GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
COURSE CURRICULUM

Course Title: Basics Mathematics
(Code: 3300001)

Diploma Programmes in which this course is offered	Semester in which offered
Automobile Engineering, Biomedical Engineering, Ceramic Engineering, Chemical Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Electronics & Communication Engineering, Environment Engineering, Fabrication Technology, Information Technology, Instrumentation & Control Engineering, Mechanical Engineering, Mechatronics Engineering, Metallurgy Engineering, Mining Engineering, Plastic Engineering, Power Elctronics Engineering, Printing Technology, Textile Manufacturing Technology, Textile Processing Technology, Transportation Engineering	**First Semester**

1. RATIONALE

The subject is classified under Basic Sciences and students are intended to know about the basic concepts and principles of Mathematics as a tool to analyze the Engineering problems. Mathematics has the potential to understand the Core Technological studies.

2. LIST OF COMPETENCIES

The course content should be taught so as to understand and perform the Engineering concepts and computations. Aim to develop the different types of Mathematical skills leading to the achievement of the following competencies:

i. **Apply the concepts and principles of mathematics to solve simple engineering problems**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**ESE**	**PA**	**ESE**	**PA**	
2	2	0	4	70	30	0	0	**100**

Legends:
L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical;**C** – Credit;
ESE -End Semester Examination; **PA** - Progressive Assessment.

4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I Logarithm	1.1 Solve simple problems using concepts of Logarithms	Concept ,Rules and related Examples
Unit– II Determinants and Matrices	2.1 Solve simultaneous equations using concepts of Determinants and Matrices	Idea of Determinant and Matrix, Addition/Subtraction, Product, Inverse up to 3X3 matrix, Solution of Simultaneous Equations(up to three variables)
Unit– III Trigonometry	3.1 Solve simple problems using concepts of Trigonometry	Units of Angles(degree and radian), Allied & Compound Angles, Multiple –Submultiples angles, Graph of Sine and Cosine, Periodic function, sum and factor formulae, Inverse trigonometric function
Unit– IV Vectors	4.1 Solve simple problems using concepts of Vectors	Basic concept of Vector and Scalar, addition & subtraction, Product of Vectors, Geometric meaning of Scalar and Vector Product. Angle between two vectors, Applications of Dot (scalar) and Cross (vector) Product, Work Done and Moment of Force.
Unit-V Menstruation	5.1 Calculate the surface area and volume of different shapes and bodies.	Area of Triangle, Square, Rectangle, Trapezium, Parallelogram, Rhombus and Circle Surface & Volume of Cuboids, Cone, Cylinder and Sphere.

5. SUGGESTED SPRCIFICATION TABLE WITH HOURS AND MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
1.	Logarithms	03	4	4	2	10
2.	Determinants and Matrices	08	6	8	4	18
3.	Trigonometry	08	8	6	4	18
4.	Vectors	06	5	5	4	14
5.	Mensuration	03	3	3	4	10
Total		**28**	**26**	**26**	**18**	**70**

Legends:
R = Remembrance; U= Understanding; A= Application and above levels (Revised Bloom's Taxonomy)

6. SUGGESTED LIST OF EXERCISES (During tutorial hours)

The exercises should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the competency.

S. No.	Unit No.	Exercises/Tutorial
1	1	Logarithms-Simple Examples related Definition and Rules
2		Examples on various types and Graphs
3	2	Determinants, Simple Examples on Matrix Addition/Subtraction and Product
4		Co-factors, Adjoint and Inverse of Matrix
5	2	Solution of Simultaneous Equation using 3X3 Matrix and its Applications
6	3	Practice Examples: Allied & Compound Angles
7		Practice Examples: Periodic functions, Sum/Diff and factor formulae, Inverse Trigonometric function etc.
8		Simple Graphs of Sine and Cosine Functions(Explain Spherical Trigonometry, if possible, for Applications)
9	4	Practice Simple Examples Vectors
10		Example related to Dot and Cross Products and Applications
11	5	Examples on Area
12		Surface Area & Volume and its Applications

Note: The above Tutor sessions are for guideline only. The remaining Tutorial hours are for revision and practice.

7. SUGGESTED LIST OF STUENT ACTIVITIES

Following is the list of proposed student activities like: course/topic based seminars, internet based assignments, teacher guided self learning activities, course/library/internet/lab based Mini-Projects etc. These could be individual or group-based.

1. Applications to solve identified Engineering problems and use of Internet.
2. Learn MathCAD to use Mathematical Tools and solve the problems of Calculus.
3. .Learn MATLAB and use to solve the identified problems.

8. SUGGESTED LEARNING RESOURCES

A. List of Books

S.No.	Author	Title of Books	Publication
1	Anthony croft and others	Engineering Mathematics (third edition)	Pearson Education
2	W R Neelkanth	Applied Mathematics-I	Sapna Publication
3	S P Deshpande	Polytechnic Mathematics	Pune Vidyarthi Gruh Prakashan
4	Rudra Pratap	Getting Started with MATLAB-7	OXFORD University Press

B. List of Major Equipment/ Instrument

1. Simple Calculator
2. Computer System with Printer, Internet
3. LCD Projector

C. List of Software/Learning Websites

1. Excel
2. DPlot
3. MathCAD
4. MATLAB

You may use other Software like Mathematica and other Graph Plotting software. Use wikipedia.org, mathworld.wolfram.com Etc…

9. COURSE CURRICULUM DEVELOPMENT COMMITTEE:

Faculty Members from Polytechnics

- **Dr.N.R.Pandya**, HOD-General Dept. Govt. Polytechnic, Ahmedabad
- **Dr N. A. Dani**, Lecturer, Govt. Polytechnic, Junagadh.
- **Smt R. L. Wadhwa**, Lecturer, Govt. Polytechnic, Ahmedabad
- **Shri H. C. Suthar**, Lecturer, BPTI, Bhavnagar
- **Shri P. N. Joshi**, Lecturer, Govt. Polytechnic, Rajkot
- **Shri P. T. Polara**, Lecturer, Om Institute of Engg. And Tech, Junagadh,
- **Smt Ami C. Shah**, Lecturer, BBIT, V. V. Nagar.

Coordinator and Faculty Member From NITTTR Bhopal

- **Dr. P. K. Purohit**, Associate Professor, Dept. of Science, NITTTR, Bhopal

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
COURSE CURRICULUM

Course Title: English
(Code: 3300002)

Diploma Programmes in which this course is offered	Semester in which offered
Architectural Assistanship, Automobile Engineering, Biomedical Engineering, Ceramic Engineering, Chemical Engineering, Civil Engineering,Computer Aided Costume Design & Dress Making, Computer Engineering, Electrical Engineering, Electronics & Communication Engineering, Environment Engineering, Fabrication Technology, Information Technology, Instrumentation & Control Engineering, Mechanical Engineering, Mechatronics Engineering, Metallurgy Engineering, Mining Engineering, Plastic Engineering, Power Elctronics Engineering, Printing Technology, Textile Designing, Textile Manufacturing Technology, Textile Processing Technology, Transportation Engineering	**First Semester**

1. RATIONALE

English language has become a dire need to deal successfully in the globalized and competitive market and hence this curriculum aims at developing the functional and communicative abilities of the students in English. Proficiency in English is one of the basic needs of technical students. A technician has to communicate all the time with peers, superiors, subordinates and clients in his professional life. Hence this course is being offered.

2. LIST OF COMPETENCIES

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competencies:

i. **Communicate verbally and in writing in English.**
ii. **Comprehend the given passages and summarize them.**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Tutorial Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	150
3	2	0	5	70	30	20	30	

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; C – Credit;
ESE - End Semester Examination; **PA** - Progressive Assessment.

4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes		Topics and Sub-topics
	Writing Skills	**Speaking Skills**	
Unit – I Grammar	1.1 Apply correct verb in the given sentence	1b. Use grammatically correct sentence in day to day communication	**1.1 Tenses** - Present Tense (Simple, Continuous, Perfect, Perfect Continuous) - Past Tense (Simple, Continuous, Perfect) - Future Tense (Simple)
	1.2 Distinguish among various Determiners	1d. Distinguish among determiners and apply correctly in communicative usage.	**1.2 Determiners** - Articles (A, An, The) Some, Any, Much, Many, All, Both, Few, A few, The few, Little, A little, The little, Each, Every.
	1.3 Use appropriate modal auxiliaries in a given expression	1f. Choose appropriate modals in situations where different modes of expressions are used.	**1.3 Modal Auxiliaries** Can, Could, May, Might, Shall, Should, Will, Would, Must, Have to, Need, Ought to
	1.4 Choose the correct verb for the given subject	1h. Use the correct verb depending on the subject in a sentence.	**1.4 Subject- Verb Agreement**
	1.5 Distinguish between Active and Passive structures. Apply correct model auxiliary in the given sentence.	1j. Apply the correct voice in formal communication	**1.5 The Passive Voice** Simple Tenses, Perfect Tenses And Modal Auxiliary Verbs
	1.6 Use appropriate preposition in a sentence	1l. Usage of correct preposition as per time, place and direction.	**1.6 Prepositions**: Time, Place and Direction
	1.7 Identify different connectors and their usage.	1n. Join words or sentences using connectors and bring out the desired meaning.	**1.7 Connectors**: And, But, Or, Nor, Though, Although, If, Unless, Otherwise, Because, as, Therefore, So, Who, Whom, Whose, Which, Where, When, Why.

