatus/ glassware required
1	SOAP	Sodium hydroxide (20% solution), ethanol saturated solution of sodium chloride ,calcium chloride (5% solution), magnesium chloride (5% solution), ferric chloride (5% solution), cooking oil, phenolphthalein indicator solution.	250-mL beaker, 100- mL beaker; wire gauze; laboratory burner; glass stirring rod; test tubes; filter flask and B¨uchner funnel; filter paper ;graduated cylinder
2	ALUM FROM ALUMINUM	Aluminum can or aluminum metal, Crushed ice, 9M H_2SO_4, 1.5M KOH solution, Methanol, $NaHCO_3$ (sodium bicarbonate)	Glass filter funnel, B¨uchner filter funnel, filter paper, Steel wool, two 150 mL and two 150 ml beakers, 500 ml beaker, thermometer, ruler, stirring rod.
3	ASPRIN	2 gm salicylic acid, 5.0 ml of acetic anhydride, five drops of 85% phosphoric acid, distilled water	burette clamp, burner, stand with iron ring, wire gauze, ice bath,50 ml flask beaker, B¨uchner funnel aspirator
4	METHYL ORANGE	0.29 g of anhydrous sodium carbonate, 1.0 g of sulfanilic acid monohydrate, 0.375 g of sodium nitrite, 0.7 ml of dimethylaniline and 0.5 mL of glacial acetic acid, 10% aqueous sodium hydroxide, 1.25 ml of concentrated hydrochloric acid	50 ml Erlenmeyer flask, filter,100 ml beaker, test tube
5	THIOKOL RUBBER	Sodium hydroxide solution, 1M Sulfur 1,2-dichloroethane distilled or deionized water	Copper wire, approximately 6 inches long (15 cm); two 10 ml vials with Teflon cap liners, two 400 ml beakers ,10 ml graduated cylinder ,glass pipette (dropper), hot plate, chemical resistant gloves
6	RUBBER BALL FROM RUBBER LATEX	15 ml rubber latex, 15 ml vinegar, 15 ml water	Two paper cups (5 ounce), stirring rod (popsicle stick or equivalent), small bucket or large beaker (1000 ml or larger)
7	p-BROMONITROBENEZENE FROM BROMOBENEZENE	Conc. H_2SO_4, conc. HNO_3, bromobenzene, ethyl alcohol, conical flask, funnel, filter paper, water Bath.	Conical flask, funnel, filter paper, water bath.
8	DETERGENT	Dodecanol (dodecyl alcohol), sulphuric acid, concentrated sodium hydroxide, 6M phenolphthalein solution, 1% sodium chloride	Erlenmeyer flask, 125 ml beakers, 400 ml, 150 ml, 100 ml graduated cylinders, 10 ml, 25 ml, 125 ml funnel, spatula, stirring rod, Cheese cloth, watch glass, scissors

9	Biodiesel	Transesterification is carried out between oil and methanol in presence of homogeneous catalyst.	Magnetic stirrer with heater , separating funnel, glass rod, beaker
10	Artificial flevor,banana flevor	Fischer esterification method is used to prepare Isoamyle acetate by reaction of carboxylic acid and alcohol	Round bottom flask, Reflux, heating element, separating funnel

Text books:

1. Austin G.T., Shreve's Chemical Process Industries, 5th Edition, McGraw Hill International Edition,1984
2. Rao, G.N. and Sittig M., Dryden's Outlines of Chemical Technology for 21st Century, East West Press, 3rd Edition.,1997
3. B.K. Bhaskara Rao, A Textbook of Petrochemicals. 5th edition, 2004

Reference

1. Pandey, G.N., A Textbook of Chemical Technology, Vol.I and II, Vikas Publications, 1984.
2. B.K. Bhaskara Rao, Modern petroleum refining processes.
3. Heaton, C.A., An Introduction to Industrial Chemistry, Leonard Hill, 1984.
4. Chemical Process Technology, Moulijin, M. and Van Dippen, Wiley, 2013
5. Thomson, R., Modern Inorganic Chemical Industries, Royal Society of Chemistry, 2nd. Edition, 1994.
6. Kirk-Othmer's Encyclopedia of Chemical Technology, John Wiley and Sons,
7. Inc., 4th Edition, 1990.
8. Ullmann's Encyclopedia of Industrial Chemistry, VCH, 1985.
9. McKetta's Encyclopedia of Chemical Processing and Design, Marcel Dekker, 1999.
10. Pletcher D. and Walsh, F.C., Industrial Electrochemistry, Chapman and Hall, 1990.
11. Alok Adholeya and Pradeepkumar Dadhich, Production and Technology of Biodiesel: Seeding a Change, TERI Publication, New Delhi, 2008.
12. NIIR Board of Consultants and Engineers, The complete book on Jatropha (Biodiesel) with Ashwagandha, Stevia, Brahmi and Jatamansi Herbs (Cultivation, Processing and Uses), Asia Pacific Business Press Inc.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory:

1. Oral examination will be based on the entire syllabus including, the practicals performed during laboratory sessions.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

1. Term work shall consist of minimum 8 experiments.

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments): 15 Marks
ii. Journal Documentation (Write-up, Power Point Presentation and Assignments: 10 marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

<table>
<tr><td colspan="5">Program: Second Year Chemical Engineering</td><td colspan="5">Semester : III</td></tr>
<tr><td colspan="5">Course : Innovative Product Development – I</td><td colspan="5">Course Code: DJ19A2</td></tr>
<tr><td colspan="4" rowspan="3">Teaching Scheme (Hours/week)</td><td colspan="9">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="4">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="2">Lectures</td><td rowspan="2">Practical</td><td rowspan="2">Tutorial</td><td rowspan="2">Total Credits</td><td colspan="4">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="4">--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
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</table>

Objectives:

1. To acquaint the students with the process of identifying the need (considering a societal requirement) and ensuring that a solution is found out to address the same by designing and developing an innovative product.
2. To familiarize the students with the process of designing and developing a product, while they work as part of a team.
3. To acquaint the students with the process of applying basic engineering fundamentals, so as to attempt at the design and development of a successful value added product.
4. To inculcate the basic concepts of entrepreneurship and the process of self-learning and research required to conceptualize and create a successful product.