Unit	Major Learning Outcomes		Topics and Sub-topics
	Writing Skills	**Speaking Skills**	
Unit – II Comprehension Passages	2.1 Formulate sentences using new words. 2.2 Enrich vocabulary through reading. 2.3 Write short as well as long answers to questions. 2.4 Express ideas in English in written form effectively	2e.Discuss the content of the passage/story in the class. 2f. Ask appropriate questions as well to answer them. 2g. Follow oral instructions and interpret them to others. 2h. Present topics effectively and clearly. 2i.Use dictionary, thesaurus and other reference books. 2j.Describe an object or product. 2k. Use correct pronunciations and intonations. 2l. Give instructions orally	**2.1 Comprehension Passages** • Lincoln's Letter to His Son's Teacher (Abraham Lincoln) • What we must Learn from the West (Narayana Murthy) • Dabbawallas: Mumbai's Best Managed Business (Amberish K. Diwanji) • Internet (Jagdish Joshi) **2.2 Vocabulary Items:** -Matching items (word and its Meaning) - One word Substitution - Phrases and idioms - S ynonyms and Antonyms from given MCQs
Unit – III Short Stories		3a Express ideas and views on given topics. 3b. Speak briefly on a given topic fluently and clearly. 3c. Participate in formal and informal conversations 3d. Recapitulate orally the facts or ideas presented by the speaker	• My Lost Dollar by Stephen Leacock • The Snake in the Grass by R K Narayan • A Day's Wait by Earnest Hemingway
Unit – IV **Writing Skills**	4.1 Write letters and dialogues on given topics / situations.	4b.Face oral examinations and interviews	**4.1 Dialogue Writing** **4.2 Samples for Practice:** - Meeting ad Parting - Introducing and Influencing - Requests - Agreeing and Disagreeing - Inquiries and Information **4.3 Letter:** - Placing an order - Letter to Inquiry - Letter of Complaint - Letter of Adjustment - Letter seeking permission
Unit – V Speaking Skills		5a.Follow correct pronunciation, stress and intonation in everyday conversation.	**For 28 hours of practical periods**, digital language laboratory is recommended to be established in every polytechnic. But as polytechnics currently do not have digital language laboratories practical periods will be engaged encouraging the students to speak as per the text taught in the class.

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit Title	Teaching Hours 42+28	Distribution of Theory Marks			
		R Level	U Level	A Level	Total
Unit – I Grammar	14	8	8	9	25
Unit – II Comprehension Passages	07	4	6	5	15
Unit – III Short Stories	07	4	5	5	14
Unit – IV Writing Skills	14	3	6	6	15
Unit – V Speaking Skills	28	1			01
Total	**70**	**20**	**25**	**25**	**70**

Legends: R = Remembrance; U = Understanding; A = Application and above levels (Revised Bloom's taxomonoy)

6. SUGGESTED LIST OF TUTORIAL EXERCISES

The tutorial exercises should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the above mentioned competencies.

S. No.	Unit No.	Experiment
1	I	**Conversation** 1. Introducing oneself 2. Introduction about family 3. Discussion about the weather 4. Seeking Permission to do something 5. Description about hobbies 6. Seeking Information at Railway Station/ Airport 7. Taking Appointments from superiors and industry personnel 8. Conversation with the Cashier- College/ bank 9. Discussing holiday plans 10. Asking about products in a shopping mall 11. Talking on the Telephonic 12. Wishing Birthday to a Friend 13. Talking about Favourite Sports
2	II	**Presentation Skills** General Presentations pertaining to Unit I, II, III

7. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES

Following is the list of proposed student activities like:

- course/topic based seminars,
- internet based assignments,
- teacher guided self learning activities,
- course/library/internet/lab based mini-projects etc.

  These could be individual or group-based.

8. SUGGESTED LEARNING RESOURCES

A. Text Book

Sr. No.	Author/s	Title of Books	Publication
1	Juneja & Qureshi	**Active English**	Macmillan

B. List of Reference Books

Sr. No.	Author/s	Title of Books	Publication
1	Wren & Martin	High School English Grammar	S. Chand & Co. Ltd
2	M. Gnanamurali	English Grammar at Glance	S. Chand & Co. Ltd.
3	E. Suresh Kumar & Others	Effective English	Pearson
4	S. Chandrashekhar & Others	English Communication for Polytechnics	Orient BlackSwan
5	-	English Fluency Step 1 & 2	Macmillan
6	-	Active English Dictionary	Longman

C. List of Major Equipment/ Instrument

i. Digital English Language Laboratory
ii. Computers for language laboratory software
iii. Headphones with microphone
iv. Computer furniture

D. List of Software/Learning Websites

i. http://www.free-english-study.com/
ii. http://www.english-online.org.uk/course.htm
iii. http://www.english-online.org.uk/
iv. http://www.talkenglish.com/
v. http://www.learnenglish.de/

9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Polytechnic Faculty Members

- **Prof. K. H. Talati**, Govt. Polytechnic, Gandhinagar (Convener)
- **Ms. Almas Juneja**, Gujarat Technological University, Ahmedabad.
- **Shri. D. M. Patel**, Govt. Polytechnic, Ahmedabad.
- **Dr. Sonal K. Mehta**, Govt. Girls Polytechnic, Ahmedabad.
- **Shri. Bhadresh J. Dave**, Govt. Polytechnic, Rajkot.
- **Dr. Peena Thanki**, Govt. Polytechnic, Jamnagar.
- **Dr. Chetan Trivedi**, Govt. Engineering College, Bhavnagar.
- **Dr. Raviraj Raval**, Govt. Polytechnic, Rajkot.
- **Shri Vaseem Qureshi**, Vishwakarma Govt. Engineering College, Chandkheda, Ahmedabad.

NITTTR Bhopal Faculty and Co-ordinator

- **Dr. Joshua Earnest,** , NITTTR, Bhopal
- **Prof.(Mrs.) Susan S. Mathew,** NITTTR, Bhopal

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
COURSE CURRICULUM

Course Title: Basics Chemistry (Group-4)
(Code: 3300011)

Diploma Programmes in which this course is offered	Semester in which offered
Chemical Engineering, Printing Technology, Textile Manufacturing Technology, Textile Processing Technology	**First Semester**

1. RATIONALE

Science is the foundation for all technician courses. The basic aim of teaching science is to develop in the students the habit of scientific inquiry, ability to establish the cause and effect, relationship. Chemistry forms the part of applied science .The study of basic concepts of chemistry like chemical bonding, corrosion, water treatment, Organic chemistry and different engineering materials like polymers, adhesives, paints, lubricants, etc. will help the students understanding engineering subjects where the emphasis is laid on the application of these concepts Chemistry is concerned with the changes in structure and properties of matter. Many of the process which are involved to bring out this changes forms the basis of engineering activities. Teaching of chemistry should be aimed at developing the right type of aptitude in the students and the ability to predict the result under given condition

Thus good foundation in basic science will help the students in their self development to cope up with continuous flow of innovations.

2. LIST OF COMPETENCIES

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competency.

i. Apply the basic concepts and principals of Chemistry in various engineering applications.

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	**150**
3	0	2	5	70	30	20	30	

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit;
ESE - End Semester Examination; **PA** - Progressive Assessment.

4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I Chemical Bandings and Catalysis	1.1 Explain various properties of material depending upon bond formation 1.2 Describe the molecular structure of solid, liquid and gases 1.3 Comprehend the crystal structure of metal and properties reflected by packing of atoms 1.4 Explain the various types of catalysis and catalyst	**Introduction** 1.1 Theory Of Valency 1.2 Types of chemical bonds 1.2.1 Electrovalent bond,& its characteristics 1.2.2 Covalent bond & its characteristics 1.2.3 Co- ordinate bond 1.2.4 Hydrogen bond, its types and Significance 1.2.5 Metallic bond, Explanation of Metallic properties. 1.3 Intermolecular force of attraction 1.4 Molecular arrangement in solid, liquid and gases. 1.5 Structure of solids. 1.5.1 Metallic solids- Unit cell- bcc, fcc and hcp packing of metals –examples and properties reflected by the packing of atoms. 1.6 Catalysis, 1.6.1 Types of catalysis 1.6.2 Theory of Catalysis 1.7 Types of Catalyst 1.7.1 Positive Catalyst 1.7.2 Negative Catalyst 1.7.3 Auto-catalyst 1.8 Catalytic Promoter and Catalytic inhibitor 1.9 Industrial Application of Catalyst
Unit– II **Concepts of Electro Chemistry**	2.1 Describe theory of ionization and factors affecting it. 2.2 Describe the importance of pH & and its industrial application. 2.3 Describe difference between electrolytes and non- electrolytes. 2.4 Describe construction and working of electrochemical cell. 2.5 Describe the term: electrode potential and standard condition for its measurement. 2.6 Appreciate the application of electrolysis	2.1 Introduction 2.2 Arrhenius theory of ionization. 2.3 Degree of ionization 2.3.1 Factors affecting the degree of ionization 2.4 Definition of pH 2.4.1 pH of acid, base and neutral solution 2.4.2 pH calculations of acid, base and salt solution at different concentration 2.4.3 Importance of pH in various fields. 2.5 Definition of buffer solution. 2.5.1 Buffer Action & Types of buffer Solution. 2.5.2 Application of buffer solutions. 2.6 Electrolytes and Non-electrolytes 2.6.1 Types of electrolytes 2.7 Construction and working of electrochemical cell 2.8 Standard conditions 2.9 Standard hydrogen electrodes 2.10 Nernst theory of single electrode potential & Nernst equation 2.11 Electrochemical series, galvanic series 2.12 Electrolysis, Faradays laws of electrolysis 2.13 Industrial application of Electrolysis 2.14 conductance of solution (a) Conductivity (b)Specific Conductivity

Unit	Major Learning Outcomes	Topics and Sub-topics
	process for surface coating	(c) Equivalent conductivity (d) Molar conductivity
Unit– III **Corrosion of metals & its prevention**	3.1 Describe the different types of corrosion 3.2 Comprend the different factors affecting rate of corrosion 3.3Appreciate the different protective measures to prevent the corrosion	3.1. Definition of corrosion 3.2 Types of corrosion 3.2.1 Dry corrosion: Oxidation corrosion mechanism corrosion-mechanism , Nature of oxide film 3.2.2 Wet corrosion-mechanism 3.2.3 Concentration cell corrosion 3.3 Pitting corrosion 3.4 Waterline corrosion 3.5 Crevice corrosion 3.6 Factors affecting the rate of corrosion,- Nature of film, Nature of Environment,PH of Solution, Area of cathode anode and, Temperature,Moisture,Purity of metal 3.7 . Methods of prevention of corrosion- Modification of environment , Modification of the properties of metal , Use of protective coatings. Anodic and cathodic protection, Modification in design and choice of material
Unit– IV **Water Treatment**	4.1 Differentiate between hard water & soft water 4.2 Describe the ill effect of hard water in boiler operation 4.3 Explain the different methods for removal of hardness in water 4.4 Appreciate the water quality and treatment of drinking water	4.1. Hard water and soft water. 4.2 Types of hardness of water 4.2.1 Salts producing hardness of water. 4.2.2 Method to express the hardness of water. 4.3 Estimation of total hardness by EDTA Method 4.3.1 Examples to calculate the hardness 4.4 Effect of hard water in Boiler operation 4.4.1 Scale and sludge formation and it's Prevention 4.4.2 Priming and foaming and it's prevention. 4.4.3. Caustic embrittlement and it's prevention. 4.4.4 Corrosion and it's prevention. 4.5 Softening of Water 4.5.1 Soda-Lime process 4.5.2 Permutit process 4.5.3 Ion Exchange process 4.5.4 Reverse Osmosis process 4.6 Treatment of Drinking water 4.6.1 Sedimentation 4.6.2 Coagulation 4.6.3 Filtration 4.6.4 Sterilization of water by chlorination 4.6.5 Break-point chlorination

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit– V **Basic Concepts of Organic Chemistry**	5.1 Explain the classification of organic compound 5.2 Describe the function group classification of organic compound 5.3 Describe difference between saturated and unsaturated hydrocarbons	5.1 Introduction: Organic chemistry 5.2 Difference between organic and Inorganic compound 5.3 Tetravalency of carbon 5.4 Concept of hybridization-sp,sp2,sp3 type of one hybridization with example of each 5.5 Sigma and pi-bonding 5.6 Classification of Organic compound 5.7 Functional group classification 5.8 Explanation of following terms : Saturated and unsaturated hydrocarbon ,Isomerism, Homologues series, 5.9 Sources of Hydrocarbons a. distillation of coal-tar b. refining of petroleum 5.10 Study of Alkane, Alkene and Alkynes Preparation, properties & uses (Ethane, Ethylene & Acetylene)
Unit– VI **Lubricants**	6.1 Describe the terms Lubrication and Lubricants 6.2 Comprehend different tests of lubricants 6.3 Appreciate the process of selection of proper lubricants for engineering use 6.4 Explain the properties and uses insulating materials	6.1 Introduction and definition of lubricants and lubrication 6.2 function of lubricants 6.3 Types of lubrication 6.3.1 Fluid film lubrication. 6.3.2 Boundary lubrication 6.4 Classification of lubricants 6.4.1 Solid lubricants 6.4.2 Semi-solid lubricants 6.4.3 Liquid lubricants 6.4.4 Synthetic oils 6.5 Physical Properties of lubricants and their significance like 6.5.1 Viscosity and viscosity index 6.5.2 Flash point and fire point 6.5.3 Pour point and cloud point 6.5.4 oiliness 6.6 Chemical Properties of lubricants like 6.6.1 Soaponification value 6.6.2 Neutralization number 6.6.3 Emulsification number 6.7 Selection of lubricants for 6.7.1 Gears 6.7.2 Cutting tools 6.7.3 Steam turbine
Unit– VII **Polymer, Elastomers & Adhesives**	7.1 Explain the process of polymerization 7.2 Explain the properties and uses of Polymers, elastomers & adhesives.	7.1 Introduction and Definition of Polymer and Monomer 7.2 Classification of Polymer on basis of Molecular structure as Linear, Branch and Cross-linked polymers 7.3 Classification on basis of monomers (homopolymer and copolymer) 7.4 Classification of Polymers on

Unit	Major Learning Outcomes	Topics and Sub-topics
	7.3 Explain the process of vulcanization of rubber 7.4 Explain the different types of adhesives and their application	basis of Thermal behavior(Thermoplastics& Thermosetting) 7.5 Types polymerization Reaction 7.5.1 Addition Polymerization 7.5.2 Condensation Polymerization 7.6 Synthesis, properties and application of 7.6.1 Polyethylene 7.6.2 Polypropylene 7.6.3 Polyvinyl chloride 7.6.4Teflon 7.6.4 Polystyrene 7.6.5 Phenol formaldehyde 7.6.6 Acrylonitrile 7.6.7 Epoxy Resin 7.7 Define the term:- elastomers 7.8 Natural rubber and its properties 7.9 vulcanization of rubber 7.10 Synthetic rubber,Synthesis,properties and uses 7.10.1 Buna-S Rubber 7.10.2 Buna-N Rubber 7.10.3 Neoprene Rubber 7.11 Definition of adhesives and Examples 7.11.1 Characteristics of adhesives 7.11.2 Classification of adhesives and their uses.

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
1	Chemical Bonding and Catalysis	06	3	2	3	08
2	Concepts of Electro Chemistry	07	4	4	4	12
3	Corrosion of metals & its prevention	05	3	2	3	08
4	Water Treatment	06	4	2	4	10
5	Basic concepts of Organic Chemistry	06	3	4	3	10
6	Lubricants	05	3	2	3	08
7	Polymer ,Elastomers & Adhesives	07	4	4	6	14
	Total	**42**	**24**	**20**	**26**	**70**

Legends:

R = Remembrance; U = Understanding; A = Application and above levels (Revised Bloom's taxonomy)

6. SUGGESTED LIST OF EXERCISES/PRACTICAL/EXPERIMENTS

The exercises/practical/experiments should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the competency. Following is the list of exercises/practical/experiments for guidance.

S. No.	Unit No.	Experiment/Practical Exercises
1	1	Determine the strength of given acidic solution using standard solution of base.
2	3	Standardize KMnO4 solution by preparing standard oxalic acid and to estimate ferrous ions.
3	3	Standardize Na2S2O3 solution by preparing standard potassium dichromate and to estimate percentage of copper from brass.
4	6	Determine the viscosity of given lubricating oil by using Red-wood Viscometer
5	2	Determine PH-Values of given samples of Solution by using Universal Indicator and PH-meter
6	--	Determination of phenol by iodometric method.
7	7	To Determine molecular weight of a polymer using Ostwald viscometer
8	5	Assign IUPAC names to first five members of Alkane and Alkene seris
9	7	Preparation of (any one) polystyrene, urea formaldehyde, phenol formaldehyde and its Characterization
10	6	To Determine Acid Value of given lubricating Oil.
11	--	Determine of percentage of moisture in given sample of coal by proximate analysis
12	6	To Determine of saponification value of an lubricating oil
13	3	Study of corrosion of metals in medium of different pH
14	4	To Determine the COD of given water sample
15	6	Determine Flash & Fire point of given lubricating oil.
16	3	Study of Corrosion of Metals in the different Mediums.
	Note	**Minimum Ten Experiments should be performed by the students from the above given list or experiments related to above topics**

7. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES

Following is the list of proposed student activities (individual or group-based)

- Teacher guided self learning activities.
- Course/topic based internet based assignments.
- Library survey regarding Engineering Material used in different industries.
- Industrial Visits of one or Two Industries.
- Quiz & Brain storming session related to Fuel properties & Utilization of fuel for different purposes.
- Sampling & Testing of water collected from different places.
- These could be individual or group-based.

8. SUGGESTED LEARNING RESOURCES

A. List of Books

S.No.	Author	Title of Books	Publication
1	Engineering Chemistry	JAIN & JAIN	Dhanpat Rai and Sons
2	A Text Book of Polytechnic Chemistry	V.P. Mehta	Jain Brothers
3	A Text Book ofApplied Chemistry	J. Rajaram	Tata McGraw Hill Co. New Delhi
4	Engineering Chemistry	S.S.Dara	S.Chand Publication

. B. List of Major Equipment/ Instrument

- pH- Meter
- Red wood Viscometer.
- Pensky Martin Apparatus / Abel's Apparatus.
- Cleveland open cup apparatus.
- Glass wares

C. List of Software/Learning Websites: ---

(a) www.chemistryteaching.com
(b) en.wikipedia.org/wiki/chemistry
(c) www.chm1.com
(d) www.em-ea.org
(e) www.ce.sc.edu
(f) www2.chemistry.msu.edu

9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof.J.C.Patel,** I/C.Head, Science & Humanities Department,
- Dr.S.& S.S. Ghandhy College of Engineering Technology, Surat
- **Prof. Dr. P.R.Patel**, Head, Science & Humanities Department N.G.Patel Polytechnic, Isroli, Bardoli
- **Prof.S.A.Nimakwala**, I/C. Head, Science & Humanities Department, Shri. K.J. Polytechnic, Bharuch.
- **Prof.R.R.Patel,** I/C.Head, Science & Humanities Department,G.P. Himmatnagar

Co-ordinator and Faculty Member from NITTTR Bhopal

- **Dr. Anju Rawlley ,** Professor Applied Science Dept. NITTTR, Bhopal
- **Dr. C.K.Chug ,**Professor & Head Dept of electronic media , NITTTR, Bhopal

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
COURSE CURRICULUM

Course Title: Physical, Analytical & Inorganic Chemistry (Code: 3310501)

Diploma Programmes in which this course is offered	Semester in which offered
Chemical Engineering	**First Semester**

1. RATIONALE

Swift progress in the study of external universe lead to the separation of Chemistry as a special branch of natural science. Chemical changes are always associated with a number of diversified physical changes. Physical chemistry uses the theoretical principles and experimental techniques to investigate the Chemical transformations and Physical changes accompanying them. Many industrial processes that have been developed are the results of Physico-Chemical investigations which are increasingly employed byorganic, in-organic and analytical chemists. Inorganic chemistry explains chemistry of qualitative analysis, while analytical chemistry deals with the quantitative analysis. Hence study of physical & Analytical chemistry in engineering branch has become essential. This being a core course provides suitable background for Chemical Engg. Technicians for understanding their respective courses and will make them suitable for their job in industries. Thus good foundation in Chemistry will help the students in their self development, to cope up with continuous flow of innovations.

2. LIST OF COMPETENCIES

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competency.

i. Apply basic concept of physical analytical and inorganic chemistry in chemical engineering application

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	2	5	70	30	20	30	**150**

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit;
ESE - End Semester Examination; **PA** - Progressive Assessment.