Outcome:

Learner will be able to:

1. Identify the requirement for a product based on societal/research needs.
2. Apply knowledge and skills required to solve a societal need by conceptualizing a product, especially while working in a team.
3. Use standard norms of engineering concepts/practices in the design and development of an innovative product.
4. Draw proper inferences through theoretical/ experimental/simulations and analyze the impact of the proposed method of design and development of the product.
5. Develop interpersonal skills, while working as a member of the team or as the leader.
6. Demonstrate capabilities of self-learning as part of the team, leading to life-long learning, which could eventually prepare themselves to be successful entrepreneurs.
7. Demonstrate product/project management principles during the design and development work and also excel in written (Technical paper preparation) as well as oral communication.

Guidelines for the proposed product design and development:

1. Students shall form a team of 3 to 4 students (max allowed: 5-6 in extraordinary cases, subject to the approval of the department review committee and the Head of the department).
2. Students should carry out a survey and identify the need, which shall be converted into conceptualization of a product, in consultation with the faculty supervisor/head of department/internal committee of faculty members.
3. Students in the team shall understand the effective need for product development and accordingly select the best possible design in consultation with the faculty supervisor.
4. Students shall convert the best design solution into a working model, using various components drawn from their domain as well as related interdisciplinary areas.
5. Faculty supervisor may provide inputs to students during the entire span of the activity, spread over 2 semesters, wherein the main focus shall be on self-learning.
6. A record in the form of an activity log-book is to be prepared by each team, wherein the team can record weekly progress of work. The guide/supervisor should verify the recorded notes/comments and approve the same on a weekly basis.
7. The design solution is to be validated with proper justification and the report is to be compiled in a standard format and submitted to the department. Efforts are to be made by the students to try and publish a technical paper, either in the institute journal, "Techno Focus: Journal for Budding Engineers" or at a suitable publication, approved by the department research committee/ Head of the department.
8. The focus should be on self-learning, capability to design and innovate new products as well as on developing the ability to address societal problems. Advancement of entrepreneurial capabilities and quality development of the students through the year long course should ensure that the design and development of a product of appropriate level and quality is carried out, spread over two semesters , i.e. during the semesters III and IV.

Guidelines for Assessment of the work:

1. The review/ progress monitoring committee shall be constituted by the Head of the Department. The progress of design and development of the product is to be evaluated on a continuous basis, holding a minimum of two reviews in each semester.
2. In the continuous assessment, focus shall also be on each individual student's contribution to the team activity, their understanding and involvement as well as responses to the questions being raised at all points in time.
3. Distribution of marks individually for the both reviews as well as for the first review during the subsequent semester shall be as given below:
    A. Marks awarded by the supervisor based on log-book :20
    B. Marks awarded by review committee : 20
    C. Quality of the write-up : 10

In the last review of the semester III, the marks will be awarded as follows.

1. Marks awarded by the supervisor (Considering technical paper writing) :30
2. Marks awarded by the review committee: :20

Note: - A candidate needs to secure minimum of 50% marks to be declared to have completed the audit course.

Review/progress monitoring committee may consider the following points during the assessment.

In the semester III, the entire design proposal shall be ready, including components/system selection as well as the cost analysis. Two reviews will be conducted based on the presentation given by the student's team.

1. First shall be for finalization of the product selected.
2. Second shall be on finalization of the proposed design of the product.

The overall work done by the team shall be assessed based on the following criteria;

1. Quality of survey/ need identification of the product.
2. Clarity of Problem definition (design and development) based on need.
3. Innovativeness in the proposed design.
4. Feasibility of the proposed design and selection of the best solution.
5. Cost effectiveness of the product.
6. Societal impact of the product.
7. Functioning of the working model as per stated requirements.
8. Effective use of standard engineering norms.
9. Contribution of each individual as a member or the team leader.
10. Clarity on the write-up and the technical paper prepared.

The semester reviews (III) may be based on relevant points listed above, as applicable.

Guidelines for Assessment of Semester Reviews:

1. The write-up should be prepared as per the guidelines given by the department.
2. The design and the development of the product shall be assessed through a presentation and demonstration of the working model by the student team to a panel of Internal and External Examiners, preferably from industry or any research organizations having an experience of more than five years, approved by the Head of the Institution. The presence of the external examiner is desirable only for the 2nd presentation in semester IV. Students are compulsorily required to present the outline of the technical paper prepared by them during the final review in semester IV.

Syllabus for Second Year Chemical Engineering - Semester III (Autonomous)
(Academic Year 2020-2021)

<table>
<tr><td colspan="8">Program: Common for All programs</td><td colspan="4">Semester: III</td></tr>
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<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="8">Evaluation Scheme</td></tr>
<tr><td colspan="5">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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Objectives:

1. To provide basic information about Indian constitution.
2. To identify individual role and ethical responsibility towards society.
3. To understand human rights and its implications.

Outcomes: On completion of the course, learner will be able to

1. Have general knowledge and legal literacy and thereby to take up competitive examinations.
2. Understand state and central policies, fundamental duties.
3. Understand Electoral Process, special provisions.
4. Understand powers and functions of Municipalities, Panchayats and Co- operative Societies,
5. Understand Engineering ethics and responsibilities of Engineers
6. Understand Engineering Integrity & Reliability

Detailed Syllabus: (unit wise)

Unit	Description	Duration
1	**Introduction to the Constitution of India** The Making of the Constitution and Salient features of the Constitution. Preamble to the Indian Constitution Fundamental Rights & its limitations.	02
2	**Directive Principles of State Policy:** Relevance of Directive Principles State Policy Fundamental Duties. Union Executives – President, Prime Minister Parliament Supreme Court of India.	03
3	**State Executives:** Governor, Chief Minister, State Legislature High Court of State. Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th & 91st Amendments.	03

4	**Special Provision**s: For SC & ST Special Provision for Women, Children & Backward Classes Emergency Provisions. **Human Rights:** Meaning and Definitions, Legislation Specific Themes in Human Rights- Working of National Human Rights Commission in India Powers and functions of Municipalities, Panchyats and Co – Operative Societies.	03
5	**Scope & Aims of Engineering Ethics**: Responsibility of Engineers Impediments to Responsibility. Risks, Safety and liability of Engineers, Honesty, Integrity & Reliability in Engineering	03

Books Recommended:

Textbooks:

1. Durga Das Basu: "Introduction to the Constitution on India", (Students Edn.) Prentice – Hall EEE, 19th / 20th Edn., 2001
2. Charles E. Haries, Michael S Pritchard and Michael J. Robins "Engineering Ethics" Thompson Asia, 2003-08-05.

Reference Books:

1. M.V.Pylee, "An Introduction to Constitution of India", Vikas Publishing, 2002.
2. M.Govindarajan, S.Natarajan, V.S.Senthilkumar, "Engineering Ethics", Prentice – Hall of India Pvt. Ltd. New Delhi, 2004
3. Brij Kishore Sharma, "Introduction to the Constitution of India", PHI Learning Pvt. Ltd., New Delhi, 2011.
4. Latest Publications of Indian Institute of Human Rights, New Delhi

Website Resources:

1.www.nptel.ac.in
2.www.hnlu.ac.in
3.www.nspe.org
4.www.preservearticles.com

Syllabus for Second Year Chemical Engineering - Semester IV (Autonomous)
(Academic Year 2020-2021)

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<tr><td colspan="8">Program: Second Year Chemical Engineering</td><td colspan="3">Semester: IV</td></tr>
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<tr><td colspan="4">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
<tr><td colspan="4">Laboratory Examination</td><td colspan="3">Term work</td><td rowspan="3">Total Term work</td><td rowspan="3">25</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">-</td><td rowspan="2">1</td><td rowspan="2">4</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td colspan="2">Tutorial / Mini project / presentation/ Journal</td></tr>
<tr><td>-</td><td>--</td><td>--</td><td>-</td><td colspan="2">25</td><td>25</td></tr>
</table>

Pre-requisite: Knowledge of the concepts of basic mathematics like Differential and Integral Calculus Vector Differentiation, Gradient ,Partial Differentiation and Maxima Minima .

Objectives:

1. To provide sound foundation in the mathematical fundamentals necessary to formulate, solve and analyze engineering problems
2. To study the basic principles of Fourier Series, Fourier Transform, Vector Integration, Complex Integration

Outcomes: On completion of the course, learner will be able to:

1. Demonstrate the ability of using Fourier Series and Fourier Transform.
2. Solve certain partial differential equations analytically
3. Enable the students to solve Vector Integration.
4. Identify the applicability of theorems and evaluate the Contour Integral.
5. Solve Non-Linear Optimization Problem.

Detailed Syllabus: (unit wise)		**Total Duration: 42**
Unit	**Description**	**Duration**
1	Fourier Series: 1.1 Orthogonal and Ortho-normal functions 1.2 Dirichlet's conditions, Fourier series of periodic functions with period 2π and 2L. Parsevel's identities (without proof). 1.3 Fourier series for even and odd functions. 1.4 Half range sine and cosine Fourier series, 1.5 Complex form of Fourier series. 1.6 Fourier Integral Representation, sine & cosine Integrals 1.7 Introduction to Fourier Transform, sine & cosine transforms, complex transforms. NO PROOFS REQUIRED	**10**
2	Partial Differential Equations: 2.1 Solutions of linear partial differential Equation by method of separation of variables 2.2 Partial differential equations governing transverse vibrations of elastic string its solution using Fourier series. 2.3 Heat equation, steady-state configuration for heat flow. 2.4 Two dimensional Laplace equations.	**8**
3	**Vector Integration** Green's Theorem in the plain; Conservative &Solenoidal Fields. Gauss Divergence Theorem, Stokes' Theorem. (ONLY NUMERICAL PROBLEMS. NO PROOFS REQUIRED).	**7**
4	Complex Integration 4.1 Line Integral, Cauchy's Integral theorem for simply connected regions, Cauchy's Integral formula(without proof) 4.2 Taylor's and Laurent's series (without proof) 4.3 Zeros, poles of f(z), Residues, Cauchy's Residue theorem 4.4 Applications of Residue theorem to evaluate Integrals of the type $\int_0^{2\pi} (\sin\theta, \cos\theta)\, d\theta, \int_{-\infty}^{\infty} f(x)\, dx$	**7**
5	Optimization (No theory) 5.1Non-linear programming: Lagrange multiplier method for one and two equality constraints for 2 and 3 variables, conditions on the Hessian matrix (no proof); 5.2 Non-linear programming: Kuhn-Tucker conditions with at most 2 constraints with two variables.	**7**

Books Recommended:

Text books:

1. Higher Engineering Mathematics by Dr. B. S. Grewal,44th Edition, Khanna Publication, 2020
2. Operation Research by ER. Prem Kumar Gupta and Dr. D. S. Hira, 7th Edition, S. Chand Publishing, 2014

Reference Books:

1. Advanced Engineering Mathematics by Kreyszig E. 10th edition, John Wiley and Sons, inc., 2011
2. Advanced Engineering. Mathematics by C. Ray Wylie and Louis Barrett.TMH International Edition, 1995

3. Mathematical Methods of Science and Engineering: Aided with MATLAB by Kanti B. Datta, Cengage Learning , 2012
4. Advanced Engineering Mathematics –Fourth Edition , Dennis G Zill and Michael R Cullen ,4th Edition, Narosa Publication
5. Nonlinear Programming : Theory And Algorithms 3rd Edition by Mokhtar S. Bazaraa , Hanif D. Sherali and C. M. Shetty, Wiley India .

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Tutorial: (Term work)

Term work shall consist of **minimum** 8 Tutorials covering the entire modules.

The Tutorials could be conducted as follows:

Tutorial No	Topics
1	Fourier Series -Finding Fourier Coefficients
2	Fourier Series-Complex Fourier Series
3	Fourier Transform
4	Partial Differential Equation -Wave equation
5	Partial Differential Equation -Heat equation
6	Vector Integration- Green's Theorem in the plain; Conservative &Solenoidal Fields
7	Vector Integration-Stoke's Theorem and Gauss Divergence Theorem
8	Complex Integration – Contour Integration
9	Complex Integration- Application of Residue Theorem
10	Optimization-NLPP

The distribution of marks for term work shall be as follows:

Tutorial– 25 marks

The final certification and acceptance of term work will be subject to satisfactory performance of tutorial work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Second Year Chemical Engineering - Semester IV (Autonomous)
(Academic Year 2020-2021)

Program: Second Year Chemical Engineering	**Semester : IV**
Course : Advanced Chemistry-II Theory	**Course Code: DJ19CHC402**
Course : Advanced Chemistry-II Laboratory	**Course Code: DJ19CHL402**

Teaching Scheme (Hours / week)				**Evaluation Scheme**						
				Semester End Examination Marks (A)			**Continuous Assessment Marks (B)**			**Total marks (A+ B)**
Lectures	**Practical**	**Tutorial**	**Total Credits**	**Theory**			**Term Test 1**	**Term Test 2**	**Avg.**	
				75			**25**	**25**	**25**	**100**
				Laboratory Examination			**Term work**		**Total Term work**	**50**
2	**2**	**--**	**3**	**Oral**	**Practical**	**Oral & Practical**	**Term Work**	**Tutorial / Mini project / presentation/ Journal**		
				--	**25**	**--**	**25**	**--**	**25**	

Pre-requisite:

- Syllabus of First Year Engineering, Semester I and Semester II (DISCOE – Autonomous).