4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I **PROPERTIES OF LIQUID**	1.1 Explain the different Physical properties of liquids. 1.2 Describe the properties of liquids. 1.3 Different use to determine the properties of liquids	1.1 Physical properties of liquid 1.2 Types of physical properties and Characteristics of each property. 1.3 Definition of the Surface tension, Parachor, Refractive index, Molar refraction, Specific refraction, Viscosity. 1.4 Surface tension and viscosity 1.5 Drop pipette method (Stalagmometer) to determine the Surface tension. 1.6 Ostwald's viscometer to determine viscosity of liquids. 1.7 Refractometer to determine refractive Index of liquid.
Unit– II **CHEMICAL KINETICS**	2.1 Explain the different reactions & kinetics of reaction. 2.2 Describe about order of reaction 2.3 List the of factors affecting the rate of reaction. 2.4 Solve problems	2.1 Define the terms : 2.1.1 Rate of reaction 2.1.2 Specific reaction rate 2.1.3 Velocity constant 2.2 Molecularity and order of reaction 2.3 Definition the terms : 2.3.1First order reaction 2.3.2 Half concentration period 2.4 Derivation equation for first order reaction. 2.5 Derivation of equation for second order reaction. 2.6 Half life period for first & second order reaction. 2.7 Problems related chemical kinetics.
Unit– III **CHEMICAL THERMO DYNAMICS**	3.1 Explain the different types of processes. 3.2Explain thermodynamic terms like- System, Surrounding etc. 3.3 Explain the laws of Chemical Thermodynamics. 3.4 State Hess's law & its application. 3.5 Differentiate between Exothermic & endothermic of reactions	3.1 System and surroundings, Types of System and suitable illustrations 3.2 Thermodynamic property- extensive and intensive 3.3 First law of thermodynamics. 3.4 Function ,Internal energy, Enthalpy 3.5 Rule of assigning sign to work done(W) and heat transferred (Q) as positive and negative. 3.6 Molar heat capacity- at constant volume (Cv) and at Constant pressure (Cp). the relationship Cp - Cv = R 3.7 Adiabatic change, Isothermal change , Reversible process, Irreversible process 3.8 Derivation equation for Adiabatic Expansion of an Ideal gas. PV^{γ} = Constant 3.9 Second law of thermodynamics 3.10 Aspects of thermo-chemistry & Phenomenon of heat of reaction. 3.11 Types of heat of reactions – Exothermic and endothermic processes with examples

Unit	Major Learning Outcomes	Topics and Sub-topics
		3.12 State Hess's law of constant heat Summation. 3.13 Problems applying Hess's law.
Unit-IV **BASIC CONCEPTS OF CHEMICAL ANALYSIS**	4.1 Explain the concept of solubility product and ionic product and its application in inorganic analysis. 4.2 Explain the basic concepts of volumetric analysis. 4.3 Describe basic concepts of chromatography. 4.4 Use chromatograph analysis.	4.1 Basic Concepts: Common ion Effect, Solubility Product, Ionic product, Salt hydrolysis 4.2 State conditions for precipitation Considering Ip and Ksp 4.3 Application of H_2S and NH_4CL in inorganic qualitative analysis 4.4 Volumetric analysis 4.4.1 Acid-base titration 4.4.2 Complex metric titration 4.4.3 Oxidation-reduction titration 4.4.4 Precipitation titration 4.5 Chromatography 4.5.1 Classification of chromatography 4.5.2 (a) Paper chromatography (b) Gas Chromatography
Unit– V **SURFACE CHEMISTRY**	5.1 Explain basic concepts of colloidal 5.2 Describe the preparation, properties of sol. 5.3 Describe about the purification of sol solutions. 5.4 Explain of Emulsion & its types. 5.5 Explain the Concepts of Adsorption & related terms. 5.6 Use basis concepts of colloids in different application such as smoke precipitation etc.	5.1 Adsorption, Adsorbate, Definition of Adsorbent 5.2 Classification of adsorption: Physical adsorption and Chemisorption 5.3 Types of solution: True solution, Suspension and colloidal solution 5.4 Classification of colloidal solution 5.5Lyophobic and Lyophilic sol. 5.6 Methods of preparing colloidal Solutions. 5.6.1 Condensation methods 5.6.2 Dispersion methods 5.7 Purification of colloidal solutions 5.7.1 Dialysis 5.7.2 Ultra filtration 5.8 Important properties of colloidal solution and explain the following in details 5.8.1 Scattering of light (Tyndall effect) 5.8.2 Brownian movement 5.8.3 Electrophoresis 5.8.4 Electro osmosis 5.9 Emulsion & Gels. 5.7.1 Types of emulsion 5.7.2 Cleansing action of soap 5.10 Application of colloids Smoke precipitation, Purification of water, Sewage treatment, Leather tanning etc.

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit– VI **ELECTROMETRIC METHODS OF ANALYSIS**	6.1 Explain basic concepts of electrometric 6.2 Explain of construction & Working of electrochemical cells. 6.3 Describe about pH metry & Potentiometry titrations. 6.4 Describe Various aspects of conductometery & Kohlrausch Law of independent Migration of ions.	6.1 Defintion the term ` Electrode ' the Types of Electrodes 6.2 Distinction among the : Inert electrode, Working electrode & Reference electrode; with suitable Illustrations. 6.3 Construction & Working of reference electrode: 6.3.1 Hydrogen electrode 6.3.2 Calomel electrode 6.3.3 Quinhydrone electrode 6.3.4 Glass electrode 6.3.5 Ag/ Agcl/ Kcl electrode 6.4 p^{H} & p^{OH}, give their relationship 6.4.1 Methods used to determine p^{H} of given solution by— - p^{H} paper, - p^{H} meter & - Universal indicator methods. 6.4.2 Problem to ascertain p^{H} and p^{OH}. 6.5 p^{H} metry titration 6.6 Potentiometry titration. 6.7 Various aspects of conductometric titration 6.8 Kohlrausch Law of independent Migration of ions.
Unit– VII **PREPARATION OF STANDARD SOLUTION**	7.1 Define the terms: Solute, Solvent and Solution. 7.2 Explain different methods of expressing concentration with examples. 7.3 List the types of chemicals & its uses. 7.4 Describe about primary & secondary standard solutions. 7.5 Describe the	7.1 Different methods of expressing concentration. i) Weight/Weight method (W /W) ii) Weight/Volume method (W/V) 7.1.1 Types of W/W methods -Molality (M), -Mole fraction (X), -Parts per million (PPM) 7.1.2 Different types of W/V Methods. i) gms/liter ii) Normality (N) iii) Molarity (M) iv) Formality (F) v) P.P.M. / mg/liter 7.1.3 Problems on them. 7.2 Types of different standards i) Primary standards ii) Secondary standards 7.2.1 Conditions for primary standard 7.2.2 Procedure for preparing primary standard Solution.

Unit	Major Learning Outcomes	Topics and Sub-topics
	methods of preparation of standard solutions.	7.2.3 Primary standard for standardization of i) Acids ii) Bases iii) $FeSo_4$ $7H_2O$ iv) $KMnO_4$ & v) $AgNO_3$.
Unit– VIII INDUSTRIALLY IMPORTANT COMPOUNDS	8.1 Describe the manufacture and uses of important compounds	8.1 Caustic soda-Manufacture and uses 8.2 Ammonia- Manufacture and uses 8.3 Suphuric Acid- Manufacture and uses 8.4 Potassium Dichromate- Manufacture and uses

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
1.	PROPERTIES OF LIQUID	04	03	03	04	10
2.	CHEMICAL KINETICS	05	04	04	02	10
3.	CHEMICAL THERMODYNAMICS	08	04	05	04	14
4.	BASIC CONCEPTS OF CHEMICAL ANALYSIS	05	02	03	02	08
5.	SURFACE CHEMISTRY	06	03	03	04	10
6.	ELECTROMETRIC METHODS OF ANALYSIS	06	02	02	03	07
7.	PREPARATION OF STANDARD SOLUTION	04	01	02	02	05
8.	INDUSTRIALLY IMPORTANT COMPOUNDS	04	02	02	02	06
	Total	**42**	**20**	**21**	**29**	**70**

Legends:
R = Remembrance; U = Understanding; A = Application and above levels (Revised Bloom's taxonomy)

6. SUGGESTED LIST OF EXERCISES/PRACTICAL/EXPERIMENTS

The exercises/practical/experiments should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the competency. Following is the list of exercises/practical/experiments for guidance.

S. No.	Unit No.	Exercises/Practical/Experiments
1	All	about Course & Lab.
2	7	Acid-Base titration- Strong acid Vs Strong base using Phenolphthalein as an indicator. Prepare of standard solution.
3	7	Acid-Base titration- Strong acid Vs weak base using methyl orange as an indicator.
4	1	Determine viscosity by Oswald's Viscometer.
5	1	Determine f surface tension by Stalagmometer.
6	1	Determine Refractive Index Using Abbes Refractometer.
7	6	Find out pH value by: •Universal indicator method •pH paper pH meter
8	6	Determine the amount of HCl in the given solution by using NaOH solution by pH metrically
9	4,6,7	Redox titration
10	6&7	Titrate NaCl AgNO3 Potentiometrically and explain the nature of graph
11	6&7	Titrate HCl NaOH by conductometer and explain nature of graph
12	2&4	Determine the first order reaction.
13	2&4	Determine the second order reaction.
	Note:	**Minimum Ten Experiments should be performed by the students from the above given list.OR any Other experiments related to above topics**

7. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES

Following is the list of proposed student activities like:

- Teacher guided self learning activities.
- Course/topic based internet based assignments.
- Library survey regarding Engineering Material used in different industries.
- Industrial Visits of one or Two Industries.
- Quiz & Brain storming session related to Fuel properties & Utilization of fuel for different purposes.
- Sampling & Testing of water collected from different places.
- These could be individual or group-based.