Objectives:

- To understand applications of EMF measurement.
- To get acquainted with the principles of different instrumental and spectroscopic techniques.
- To be able to predict the significance of active methylene group.
- To illustrate the importance of colloids, emulsions and emulsifying agents in various fields
- To understand the importance of rearrangement reactions.
- To understand different concepts of organic reactions.

Outcomes: After completion of the course, students would be able to:

- Describe different types of cells and compare cells with transference and without transference.
- Understand the principles of different instrumental and spectroscopic techniques.
- Explain the reactions containing compounds containing active methylene group.
- To acquire knowledge of colloids, emulsions and emulsifying agents in various fields.
- Understand the mechanism of rearrangement reactions.
- Understand the mechanism of various reactions.
- To state and understand Nernst distribution law in solvent extraction.
- To be able to solve numerical on solvent extraction and ion exchange.

Detailed Syllabus: (Unit wise)		
Unit	**Description**	**Duration (Hours)**
1	**Electrochemistry:** Conductance, specific conductance, equivalent conductance, molar conductance. Effect of dilution and temperature on conductance. Transport number (numerical on moving boundary method). Debye Huckel theory of strong electrolytes. Hydrogen ion concentration by glass electrode/Quinhydrone electrode. Concentration cells with and without transference w.r.t. cations. Weston Standard cells. Application of EMF measurement and other technique for determination of solubility product (Ksp) of sparingly soluble salt.	**08**
2	**Instrumental methods of Analysis & Separation technique:** Conductometry: Principle and types of titrations - Acid-base and precipitation. Potentiometry: Principle and types of titrations - Acid-base and precipitation. Amperometry: Methods and applications. Spectroscopic techniques: Beer Lambert law, UV, IR, NMR. Solvent extraction: Nernst distribution law. Distribution ratio. Batch, continuous and countercurrent extraction. Numerical based on solvent extraction.	**08**
3	**Industrially important esters:** Synthesis and properties of malonic ester and acetoacetic ester.	**02**
4	**Colloids and surfactants:** Origin of charge on colloidal particles. Concept of electrical double layer. Helmholtz and stern models. Electro-kinetic Phenomenon- Electrophoresis, electro-osmosis, streaming potential and Dorn effect (Sedimentation potential). Colloidal electrolytes, Donnan Membrane equilibrium and its significance.	**04**
5	**Alkylation, acylation and rearrangement reactions:** Mechanism and applications of Friedal-Crafts Alkylation and Acylation reactions, Wagner-Meerwein rearrangement, Beckmann rearrangement, Benzil- Benzilic acid rearrangement.	**04**
6	**Name reactions:** Mechanism and applications of Fischer-Indole synthesis, Knoevenagel reaction, Reformatsky reaction, Meerwein-Ponndorf-Verley reduction.	**04**

Books Recommended:

Reference Books:

1. B.R. Puri, L.R. Sharma & K.C. Kalia., "Principles of Inorganic Chemistry", 33rd edition. Milestone/Vishal Publishers, New Delhi (2017).
2. J. D. Lee, "Concise Inorganic Chemistry", 5th edition. Wiley India Pvt. Ltd., New Delhi, (2014).
3. Michael B. Smith, Jerry March, "March's Advanced Organic Chemistry – Reactions, Mechanisms, and Structure", Sixth Edition. John Wiley & Sons, Inc., New Jersey, (2007).
4. V.K. Ahluwalia, Rakesh K. Parashar, "Organic Reaction Mechanisms", Fourth Edition. Narosa Publishing House, New Delhi, (2018).
5. Peter Skyes, "A Guidebook To Mechanisms In Organic Chemistry", Sixth Edition. PEARSON INDIA, New Delhi, (2003).
6. Glasstone Samuel, "Textbook of Physical Chemistry", 2nd edition. Macmillan India Ltd., London, (1962).
7. B.R. Puri, L.R. Sharma, M.S. Pathania, "Principles of Physical Chemistry", 47th edition. Vishal Publishing Co., Punjab, (2016).
8. S.S. Dara, S.S. Umare, "A Textbook of Engineering Chemistry", 25th edition. S. Chand & Company Pvt. Ltd. New Delhi, (2010).
9. Gurdeep R. Chatwal, Sham Anand, "Instrumental methods of Chemical Analysis", Fifth Edition, Himalaya Publishing House, Mumbai, (2019).
10. A.I. Vogel, A.R. Tatchell, B.S. Furnis, A.J. Hannaford, P.W.G. Smith, "Vogel's Textbook of Practical Organic Chemistry", Fifth Edition, Longman Scientific & Technical, England, (1989).

List of Experiments Suggested:

A] Organic spotting: Identification of organic compounds at least 05.

B] Potentiometric titrations.

i) Titration of strong acid and strong base potentiometrically.
ii) Determination of solubility and solubility product of AgCl.

C] pH-metry.

Determination of dissociation constant of dibasic organic acids such as malonic acid, succinic acid.

D] Conductometric Titrations.

i) Titration of strong acid with strong base.
ii) Weak acid against strong base.
iii) Titration of mixture of weak acid and strong acid against strong base.

E] Chromatography.

Estimation of Sodium by Ion Exchange chromatography.

F] Spectrophotometry.

. i) Estimation of Fe^{3+} ions by Spectrophotometry.

G] Organic Estimations.

i) Estimation of Glucose Iodometrically.
ii) Estimation of Ester by Hydrolysis.
iii) Volume strength and amount of H_2O_2.

Students have to perform at least 10 practicals from the above during the semester.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Practical Examination:

1. A student become eligible for practical examination after completing a minimum of eight experiments out of ten experiments.
2. Practical examination: 25 Marks.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Term work:

1. Batch wise laboratory work is to be conducted to develop a rational temperament for scientific observations which lead to constructive inferences essential for technology studies. Students must be encouraged to perform minimum ten experiments and submit the Laboratory Journal.
2. Total Marks: 25

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Second Year Chemical Engineering - Semester IV (Autonomous)
(Academic Year 2020-2021)

Program: Second Year Chemical Engineering	**Semester : IV**
Course : Solid Fluid Mechanical Operations- Theory	**Course Code:DJ19CHC403**
Course : Solid Fluid Mechanical Operations- Laboratory	**Course Code:DJ19CHL403**

Teaching Scheme (Hours / week)				**Evaluation Scheme**						
				Semester End Examination Marks (A)			**Continuous Assessment Marks (B)**			**Total marks (A+ B)**
Lectures	**Practical**	**Tutorial**	**Total Credits**	**Theory**			**Term Test 1**	**Term Test 2**	**Avg.**	
				75			**25**	**25**	**25**	**100**
				Laboratory Examination			**Term work**		**Total Term work**	**50**
3	**2**	**-**	**4**	**Oral**	**Practical**	**Oral & Practical**	**Laboratory Work**	**Tutorial / Mini project / presentation/ Journal**		
				-	**-**	**25**	**10**	**15**	**25**	

Pre-requisite: Knowledge of

- Fluid Flow
- Engineering Mechanics
- Differential equations

Objectives:

1. Understanding basic concept of particle size analysis and size reduction.
2. Understanding concept of filtration, types of filtration and equipments used for filtration.
3. Understanding concept of solid-liquid and gas-solid separation.
4. Understanding concept of size enlargement, solid mixing and solid handling.

Outcomes: On completion of the course:

1. Students would understand the concept of particle size analysis and size reduction.
2. Students would understand the concept of filtration, types of filtration and equipments used for filtration.
3. Students would understand the concept of solid-liquid and gas- solid separation.
4. Students would understand the concept of size enlargement, solid mixing and solid handling.

Detailed Syllabus: (unit wise)

Unit	**Description**	**Duration**
1	**Particle Technology and Size Reduction-** Introduction- Scope & applications of solid fluid operation; Particle size analysis; particle size measurement and Distribution; Sieve analysi; Capacity and effectiveness of screen; Screening Equipment: Vibrating screens, Grizzlier, TrommelsP; Size reduction of solids; Mechanism of size reduction and methods of operation; Energy of size reduction; Size reduction Equipments: Jaw Crusher, Hammer Mill, Ball Mill, Roll Crusher.	**12**
2	**Filtration-** Flow through packed bed and Types of packings; Flow of a single fluid through a packed bed, Ergun's Equation; Filtration: Mechanism of Filtration; Types of	**10**

	Filtration – constant rate & constant pressure filtration; Filter aids, washing of filter cake; Flow of filtrate through the cloth & cake combined; Numericals on constant pressure & constant cloth rate & combine cake; Filters: Rotary drum vacuum filter, Plate & frame filter press.	
3	**Solid-Liquid and Gas-Solid Separation Methods-** Sedimentation: Batch sedimentation; Kynch Theory of sedimentation; Area and Depth of thickener; Particle separation by Flotation and Elutriation; Gas solid separation Equipments: Cyclone separator- theory and derivation for minimum particle size separated in cyclone separator; Fabric filter. Electrostatic precipitator	**10**
4	**Size Enlargement, Solid Handling and Solid Mixing-** Size enlargement of particles: Agglomeration & granulation. Growth mechanism; Size enlargement processes; Storage of solids: Properties of particulate masses; Pressures in Bins & Silos; Janssen equation. Conveying of solids: Belt conveyor, bucket conveyer, screw conveyer, pneumatic conveyer. Solid mixing: Introduction to solid mixing, degree of mixing, mixing Index & rate of mixing; Mixing Equipments:1) Mixers for cohesive solids: Muller Mixer; Kneaders 2) Mixers for free flowing solids: Ribben Blender; Internal Screw mixer	**10**

Books Recommended:

Text books:

1. Unit operations of Chemical engineering, WC McCabe & J C Smith, McGraw Hill, 7th Ed, 2017.
2. Chemical Engineering, Vol II. J M Coulson & J F Richardson, Pergamon Press, 6th Ed, 2019.
3. Mechanical operations for Chemical engineers by C. M. Narayanan and B. C. Bhattacharya. Khanna Publications, 3rd Ed, 1999.

Reference Books:

1. Perry's Handbook for chemical Engineers, Robert H. Perry & Don W. Green, McGraw Hill, 8th Ed, 2007.
2. Principles of Unit operations by Foust et al, John Wiley & Sons, 2nd Ed, 1980.

List of Experiments Suggested:

1. Sieve Analysis
2. Effectiveness of Screen
3. Size reduction by Jaw Crusher
4. Size reduction by Hammer Mill
5. Size reduction by Ball Mill
6. Roll Crusher
7. Batch Sedimentation
8. Flow through Packed Bed
9. Filtration
10. Mixing
11. Cyclone Separator
12. Elutriation
13. Froth Floatation

Minimum 10 Experiments should be performed.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper will be based on the entire syllabus of the subject and will be of 75 marks.
2. Duration: 3 hrs.

1. A student becomes eligible for practical examination after completing a minimum of eight experiments out of ten experiments.
2. Practical examination: 25 Marks.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Term work:

1. Batch wise laboratory work is to be conducted to develop a rational temperament for scientific observations which lead to constructive inferences, essential for technology studies. Students must be encouraged to perform ten experiments and submit the Laboratory Journal.
2. Total Marks: 25

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Second Year Chemical Engineering - Semester IV (Autonomous)
(Academic Year 2020-2021)

Program: Second Year Chemical Engineering	**Semester : IV**
Course : Chemical Engineering Thermodynamics -II	**Course Code: DJ19CHC404**
Course : Chemical Engineering Thermodynamics -II Tutorial	**Course Code: DJ19CHT404**

Teaching Scheme (Hours / week)				**Evaluation Scheme**						
				Semester End Examination Marks (A)			**Continuous Assessment Marks (B)**			**Total marks (A+ B)**
Lectures	**Practical**	**Tutorial**	**Total Credits**	**Theory**			**Term Test 1**	**Term Test 2**	**Avg.**	
				75			**25**	**25**	**25**	**100**
				Laboratory Examination			**Term work**		**Total Term work**	**25**
3	**--**	**1**	**4**	**Oral**	**Practical**	**Oral & Practical**	**Laboratory Work**	**Tutorial / Mini project / presentation/ Journal**		
				--	--	--	--	**25**	**25**	

Pre-requisite:

- Engineering Mathematics, First Law, Second Law for open systems.

Objectives:

- Understanding the concepts of equilibrium in phases and in chemical reactions.
- Learn to calculate conditions and compositions of ideal and non- ideal vapor liquid equilibrium systems and of various chemical reactions at equilibria.