8. SUGGESTED LEARNING RESOURCES

A. List of Books

S.No.	Title of Books	Author	Publication
1	Essentials of Physical chemistry	Bahl & Tuli	S. Chand & Co. New Delhi.
2	Principals of Physical chemistry	Puri, Sharma & Pathania	S.N. Chand & Co. Jalandhar
3	Basic Concepts of Analytical Chemistry	S. M. Khopkar	New Age Publication, New Delhi
4	Physical Chemistry	N. B. Singh, Shiva Saran Das & A. K. Singh	New Age Publication, New Delhi
5	Analytical Chemistry Problems & Solution	S. M. Khopkar	New Age Publication, New Delhi
6	Vogel's textbook of quantitative Chemical analysis (including instrumental methods)	Jeffery G.H	E.L.B.S. With Longman
7	Textbook of Physical Chemistry	Glasston & Samuel	Macmillan New Delhi

B.**List of Major Equipment/ Instrument**

- ph- Meter
- Ostwald's Viscometer
- Potentiometer
- Conductometer
- Stalagmometer
- Glass wares

9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Polytechnic Faculty Members

- **Prof. J. C. Patel,** I/C.Head, Dept. of Science & Humanities, Dr. S.& S.S. Ghandhy College of Engineering, Surat
- **Prof. Dr. P. R. Patel**, Head, Dept. of Science & Humanities, N.G. Patel Polytechnic, Bardoli
- **Prof. S. A. Nimakwala**, I/C Head, Dept. of Science & Humanities, Shri. K.J. Polytechnic, Bharuch.
- **Prof. R. R. Patel,** I/C Head, Dept. of Science & Humanities, G.P. Himmatnagar

NITTTR Bhopal Co-ordinator

- **Dr. Anju Rawlley** Professor, Dept of Applied Science, NITTTR, Bhopal

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
COURSE CURRICULUM

Course Title: Chemical Engineering Drawing (Code: 3310502)

Diploma Programmes in which this course is offered	Semester in which offered
Chemical Engineering	**First Semester**

1. RATIONALE

Engineering technicians irrespective of their field of operation in an industry is expected to possess a thorough understanding of engineering drawing, which includes clear spatial visualization of objects and the proficiency in identifying various equipment and devices from their symbols on control panel, to read and interpret process flow diagram & instrumentation diagram. Besides this they are also expected to possess a certain degree of drafting skill- depending upon their job functions-in day-to-day activities. This course of Chemical Engineering Drawing is aimed at developing deeper understanding of construction and working of some of the important chemical engineering equipment and valves.

2. LIST OF COMPETENCIES

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competency:

i. Prepare and interpret symbols, sketches, & drawings of various equipment, valves, devices and flow diagrams for chemical engineering applications

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
0	0	4	4	0	0	40	60	**100**

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; C – Credit;
ESE - End Semester Examination; **PA** - Progressive Assessment

4. DETAILED COURSE CONTENTS

Not applicable as only practical

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Not Applicable

6. SUGGESTED LIST OF EXERCISES/PRACTICAL/EXPERIMENTS

The exercises/practical/experiments should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the competency. Following is the list of exercises/practical/experiments for guidance.

S. No.	Unit No.	EXERCISES/PRACTICAL
1		Draw symbols of various equipment and devices for heat exchange, mass transfer and mechanical operations for example crusher, filter press, rotary filter, conveyors, screen, distillation and absorption columns, scrubbers, dryers, condenser, heat exchanger, jacketed vessel, cyclone, ESP, pump etc. in sketch book.
2		Draw symbols of various controllers such as pressure, temperature, flow & level in sketch book.
3		Draw various types of valves such as Globe valve, Gate valve, Diaphragm valve and non-return valves in a sheet.
4		Draw sketches of different pumps such as Centrifugal, reciprocating and rotary pumps-Gear, Lobe and Vane type in a sheet.
5		Draw sketches of different size reduction equipments such as Jaw crusher, Gyratory crusher, Roll crusher, Ball mill in sketch book.
6		Draw Jacketed reactor with agitator.
7		Draw 1-1 Shell & Tube Heat exchanger.
8		Draw complete distillation tower assembly (Packed tower & Tray tower).
9		Draw process flow diagram of a continuous manufacturing process.
10		Draw a simple process & instrumentation diagram of manufacturing processes / Unit operation

7. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES

To be decided by the concerned teacher..

8. SUGGESTED LEARNING RESOURCES

A. List of Books

S.No.	Author	Title of Books	Publication
1	W.L. McCabe, J.C. Smith	Unit Operations of Chemical Engineering	McGraw Hill
2	M. Gopala Rao, Marshall Sittig	Outline of Chemical Technology	Affiliated East West Press

B. List of Major Equipment/ Instrument

Models or working equipments like crusher, filter press, rotary filter, conveyors, screen, distillation and absorption columns, scrubbers, dryers, condenser, heat exchanger, jacketed vessel, cyclone, ESP, pump, Globe valve, Gate valve, Diaphragm valve and non-return valves to study construction and working.

C. List of Software/Learning Websites

www.fotosearch.com/photos-images/chemical-plant.html

9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Polytechnic Faculty Members

- **Shri N. N. Hansalia**, Lecturer in chemical engineering, G. P. Rajkot
- **Shri D. H. Joshi**, Lecturer in chemical engineering, G. P. Gandhinagar
- **Shri P. M. Gadhiya**, Lecturer in chemical engineering, G. P. Rajkot

NITTTR Bhopal Co-ordinator and Faculty Member

- **Dr. K.K. Jain**, Professor & Head, Dept. of Mechanical Engg, NITTTR, Bhopal
- **Dr.Anju Rawlley** , Professor, Dept. of Applied Science, NITTTR, Bhopal

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
COURSE CURRICULUM

Course Title: Computer Application & Graphics
(Code: 3300012)

Diploma Programmes in which this course is offered	Semester in which offered
Ceramic Engineering, Chemical Engineering, Civil Engineering, Environment Engineering, Fabrication Technology, Mining Engineering, Plastic Engineering, Textile Manufacturing Technology, Textile Processing Technology, Transportation Engineering	**First Semester**
Automobile Engineering,	**Second Semester**

1. RATIONALE

This subject envisages making the student know the fundamentals of Computer Application. It will also helps the student to have hands on experience on different application software used for office automation like MS-Word day-to-day problem solving, in particular for creating business documents, data analysis and graphical representations. Computer Application & Graphics is a course where student will be able to write, Draw, Tabulate, Report, Store and Retrieve and also print on Computer using various Hardware and Software.

Moreover the market driven economy demands frequent changes in product design to suit the customer needs. With the introduction of computers the task of incorporating frequent changes as per requirement is becoming simpler. Some units in this course has been introduced at Diploma level in order to develop the skills in student so that they can generate various digital drawings as required using various CAD software.

2. LIST OF COMPETENCIES

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competencies.

i. **Use MS word software for word processing applications.**
ii. **Use relevant software for drafting and editing 2D entities.**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**ESE**	**PA**	**ESE**	**PA**	**100**
0	0	4	4	0	0	40	60	

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit;
ESE - End Semester Examination; **PA** - Progressive Assessment.

4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I Basics of Computer System	1.1 Describe computer hardware and software 1.2 Identify I/O devices 1.3 Describe functioning of CU ALU and memory unit 1.4 Differentiate various types of printers 1.5Explain use of OS 1.6Demonstrate various file handling operations	**Basics of Computer System** • Concept of Hardware and Software • Computer block diagram • Input Output unit • CPU, Control Unit, Arithmetic logic Unit (ALU), Memory Unit • Monitor, Printers: Dot matrix, Laser, Inkjet, Plotters, Scanner • System software and Application Software • Operating system concepts, purpose and functions • Operations of Windows OS. • Creating and naming of file and folders • Copying file, renaming and deleting of files and folders, • Searching files and folders, installation application, creating shortcut of application on the desktop • Overview of control Panel, Taskbar.
Unit– II Using MS - Word 2007	2.1Use basics text formatting features 2.2Manipulate text 2.3Use page Setup features 2.4Use spell and grammar utility 2.5Work with graphics/ clipart 2.6Create and manipulate table 2.7Use auto shapes and its formatting with text	**Using MS - Word 2007** • Overview of Word processor • Basics of Font type, size, colour, • Effects like Bold, italic , underline, Subscript and superscript, • Case changing options, • Inserting, deleting, undo and redo, Copy and Moving (cutting) text within a document, • Formatting Paragraphs and Lists • Setting line spacing; single • Page settings and margins including header and footer • Spelling and Grammatical checks • Table and its options, Inserting rows or columns, merging and splitting cells, Arithmetic Calculations in a Table. • Working with pictures, Inserting Pictures from Files, • Using Drawings and WordArt; Lines and Shapes, Modifying Drawn Objects, Formatting Drawn Objects, options for Creating and Modifying a WordArt Object
Unit– III Creating digital drawings using a Computer Aided Drafting (CAD) Software	3.1Start Computer aided drafting software (AutoCAD). 3.2Invoke commands in AutoCAD. 3.3Set limits & Coordinate systems. 3.4 Use object selection methods. 3.5Create basic & advance 2D	Introduction to Basic Draw Commands in any Computer Aided Drafting software like Auto CAD Power draft, Micro station: • System requirement & Understanding the interface. • Components of a CAD software window: Such as Title bar, standard tool bar, menu bar, object properties tool bar, draw tool bar, modify toolbar, cursor cross hair. Command window, status bar,

Unit	Major Learning Outcomes	Topics and Sub-topics
	entities. 3.6Close & save your work	drawing area, UCS icon. • File features: New file, Saving the file, Opening an existing drawing file, Creating Templates, Quit. • Setting up new drawing: Units, Limits, Grid, Snap, • Methods of Specifying points- Absolute coordinates and Relative Cartesian & Polar coordinates. • Using Object Snap like Endpoint, Midpoint, Intersection, Center Point, Quadrant Point, Nearest, Perpendicular, Apparent Intersection • SNAP, GRID, OTRACK, LINE, PLINE, ARC, CIRCLE, Ellipse, DONUT, Polygon, Region, File Commands: New, Open, Templates Save, Exit, • Standard sizes of sheet. Selecting Various plotting parameters such as Paper size, paper units, Drawing orientation, plot scale, plot offset, plot area, print preview • Concept of model space and paper space. • Creating view ports in model space and creating floating viewport in paper space. Shifting from model space to paper space and vice versa
Unit – IV Editing & viewing a Digital Drawing using a CAD software	4.1Modify existing 2D entities. 4.2Use different arrays in existing 2D drawing. 4.3View given drawing entities properly. 4.4Enquire about various attributes of existing 2D entities.	Introduction to Basic Edit, Inquiry and display Commands in any Computer Aided Drafting software like Auto CAD Power draft, Micro station: • Copy, Rotate, Move, Erase, Mirror, Array, Trim, Break, Extend, Chamfer, Fillet • Zoom window, Zoom in-out, PAN • List, Dblist, Area, Massprop
Unit – V Advance editing of a digital drawing using a CAD Software	5.1Use layers for proper management of drawings. 5.2Set properties of existing drawing entities as per requirement. 5.3 Able to dimension given 2D entities with perfection. 5.4Use Blocks effectively to create perfect drawings.	Introduction to Advanced Modify & other utility Commands in any Computer Aided Drafting software like Auto CAD Power draft, Micro station: • Properties, Line type, colour, line weight • Concept of Layers: Creating Layers, Naming layers, Making layers ON/OFF, Freeze-Thaw layers, Lock/Unlock Layers. Setting the properties of layers like Color, Line type, Line weight • Concept of Blocks: Local block, global block. Creating, inserting, redefining & exploding blocks. • Concept of Hatch: Selecting Hatch pattern, Hatch styles, Hatch Orientations. Associative Hatch. Boundary Hatch, Hatching Object. • Dimensioning: Types of dimensioning: Linear-Horizontal, Vertical, Aligned, Rotated, Baseline, Continuous, Diameter, Radius, Angular Dimensions. • Dim scale variable. • Editing dimensions.