Outcomes:

- The calculation of phase equilibria and the understanding of it is a fundamental concept to design of mass transfer.
- Chemical Reaction equilibria, its variation with process conditions.
- Mass and energy balance of Batch and Continuous Reactor.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration (Hours)**
01	Non ideal solutions and mixutures, Chemical potential, Activity and activity coefficients, Gibbs Duhem equations	**10**
02	Partial molar properties, Properties changes of mixing, Excess properties	**12**
03	Concept of equilibrium between phases, Review of Raoult's law and Henry's law, Phase diagrams for binary solutions, Vapor liquid equilibria in ideal and non-ideal solutions, Estimation of activity coefficients using Van Laar equation, Margules equation, Wilson equation	**10**
04	Representation of reaction stoichiometry, Concept of reaction equilibrium in single and multiple reactions, Estimation of standard enthalpy change of a reaction, Heat of reaction in a batch and continuous reactor	**10**

Books Recommended:

Text books:

1. Chemical, Biochemical and Engineering Thermodynamics, by Stanley I Sandler, John Wiley & Sons, 4th Edition.

Reference Books:

Introduction to Chemical Engineering Thermodynamic by J.M. Smith, H.C. Van Ness, M.M. Abbott, 8th Edition McGraw Hill Publishing Company Limited, 2018

Fundamentals of Engineering Thermodynamics by Micheal J Moran , Howard N Shaprio, 9th Edition, Wiley publication.

Phase Equilibria in Chemical Engineering by Stanley Walas, Butterworth-Heinemann (Published on 22 October 2013).

Evaluation Scheme:

Semester End Examination (A):

Theory:

Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.

Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

Two term tests of 25 marks each will be conducted during the semester. Total duration allotted for writing each of the paper is 1 hr.

Average of the marks scored in both the two tests will be considered for final grading. *Tutorial: (Term work)*

1. Term work shall consist of minimum ten tutorials from entire syllabus which are to be given at regular intervals batch wise. Total Marks: 25
2. Use of MS Excel or Libre Office Calc to do calculation is mandatory.
3. The tutorials could be conducted as per the following topics: -

Tutorial No 1	Calculate the partial volumes from the equation for excess volume
Tutorial No 2	Calculate the partial enthalpy from equation of excess enthalpy
Tutorial No 3	Calculate the heat of solution for a mixer in steady state.
Tutorial No 4	Calculate P-x-y using Raoults law.
Tutorial No 5	Calculate T-x-y using Raoults law.
Tutorial No 6	Draw P-x-y using Margules equation for a binary mixutre.
Tutorial No 7	Draw T-x-y using Margules equations for a binary mixture.
Tutorial No 8	Find the reaction equlibria.
Tutorial No 9	Find the reaction equlibria and heat to be removed in a plug flow reactor.
Tutorial No 10	Find the temperature profile in an adiabatic exothermic reactor.

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work and upon fulfilling minimum passing criteria in the term work.

Syllabus for Second Year Chemical Engineering - Semester IV (Autonomous)
(Academic Year 2020-2021)

<table>
<tr><td colspan="8">Program: Second Year Chemical Engineering</td><td colspan="3">Semester: IV</td></tr>
<tr><td colspan="8">Course: Chemical Engineering Economics</td><td colspan="3">Course Code: DJ19CHC405</td></tr>
<tr><td colspan="8">Course: Chemical Engineering Economics Tutorial</td><td colspan="3">Course Code: DJ19CHT405</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours / week)</td><td colspan="7">Evaluation Scheme</td></tr>
<tr><td colspan="4">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
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<tr><td colspan="4">75</td><td>25</td><td>25</td><td>25</td><td>100</td></tr>
<tr><td colspan="4">Laboratory Examination</td><td colspan="3">Term work</td><td rowspan="3">Total Term work</td><td rowspan="3">25</td></tr>
<tr><td rowspan="2">3</td><td rowspan="2">--</td><td rowspan="2">1</td><td rowspan="2">4</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Laboratory Work</td><td colspan="2">Tutorial / Mini project / presentation/ Journal</td></tr>
<tr><td>--</td><td>--</td><td>--</td><td>--</td><td>25</td><td>25</td></tr>
</table>

Pre-requisite:

- The concepts of basic mathematics as well as a few concepts of higher mathematics.
- The concepts of basic chemistry, basic civil engineering, basic mechanical engineering in order to understand the concepts like, corrosion, corrosion allowance, construction costs and equipment costs

Objectives:

- To understand various economical terms and economics related activities which can be helpful to them during economical evaluation of any chemical engineering related problem.
- To learn about various basic economic aspects like need, demand, supply, price, cost and market.
- To make familiar to calculate the interest amount on investments as well as loans by different methods
- To understand the concepts of present and future worth of property.
- To understand existing rules and regulations as well as types related to taxes and insurance.
- To understand the methodology of cost estimation including fixed and variable costs by considering the concept of cost indices.
- To have the knowledge about evaluation of depreciation cost as well as salvage value, scrap value, book value of property.
- To understand the concept of profitability evaluation of project and select best process alternative based on its economic evaluation.
- To understand the concept of balance sheet, profit and loss accounting and income statement

Outcomes:

- Students should will be expose to market and demand driven economics in chemical industry.
- Get an idea on the growth and development of futuristic planning.
- Students will be able to calculate the profitability, rate of return on investments and cost estimation.
- After acquiring the knowledge in this subject, students become familiar with various aspects related to economics and can apply them for economic evaluation of chemical process and decide its economic feasibility.

- The knowledge in this subject will make the students well aware about economic evaluation of dissertation work that they will undertake in final year of their curriculum.

Detailed Syllabus: (unit wise)

Unit	Description	Duration (Hours)
1	**Introduction to Basic Principles of Economics:** • Economics-various definitions • Concept of Need – hierarchy • Market - Concept of Price determination under particular market conditions • Price Discrimination-concept, types	01
2	**Demand and Supply analysis**: • Law of demand-assumptions and exceptions • Demand schedule and demand curve • Demand elasticity • Law of Supply-assumptions and exceptions • Supply schedule and supply curve • Determinants of supply, changes and variations in supply • Supply elasticity	02
3	**Economics of production and Growth:** • Diseconomies of scale • Growth v/s Development • Determinants of growth (economic and non-economic) • Stages of growth • Growth strategy	02
4	**Cost Accounting:** • Outline of Accounting Procedure • Basic Relationship in Accounting • Balance Sheet- Types of Asset; Current and Cash Ratio • Income Statement • Material cost – Different Methods: current average, fifo, lifo	04
5	**Interests and Investment Costs:** • Types of Interest • Present worth and Discount • Annuities, Perpetuities and Capitalized costs	05
6	**Taxes and Insurance:** • Concept of taxes and insurance • Types of Taxes - property tax, excise tax, income tax, capital gain tax, surtax etc. • Insurance types, Self-insurance	02
7	**Depreciation** • Types of depreciation • Methods for determining depreciation - straight-line method, declining-balance (or fixed percentage) method, sum-of-the-years-digits method and sinking-fund method.	04
8	**Cost Estimation:** • Cash flow to Industrial operation – Tree diagram; Cumulative Cash position • Total, fixed, working capital investment • Breakdown of Fixed capital investment- Direct costs; Indirect costs; • Concept of Cost-total cost, fixed and variable cost, direct and indirect cost • Cost index – definition, types • Estimation of equipment cost by scaling (six tenth rule); Components of costs in FCI; • Estimation of Total Product Cost • Break even analysis	11

9	**Profitability, Alternative Investments & Replacements:** • Introduction; Profitability Standards; • Mathematical methods for profitability evaluation- Rate of Return on investment method, Discounted cash flow method, Net present worth method, Capitalized Cost method, Pay out period method • Alternative investments • Replacement analysis	**11**

Books Recommended:

Text books:

1. Peters, M. S. and Timmerhaus, K. D., "Plant design and economics for chemical engineers", latest edition, McGraw Hill, New York
2. K. K Dewett and Adarshchand, "Modern Economic Theory", latest edition, S Chand and Company P Khanna, "Industrial Engineering and Management" Dhanpat Rai Publications (P) Ltd.

Reference Books:

1. Pravin Kumar "Fundamentals of Engineering Economics" Wiley India.
2. Kharbanda, O. P. and Stallworthy, E. A. "Capital cost estimating for Process Industries", Butterworths, London.
3. Atul Sathe, Shubhada Kanchan, "Chemical Engineering Economics", Vipul Prakashan, Mumbai.

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper based on the entire syllabus will comprise of 5 questions (All compulsory, but with internal choice as appropriate), each carrying 15 marks, total summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading. *Tutorial: (Term work)*

1. Term work shall consist of minimum ten tutorials from entire syllabus which are to be given at regular intervals batch wise. Total Marks: 25
2. The tutorials could be conducted as per the following topics: -

Tutorial No 1	Interest and Investment Cost
Tutorial No 2	Capitalized Cost
Tutorial No 3	Taxes and Insurance
Tutorial No 4	Cost Estimation
Tutorial No 5	Total product cost
Tutorial No 6	Estimation of FCI
Tutorial No 7	Depreciation
Tutorial No 8	Profitability
Tutorial No 9	Alternative Investment
Tutorial No 10	Balance sheet

The final certification and acceptance of term work will be subject to satisfactory performance of tutorial work and upon fulfilling minimum passing criteria in the term work.

Program: Common for all program				Semester: IV				
Course: Universal Human Values				Course Code: DJ19IHC1				
Course: Universal Human Values Tutorial				Course Code: DJ19IHT1				
Teaching Scheme (Hours / week)				Evaluation Scheme				
				Semester End Examination Marks (A)			Continuous Assessment Marks (B)			Total marks (A+ B)
Lectures	Practical	Tutorial	Total Credits	Theory			Term Test 1	Term Test 2	Avg.	
				75			25	25	25	100
				Laboratory Examination						
2	--	1	3	Oral	Practical	Oral & Practical	Total Term work (C)			125
				--	--	--	25			

Objectives:

1. Development of a holistic perspective based on self-exploration about themselves (human being), family, society, and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society, and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

Outcomes: On completion of the course, learner will be able to:

1. Become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind. They would have better critical ability.
2. Become sensitive to their commitment towards what they have understood (human values, human relationship, and human society).
3. Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Unit	Description	Duration in Hrs
1	**Introduction**: **Need, Basic Guidelines, Content and Process for Value Education** Purpose and motivation for the course. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. Continuous Happiness and Prosperity- A look at basic Human Aspirations. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority. Understanding Happiness and Prosperity correctly- A critical appraisal of the current	05

scenario.
Method to fulfil the above human aspirations: understanding and living in harmony at various levels.

2	**Understanding Harmony in the Human Being - Harmony in Myself!** Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. Understanding the Body as an instrument of 'I' (I am being the doer, seer and enjoyer). Understanding the characteristics and activities of 'I' and harmony in 'I'. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. Programs to ensure Sanyam and Health.	**06**
3	**Understanding Harmony in the Family and Society: Harmony in Human-Human Relationship**. Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship. Understanding the meaning of Trust; Difference between intention and competence. Understanding the meaning of Respect, Difference between respect and **06** differentiation; the other salient values in relationship. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.	
4	**Understanding Harmony in the Nature and Existence: Whole existence as Coexistence** Understanding the harmony in the Nature 19. Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation in nature. Understanding Existence as Co-existence of mutually interacting units in all pervasive space. Holistic perception of harmony at all levels of existence.	**05**
5	**Implications of the above Holistic Understanding of Harmony on Professional Ethics**: Natural acceptance of human values 23. Definitiveness of Ethical Human Conduct. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order, b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems.	**06**

	Case studies of typical holistic technologies, management models and production systems. Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists, and managers, b. At the level of society: as mutually enriching institutions and organizations.	

Books Recommended:

Textbooks:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010

Reference books:

1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. The Story of Stuff (Book).
4. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi
5. Small is Beautiful - E. F Schumacher.
6. Slow is Beautiful - Cecile Andrews
7. Economy of Permanence - J C Kumarappa
8. Bharat Mein Angreji Raj - PanditSunderlal
9. Rediscovering India - by Dharampal
10. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi

12. Vivekananda - Romain Rolland (English)
13. Gandhi - Romain Rolland (English)

Evaluation:

Semester End Examination (A):

Theory:

1) Question paper will be based on the entire syllabus summing up to 75 marks.
2) Total duration allotted for writing the paper is 3 hrs.

Continuous Assessment (B):

Theory:

1) Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2) Total duration allotted for writing each of the paper is 1 hr.
3) Average of the marks scored in both the two tests will be considered for final grading.

Continuous Assessment (C):

Tutorials: (Term work)

1. Term work shall consist of minimum 4 activities based on activities suggested.
2. Term work shall carry total 25 marks based on the performance in the tutorials.

The tutorials could be conducted as per the following topics: -

Activity No 1	Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony, and co-existence) rather than as arbitrariness in choice based on liking-disliking.
Activity No 2	Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.
Activity No 3	Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.
Activity No 4	Practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.
Activity No 5	Practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. To discuss the conduct as an engineer or scientist etc.