Unit	Major Learning Outcomes	Topics and Sub-topics
		• Text: Single line Text, Multiline text. • Text Styles: Selecting font, size, alignment etc.

5. SPECIFICATION TABLE (for theory)

There is no theory paper and hence specification table for theory is not applicable

6. SUGGESTED LIST OF EXERCISES/PRACTICAL/EXPERIMENTS

The exercises/practical/experiments should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the competency. Following is the list of exercises/practical/experiments for guidance.

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S.No.	Unit No.	Practical Exercises
1	1	• Create and manage files and folder tree • Use accessories utilities of windows OS • Identify icons, processes going on, messages and interpretation • Write given text using WORD software and beautify • Plot and Print drawing, text on suitable paper • Prepare report using stored text and drawing
2	2	• Entering and editing text in document file. • Apply formatting features on Text like Bold, Italics, Underline, font type, colour and size. Apply features like bullet, numbering • Create documents, insert images, format tables Create and manipulate tables • Students will prepare File for the above mentioned practical and assignments on individual basis. • Students will collect photographs from internet which are related to field application of topics.
3	**3**	• Study of different types of drafting packages related to 2D e.g. AutoCAD, Power draft, Micro station. • Creating a new folder in the computer for saving your practical work. • Draw any three complicated 2D shapes using lines only following Absolute, Relative coordinate systems and object snaps. • Draw Five problems on different geometrical shapes in AutoCAD software using Lines, Polylines, Polygon, Circles, Arcs, Ellipse AutoCAD commands. • Construc a common templates for all the following assignments with institutes logo & standard title block. • Plot one drawing using above template and containing some 2D entities on suitable size of paper(A4).
4	**4**	• List different properties of entities made in above activity slot. • Try viewing commands on entities made in above activity slot.

		• Create drawing of three different Doors & Windows (Elevations). • Create drawing of a modern Study table (Elevations). • Create drawing of a modern sofa Set (Plan). • Draw three problems with polar & rectangular Arrays. • Create Top view of a circular and a rectangular Dining Table with six chairs using Polar and Rectangular array concept respectively. • Create plan & elevation of a primary school building. • Create plan & elevation of a medium size modular kitchen.

5	**5**	• Convert above door, windows, Bed, Dinning table into Blocks and use these blocks in following activities.
		• Three problems on 2D entity generation, which involve the use of layers, blocks and hatching.
		• Dimensioning of above figures.
		• Create your own text style (individually)
		• Draw two sheets on template developed at serial no.-3 and Create a plan & elevation of a Duplex Bungalow with following layers:
		  • Basic civil structure
		  • Water supply line
		  • Electric supply
		  • Toilet fittings
		  • Furniture(using blocks)

7. SUGGESTED LIST OF STUDENT ACCTIVITY

Teachers can decide on their own the list of student activities to promote the intereste of students in use of computers and develop the competencies

8. SUGGESTED LEARNING RESOURCES

A. List of Books

Sr. No.	Title of Book	Author	Publication
1.	R Taxali	Computer Course	Tata McGraw Hills. New Delhi.
2.	P. Nageswara Rao	AutoCAD For Engineering Drawing Made Easy	Tata McGraw Hill
3.	George Omura	Mastering AutoCAD	BPB publication
4.	Sham Tickoo	AutoCAD 2004	Galgotia Publications,New Delhi
5.	Devid Frey	AutoCAD 2000	BPB publication
6.	A. Yarwood	An Introduction to AutoCAD2000	LongMan
7.	Ron House	Using AutoCAD 2000	Prentice Hall
8.	Autodesk Inc.	Latest AutoCAD Manual	Autodesk Inc.

B. List of Major Equipment/ Instrument

- Computer System
- Printer
- Flat Bed Plotter A4 size

C. List of Software/Learning Websites

- Latest Educational Network version of Auto CAD Software
- MS Office

9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. H. L. Purohit**, Head of Civil Engineering Department, L. E. College, MORBI
- **Prof. B G RAJGOR**, HOD, Applied Mechanics Department , B & B Institute of Technology

Coordinator & Faculty from NITTTR Bhopal

- **Prof. Sanjay Agarawal**, Professor & Head Dept. of Computer Engg. & Application, NITTTR, Bhopal
- **Prof. Sharad Pradhan**, Associate Professor, Dept. of Mechanical Engg., NITTTR, Bhopal

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
COURSE CURRICULUM

Course Title: Advance Mathematics (Group-1)
(Code: 3320002)

Diploma Programmes in which this course is offered	**Semester in which offered**
Biomedical Engineering, Chemical Engineering, Electrical Engineering, Computer Engineering, Electronics & Communication Engineering, Information Technology, Power Electronics	**Second Semester**

1. RATIONALE

The course is classified under Advance Mathematics and students are intended to understand the advance concepts and principles of Mathematics such as calculus, complex numbers and differential equations. This knowledge is required to understand and solve engineering problems.

2. COMPETENCIES

The course content should be taught and implemented with the aim to develop different types of mathematical skills so that students are able to acquire following competencies:

- **Use proper Mathematical tool to understand engineering principles and concepts.**
- **Apply concepts of calculus or suitable mathematical tool to solve given engineering problems**.

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			**Total Credits (L+T+P)**	**Examination Scheme**				
				Theory Marks		**Practical Marks**		**Total Marks**
L	**T**	**P**	**C**	**ESE**	**PA**	**ESE**	**PA**	
2	2	0	4	70	30	0	0	**100**

Legends: **L**-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** -Practical; **C** – Credit; **ESE** -End Semester Examination; **PA** - Progressive Assessment.

Note: It is the responsibility of the institute heads that marks for **PA of theory** & **ESE and PA of practical** for each student are entered online into the GTU Portal at the end of each semester within the dates specified by GTU.

4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I Complex Number	**1a**.Simplify Complex expressions **1b**.Find Modulus and Amplitude of given expressions **1c**.Use De Moivre's Theorem to simplify mathematical expressions and to find roots	Concept, Modules and Amplitude form, Root of Complex Number, De Moivre's Theorem. Apply concept of complex numbers in simple engineering problems.
Unit– II Function & Limit	2a .Solve the problems using functions 2b .Solve the problem of function using the concept of Limit	**2.1 Function** Concept and Examples **2.2 Limit** Concept of Limit, Standard Formulae and related Examples.
Unit– III Differentiation & it's Applications	**3a**.Differentiate the various function **3b**.Apply the differentiation to Velocity, Acceleration and Maxima & Minima	**3.1Differentiation**: Definition, Rules of, Sum, Product, Quotient of Functions, Chain Rule, Derivative of Implicit functions and Parametric functions, Logarithmic Differentiation. Successive Differentiation up to second order **3.2 Application:** Velocity, Acceleration, Maxima & Minima.(simple problems)
Unit– IV Integration & its application	**4a** .Integrate the various function **4b** .Apply the Integration for finding Area and Volume	**4.1 Integration**: Concept, Integral of Standard Functions, Working Rules of Integration, Integration by Parts, Integration by Substitution Method, Definite Integral and its properties. **4.2 Application:** Area and Volume.(simple problems)
Unit-V Differential Equations(First Order First Degree)	**1a.**Find the Order and Degree of a Differential Equation. **1b.** Form a Differential Equation for simple Engineering problems **1c.** Solve Differential Equations using Variable Separable, Homogeneous and Integrating Factor methods.	**5.1** Definition, Order and Degree of Differential Equation **5.2** Formation of DE **5.3** Solution of DE of First Degree and First Order by Variable Separable, Homogeneous and Integrating Factor methods.

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
I	Complex Number	3	2	5	3	10
II	Function & Limit	4	3	5	4	12
III	Differentiation & its Application	8	4	8	6	18
IV	Integration & its Application	8	4	8	4	16
V	Differential Equations	5	2	8	4	14
Total		**28**	**15**	**34**	**21**	**70**

Legends: R = Remember; U= Understand; A= Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as only general guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table.

6. SUGGESTED LIST OF EXERCISES/PRACTICALS

The exercises should be properly designed and implemented with an attempt to develop different types of mathematical skills so that students are able to acquire above mentioned competencies.

S. No.	Unit No.	Practical Exercises
1	I	Complex Number, Practice Examples
2		Use software for further understanding of applications
3	II	Practice Examples of Function & Limit
4		Use of Various Method/Techniques
5	III	Differentiation and Related Examples
6		Solve problems related to various methods/techniques of differentiations
7		Identify the Engineering Applications from respective branches and solve the problems
8	IV	Integration & Related Examples.
9		Solve problems Related to Various Methods/Techniques of integration
10		Identify the Engineering Applications from respective branches and solve the problems
11	V	Identify the corresponding Engineering Applications for differential equations from respective branches and solve the problems.

Note: The above Tutor sessions are for guideline only. The remaining Tutorial hours are may be used by teachers appropriately for revision and practice.

7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like: course/topic based seminars, internet based assignments, teacher guided self learning activities, course/library/internet/lab based Mini-Projects etc. These could be individual or group-based. Some of these activities may be as below:

1. Applications to solve identified Engineering problems and use of Internet.
2. Learn graphical sofwares:EXCEL,DPLOT,GRAPH etc.
3. Learn MathCAD to use Mathematical Tools and solve the problems of Calculus.
4. Learn MATLAB and use it to solve the identified problems.

8. SUGGESTED LEARNING RESOURCES

A. List of Books

S.No.	Author	Title of Books	Publication
1	Anthony croft and others	Engineering Mathematics (third edition)	Pearson Education,2012
2	Pandya N R	Advanced Mathematics for Polytechnic	Macmillan Publishers India Ltd.,2012
3	Deshpande S P	Polytechnic Mathematics	Pune Vidyarthi Gruh Prakashan,1984
4	Prakash D S	Polytechnic Mathematics	S Chand,1985

B. List of Major Equipment/ Instrument

1. Simple Calculator
2. Computer System with Printer, Internet
3. LCD Projector

C. List of Software/Learning Websites

1. Excel
2. D Plot
3. Graph
4 MathCAD
5. MATLAB

You may use other Software like Mathematical and other Graph

Plotting software. Use websites such as wikipedia.org, mathworld.wolfram.com Etc…

9. COURSE CURRICULUM DEVELOPMENT COMMITTEE:

Faculty Members from Polytechnics

- **Dr. N. R. Pandya**, HOD-General Dept.,Govt. Polytechnic, Ahmedabad
- **Dr N A Dani**, Lecturer,Govt. Polytechnic,Junagadh.
- **Prof. (Smt) R L Wadhwa**, Lect Govt Polytechnic,Ahmedabad
- **Prof. H C Suthar**, BPTI,Bhavnagar
- **Prof. P N Joshi**, Govt Polytechnic,Rajkot

Coordinator and Faculty Member From NITTTR Bhopal

- **Dr. P. K. Purohit**, Associate Professor, Dept. of Science.
- **Dr. Deepak Singh**, Associate Professor, Dept. of Science.

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
COURSE CURRICULUM

Course Title: Environment Conservation & Hazard Management
(Code: 3300003)

Diploma Programmes in which this course is offered	Semester in which offered
Biomedical Engineering, Ceramic Engineering, Civil Engineering, Computer Engineering, Electrical Engineering, Environment Engineering, Fabrication Technology, Information Technology, Instrumentation & Control Engineering, Mechanical Engineering, Mining Engineering, Textile Design, Transportation Engineering	**First Semester**
Architecture Assistantship, Automobile Engineering, Chemical Engineering, Electronics & Communication, Mechatronics Engineering, Metallurgy Engineering, Plastic Engineering, Power Electronics, Printing Technology, Textile Manufacturing, Textile Processing	**Second Semester**

1. RATIONALE

For a country to progress, sustainable development is one of the key factors. Environment conservation and hazard management is of much importance to every citizen of India. The country has suffered a lot due to various natural disasters. Considerable amount of energy is being wasted. Energy saved is energy produced. Environmental pollution is on the rise due to rampant industrial mismanagement and indiscipline. Renewable energy is one of the answers to the energy crisis and also to reduce environmental pollution. Therefore this course has been designed to develop a general awareness of these and related issues so that the every student will start acting as a responsible citizen to make the country and the world a better place to live in.

2. COMPETENCIES

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competencies.

i. **Take care of issues related to environment conservation and disaster management while working as diploma engineer.**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
4	0	0	4	70	30	0	0	**100**

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; C – Credit;
ESE - End Semester Examination; **PA** - Progressive Assessment.

4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I Ecology and environment	1.1 Enhance knowledge about engineering aspects of Environment 1.2 Correlate the facts of ecology and environment A 1.3 assess the effect of pollution 1.4 List the causes of environmental pollution 1.5 State the major causes of air, water and noise pollution 1.6 Describe how industrial waste contaminates the land 1.7 Describe the effects of radiation on vegetables, animals	1.1 Importance of environment and scope 1.2 Engineering and environment issues 1.3 The natural system, Biotic and a-Biotic components and processes of natural system 1.4 Eco system, food chain and webs and other biological Systems, 1.5 Causes of environmental pollution 1.6 Pollution due to solid waste 1.7 water pollution, air pollution, the Noise as pollution, 1.8 Pollution of land due to industrial and chemical waste 1.9 Radiation and its effects on vegetables and animals
Unit– II Sustainable Development	2.1 Explain the concept of sustainable development 2.2 Justify the need for renewable energy 2.3 Describe the growth of renewable energy in India 2.4 Explain the concepts of waste management and methods of recyling	2.1 Concept of sustainable development, 2.2 Natural resources, a-biotic and biotic resources 2.3 Principles of conservation of energy and management 2.4 Need of Renewable energy 2.5 Growth of renewable energy in India and the world 2.6 Concept of waste management and recyling
Unit – III Wind Power	3.1 Describe the growth of wind power in India 3.2 State the differences between VAWTs and HAWTs 3.3 Explain the differences between drag and lift type wind turbines 3.4 Describe the working of large wind turbines 3.5 List the types of aerodynamic control of large wind turbines 3.6 Name the generators used in large wind turbines	3.1 Growth of wind power in India 3.2 Types of wind turbines – Vertical axis wind turbines (VAWT) and horizontal axis wind turbines (HAWT) 3.3 Types of HAWTs – drag and lift types 3.4 Working of large wind turbines 3.5 Aerodynamic control of large and small wind turbines 3.6 Types of electrical generators used in small and large wind turbines
Unit – IV Solar Power	4.1 Describe the salient features of solar thermal and PV systems 4.2 Describe a solar cooker and solar water heater 4.3 Describe the working of solar PV system 4.4 State the salient features of polycrystalline, monocrystalline and thin film PV systems	4.1 Features of solar thermal and PV systems 4.2 Types of solar cookers and solar water heaters 4.3 Solar PV systems and its components and their working 4.4 Types of solar PV cells 4.5 Solar PV and solar water heaters, rating and costing
Unit – V Biomass energy	5.1 State the different types of biomass energy sources 5.2 Describe about the energy content in biomass 5.3 Describe the working of simple biogas plant	5.1 Types of Biomass Energy Sources 5.2 Energy content in biomass of different types 5.3 Types of Biomass conversion processes 5.4 Biogas production

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – VI Seismic Engineering and disaster management	6.1 Explain the principles of seismic Engineering in design of structure 6.2 State the appropriate actions to be taken during disasters	6.1 Introduction of seismic engineering and its application civil engineering designs 6.2 Features of disasters such as Floods, Earthquakes, Fires, Epidemics, Gas/radioactive leaks etc. 6.3 Management and mitigation of above disasters

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
1.	Ecology and Environment	8	4	4	0	8
2.	Sustainable Development	10	4	5	1	10
3.	Wind Power	10	4	6	4	14
4.	Solar Power	10	4	6	4	14
5.	Biomass energy	8	4	4	2	10
6.	Seismic Engineering and disaster	10	6	6	2	14
	Total	**56**	**26**	**31**	**13**	**70**

Legends:
R = Remembrance; U = Understanding; A = Application and above levels (Revised Bloom's taxomonoy

6. SUGGESTED LIST OF EXPERIMENTS/PRACTICAL EXERCISES

Nil

7. SUGGESTED LIST OF STUDENT ACTIVITIES

i. Prepare paper on various sustainable development
ii. Make a report after gathering information the values of water, noise pollution and air pollution in your city/town and compare the values in other cities and towns in India with respect to environmentally acceptable levels
iii. Prepare a paper on air and water pollution in an industry/institute
iv. Undertake some small mini projects in any one of the renewable energies
v. Visit an energy park and submit project on various sources of energy
vi. Prepare powerpoint on clean and green technologies
vii. Prepare a list of do's and don'ts applicable during disasters
viii. Submit a report on garbage disposal system in your city/town.

8. SUGGESTED LEARNING RESOURCES

A. List of Books

S. No.	Title of Book	Author	Publication/Year
1	Renewable Energy Technologies	Solanki, Chetan Singh	PHI Learning, New Delhi, 2010
2	Ecology and Control of the Natural Environment	Izrael,Y.A.	Kluwer Academic Publisher
3	Environment Engineering and Disaster Management	Sharma, Sanjay K.	Luxmi Publications, New Delhi
4	Environmental Noise Pollution and Its Control	Chhatwal,G.R.; Katyal,T.; Katyal,	Anmol Publications, New Delhi
5	Wind Power Plants and Project Development	Earnest, Joshua & Wizelius, Tore	PHI Learning, New Delhi, 2011
6	Renewable Energy Sources and Emerging Technologies	Kothari, D.P. Singal, K.C., Ranjan, Rakesh	PHI Learning, New Delhi, 2009
7	Environmental Studies	Anandita Basak	Pearson
8	Environmental Science and Engineering	Alka Debi	University Press
9	Coping With Natural Hazards, Indian Context	K. S. Valadia	Orient Longman
10	Engineering and Environment	Edward S. Rubin	Mc Graw Hill Publ.

B. List of Major Equipment/ Instrument

i. Digital sound level meters (to check noise pollution)
ii. Digital air quality meter (to measure air pollution)
iii. Digital handheld anemometer (to measure wind speeds)
iv. Digital hand held pyranometer (to measure solar radiation levels)

C. List of Software/Learning Websites

i. http://www1.eere.energy.gov/wind/wind_animation.html
ii. http://www.nrel.gov/learning/re_solar.html
iii. http://www.nrel.gov/learning/re_biomass.html
iv. http://www.mnre.gov.in/schemes/grid-connected/solar-thermal-2/
v. http://www.mnre.gov.in/schemes/grid-connected/biomass-powercogen/

9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. H.L.Purohit** , HOD, Civil Engg. Dept. L.E.College. Morbi
- **Shri. P.A.Pandya**, LCE, Civil Engg. Dept, G.P , Himatnagar

Co-ordinator and Faculty Members from NITTTR Bhopal

- **Dr. J.P.Tegar**, Professor Dept of Civil and Environmental Engg, NITTTR, Bhopal.
- **Dr. Joshua Earnest,** Professor and Head, Dept. of Electrical & Electronics Engg, NITTTR, Bhopal

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
COURSE CURRICULUM

Course Title: Engineering Physics (Group-1)
(Code: 3300004)

Diploma Programmes in which this course is offered	Semester in which offered
Automobile Engineering, Ceramic Engineering, Civil Engineering, Environment Engineering, Fabrication Technology, Mechanical Engineering, Mechatronics Engineering, Metallurgy Engineering, Mining Engineering, Plastic Engineering, Transportation Engineering	**First Semester**
Chemical Engineering, Textile Manufactureing Technology,Textile Processing Technology	**Second Semester**

1. RATIONALE

As Physics is the mother of all engineering disciplines, students must have some basic knowledge on physics to understand their core engineering subjects more comfortably. Accordingly, in reviewing the syllabus, emphasis has been given on the principles, laws, working formulae and basic ideas of physics to help them study the core subjects. Complicated derivations have been avoided because applications of the laws and principles of physics are more important for engineering students.