The final certification and acceptance of term work will be subject to satisfactory performance of activities and upon fulfilling minimum passing criteria in the term work.

<table>
<tr><td colspan="5">Program: Second Year Chemical Engineering</td><td colspan="5">Semester : IV</td></tr>
<tr><td colspan="5">Course : Innovative Product Development - II</td><td colspan="5">Course Code: DJ19A4</td></tr>
<tr><td colspan="4" rowspan="2">Teaching Scheme (Hours/week)</td><td colspan="5">Evaluation Scheme</td></tr>
<tr><td colspan="3">Semester End Examination Marks (A)</td><td colspan="3">Continuous Assessment Marks (B)</td><td rowspan="2">Total marks (A+ B)</td></tr>
<tr><td rowspan="3">Lectures</td><td rowspan="3">Practical</td><td rowspan="3">Tutorial</td><td rowspan="3">Total Credits</td><td colspan="3">Theory</td><td>Term Test 1</td><td>Term Test 2</td><td>Avg.</td></tr>
<tr><td colspan="3">--</td><td>--</td><td>--</td><td>--</td><td>--</td></tr>
<tr><td colspan="3">Laboratory Examination</td><td colspan="2">Semester review</td><td rowspan="2">Total</td><td rowspan="3">100</td></tr>
<tr><td>--</td><td>2</td><td>--</td><td>--</td><td>Oral</td><td>Practical</td><td>Oral & Practical</td><td>Review 1</td><td>Review 2</td></tr>
<tr><td colspan="4"></td><td>--</td><td>--</td><td>--</td><td>50</td><td>50</td><td>100</td></tr>
</table>

Objectives:

1. To acquaint the students with the process of identifying the need (considering a societal requirement) and ensuring that a solution is found out to address the same by designing and developing an innovative product.
2. To familiarize the students with the process of designing and developing a product, while they work as part of a team.
3. To acquaint the students with the process of applying basic engineering fundamentals, so as to attempt at the design and development of a successful value added product.
4. To inculcate the basic concepts of entrepreneurship and the process of self-learning and research required to conceptualize and create a successful product.

Outcome:

Learner will be able to:

1. Identify the requirement for a product based on societal/research needs.
2. Apply knowledge and skills required to solve a societal need by conceptualizing a product, especially while working in a team.
3. Use standard norms of engineering concepts/practices in the design and development of an innovative product.
4. Draw proper inferences through theoretical/ experimental/simulations and analyze the impact of the proposed method of design and development of the product.
5. Develop interpersonal skills, while working as a member of the team or as the leader.
6. Demonstrate capabilities of self-learning as part of the team, leading to life-long learning, which could eventually prepare themselves to be successful entrepreneurs.

7. Demonstrate product/project management principles during the design and development work and also excel in written (Technical paper preparation) as well as oral communication.

Guidelines for the proposed product design and development:

1. Students shall form a team of 3 to 4 students (max allowed: 5-6 in extraordinary cases, subject to the approval of the department review committee and the Head of the department).
2. Students should carry out a survey and identify the need, which shall be converted into conceptualization of a product, in consultation with the faculty supervisor/head of department/internal committee of faculty members.
3. Students in the team shall understand the effective need for product development and accordingly select the best possible design in consultation with the faculty supervisor.
4. Students shall convert the best design solution into a working model, using various components drawn from their domain as well as related interdisciplinary areas.
5. Faculty supervisor may provide inputs to students during the entire span of the activity, spread over 2 semesters, wherein the main focus shall be on self-learning.
6. A record in the form of an activity log-book is to be prepared by each team, wherein the team can record weekly progress of work. The guide/supervisor should verify the recorded notes/comments and approve the same on a weekly basis.
7. The design solution is to be validated with proper justification and the report is to be compiled in a standard format and submitted to the department. Efforts are to be made by the students to try and publish a technical paper, either in the institute journal, "Techno Focus: Journal for Budding Engineers" or at a suitable publication, approved by the department research committee/ Head of the department.
8. The focus should be on self-learning, capability to design and innovate new products as well as on developing the ability to address societal problems. Advancement of entrepreneurial capabilities and quality development of the students through the year long course should ensure that the design and development of a product of appropriate level and quality is carried out, spread over two semesters, ie during the semesters III and IV.

Guidelines for Assessment of the work:

1. The review/ progress monitoring committee shall be constituted by the Head of the Department. The progress of design and development of the product is to be evaluated on a continuous basis, holding a minimum of two reviews in each semester.
2. In the continuous assessment, focus shall also be on each individual student's contribution to the team activity, their understanding and involvement as well as responses to the questions being raised at all points in time.
3. Distribution of marks individually for the both reviews as well as for the first review during the subsequent semester shall be as given below:
    1. Marks awarded by the supervisor based on log-book : 20
    2. Marks awarded by review committee : 20
    3. Quality of the write-up : 10

In the last review of the semester IV, the marks will be awarded as follows.

1. Marks awarded by the supervisor (Considering technical paper writing) :30
2. Marks awarded by the review committee: :20

Note: - A candidate needs to secure minimum of 50% marks to be declared to have completed the audit course.

Review/progress monitoring committee may consider the following points during the assessment.

In the semester IV, the expected work shall be procurement of components/systems, building of the working prototype, testing and validation of the results based on work completed in semester III.

1. First review is based on readiness of building the working prototype.
2. Second review shall be based on a presentation as well as the demonstration of the working model, during the last month of semester IV. This review will also look at the readiness of the proposed technical paper presentation of the team.

The overall work done by the team shall be assessed based on the following criteria;

1. Quality of survey/ need identification of the product.
2. Clarity of Problem definition (design and development) based on need.
3. Innovativeness in the proposed design.
4. Feasibility of the proposed design and selection of the best solution.
5. Cost effectiveness of the product.
6. Societal impact of the product.
7. Functioning of the working model as per stated requirements.
8. Effective use of standard engineering norms.
9. Contribution of each individual as a member or the team leader.
10. Clarity on the write-up and the technical paper prepared.

The semester reviews (IV) may be based on relevant points listed above, as applicable.

Guidelines for Assessment of Semester Reviews:

The write-up should be prepared as per the guidelines given by the department.

The design and the development of the product shall be assessed through a presentation and demonstration of the working model by the student team to a panel of Internal and External Examiners, preferably from industry or any research organizations having an experience of more than five years, approved by the Head of the Institution. The presence of the external examiner is desirable only for the 2nd presentation in semester IV. Students are compulsorily required to present the outline of the technical paper prepared by them during the final review in semester IV.