As Physics is considered as basic science its principles, laws, hypothesis, concepts, ideas are playing important role in reinforcing the knowledge of technology. Deep thought is given while selecting topics in physics. They are different for various branches of engineering. This will provide sound background for self-development in future to cope up with new innovations. Topics are relevant to particular program and students will be motivated to learn and can enjoy the course of Physics as if it is one of the subjects of their own stream.

Engineering, being the science of measurement and design, has been offspring of Physics
that plays the primary role in all professional disciplines of engineering. The different streams of Physics like Optics, Acoustics, Dynamics, Semiconductor Physics, Surface Physics, Nuclear physics, Energy Studies, Materials Science, etc provide Fundamental Facts, Principles, Laws, and Proper Sequence of Events to streamline Engineering knowledge.

Note:- Teachers should give examples of engineering/technology applications of various concepts and principles in each topic so that students are able to appreciate learning of these concepts and principles.
Laboratory experiments have been set up keeping consistency with the theory so that the students can understand the applications of the laws and principles of physics.

2. LIST OF COMPETENCIES

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competencies…….

i. Apply principles and concepts of Physics for solving various Engineering Problems

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	2	5	70	30	20	30	**150**

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit;
ESE - End Semester Examination; **PA** - Progressive Assessment.

4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I	1.1 Explain Physical Quantities and their units. 1.2Measure given dimensions by using appropriate instruments accurately. 1.3Calculate error in the measurement 1.4Solve numerical based on above outcomes	**SI Units & Measurements** 1.1 Need of measurement and unit in engineering and science, definition of unit , requirements of standard unit, systems of units-CGS,MKS and SI, fundamental and derived quantities and their units 1.2 Least count and range of instrument, least count of vernier caliper, micrometer screw gauge 1.3 Definition of accuracy, precision and error, estimation of errors -absolute error, relative error and percentage error, rules and identification of significant figures. (Numerical on above topics)
Unit– II	2.1 List Newton's laws of motion 2.2 Differentiate among various forces in nature 2.3 Define inertia, momentum and impulse of force 2.4 State Newton's laws of motion 2.5 State law of conservation of momentum 2.6 Solve numerical problems based on above topics	**Force and Motion:** Recapitulation of equations of motion, Newton's Ist law of motion, Force, basic forces in motion, gravitational force, electrostatic force, electromagnetic force, nuclear force, Inertia, types of inertia (inertia of rest, inertia of motion, inertia of direction), Momentum, Newton's IInd law of motion, measurement of force using second law, simple problems on F = ma and equations of motion, Impulse of force, Impulse as the product of force and time, impulse as the difference of momentum, examples of impulse, simple problems on impulse, Newtons IIIrd law of motion and its examples. Law of conservation of momentum, Statement, simple problems (Numerical on above topics)
Unit– III	3.1Comprehend the concept of elasticity and Define Stress, Strain and Elastic limit.	**General properties of matter** **3.1 Elasticity** Deforming force, restoring force, elastic and plastic

Unit	Major Learning Outcomes	Topics and Sub-topics
	3.2State Hooke's law. 3.3Explain the term elastic fatigue. 3.4Distinguish between Streamline and Turbulent flow 3.5Define coefficient of viscosity. 3.6Apply the principle of viscosity in solving problems. 3.7State significance of Reynold's number 3.8Explain terminal velocity. 3.9Mention Stoke's formula. 3.10Explain the effect of temperature on viscosity 3.11Comprehend the phenomenon of surface tension and its applications. 3.12Define surface tension. 3.13Explain angle of contact and capillarity. 3.14 Solve problems related to surface tension.	body, stress and strain with their types. elastic limit, Hooke's law, Young's modulus, bulk modulus, modulus of rigidity and relation between them (no derivation), stress strain diagram. behavior of wire under continuously increasing load, yield point, ultimate stress, breaking stress, factor of safety. **3.2 Surface Tension.** Molecular force, cohesive and adhesive force, Molecular range, sphere of influence, Laplace's molecular theory, Definition of surface tension and its S.I. unit, angle of contact, capillary action with examples, shape of meniscus for water and mercury, relation between surface tension , capillary rise and radius of capillary (no derivation),effect of impurity and temperature on surface tension **3.3 Viscosity** Fluid friction, viscous force, Definition of viscosity, velocity gradient, Newton's law of viscosity, coefficient of viscosity and its S.I. unit, streamline and turbulent flow with examples, critical velocity, Reynolds's number and its significance, free fall of spherical body through viscous medium (no derivation), up thrust force, terminal velocity, Stokes law (statement and formula). (Numericals on Above topics)
Unit– IV	4.1Distinguish between Heat and Temperature. 4.2Explain modes of Transmission of heat and their applications. 4.3Define heat capacity and specific heat of substances. 4.4Explain temperature 4.5List various temperature scales and convert among temperatures	**Heat Transfer** 4.1 Three modes of transmission of heat -conduction, convection and radiation, good and bad conductor of heat with examples, law of thermal conductivity, coefficient of thermal conductivity and its S.I. unit. 4.2 Heat capacity and specific heat of materials 4.3 Celsius, Fahrenheit and Kelvin temperature scales and their conversion formulae (Numericals on above topics)
Unit– V	5.1 Comprehend the concept of wave motion 5.2 Distinguish between transverse and longitudinal waves. 5.3Define period, frequency, amplitude and wavelength 5.4Explain principle of superposition of waves 5.5Define resonance 5.6Explain resonance. 5.7State Formula for velocity of sound in air 5.8Comprehend the Importance of Reverberation 5.9State Sabine's formula and Factors affecting Reverberation time 5.10Explain ultrasonic waves. Mention applications of	**Waves and Sound** Definition of wave motion, amplitude, period, frequency, and wavelength, relation between velocity, frequency and wavelength, longitudinal and transverse wave, principle of superposition of waves, definition of resonance with examples, Formula for velocity of sound in air and various factors affecting it **Ultrasonic Waves** Definition, Properties of ultrasonic waves Uses of ultrasonic waves. **Acoustics Of Building** Importance of Reverberation, Reverberation time, Optimum time of Reverberation, Coefficient of absorption of Sound, Sabine's formula for Reverberation time, Factors affecting Reverberation time and acoustics of building. (Numericals on above topics)

Unit	Major Learning Outcomes	Topics and Sub-topics
	ultrasonic waves	
Unit– VI	6.1 State Properties Of Light 6.2 Define various phenomena of light 6.3 State Snell's law of refraction. 6.4Explain importance and list applications of nanotechnology in engineering field	**Light and Nanotechnology** Properties Of Light, Electromagnetic spectrum, Reflection, refraction, snell's law, diffraction, polarization, interference of light, constructive and destructive interference (Only definitions), physical significance of refractive index, dispersion of light Introduction to Nanotechnology (Numericals on above topics)
Unit – VII	7.1Define radio activity 7.2Distinguish between Natural & Artificial radioactivity 7.3State relation between Half Life, Average Life & Decay Constant. 7.4Describe properties of Alpha, Beta and Gamma rays.	**Radioactivity** 7**.1 Radioactivity** Definition, Natural & Artificial radioactivity, Units and Laws of Radioactivity, Half Life, Average Life & Decay Constant. 7**.2 Radioactive Rays** Properties and uses of alpha particles, beta particles and gamma rays (Numericals on Above topics)

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
1.	SI Units & Measurements	05	03	02	05	10
2.	Force and Motion	05	02	02	04	08
3.	General Properties of Matter	10	04	06	08	18
4.	Heat Transfer	04	02	02	02	06
5.	Waves and sound	07	04	04	04	12
6.	Light and Nanotechnology	07	03	03	04	10
7.	Radioactivity	04	02	02	02	06
	Total	**42**	**20**	**21**	**29**	**70**

Legends:
R = Remembrance; U = Understanding; A = Application and above levels (Revised Bloom's taxonomy)

6. SUGGESTED LIST OF EXERCISES/PRACTICAL/EXPERIMENTS

The exercises/practical/experiments should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the competency. Following is the list of exercises/practical/experiments for guidance.

S. No.	Unit No.	Experiment /Practical Exercises
1	1	Linear Measurement by Vernier calipers
2	1	Linear Measurement by Micrometer screw
3	3	Measurement of Surface tension
4	3	Measurement of Viscosity
5	3	Measurement of Young's Modulus
6	3	To determine Force constant with the help of periodic time of oscillations of spring
7	3	Measurement of specific gravity
8	6	To calculate refractive index of material of prism using spectrometer device.
9	4	Joule's mechanical equivalent of heat
10	4	Measurement of co-efficient of thermal conductivity
11	5	To study the relation between the length of a stretched string and the tension in it with the help of a sonometer.
12	6	To calculate SA/V ratio of simple objects to understand nanotechnology

Minimum 8 experiments/practical exercises should be performed from the above list

- Hours distribution for Physics Experiments :

Sr. No.	Description	Hours
1	An introduction to Physics laboratory and its experiments (for the set of first four experiments)	02
2	Set of first four experiments	08
3	An introduction to experiments (for the set of next four experiments)	02
4	Set of next four experiments	08
5	Mini project	06
6	Viva and Submission	02

7. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES

Following is the list of proposed student activities like:
Laboratory based mini projects:

1. To calculate acoustics of given class room
2. To prepare models of Vernier calipers, micrometer screw gauge and travelling microscope

And many more Teacher guided self learning activities:

1. To prepare a chart of applications of nanotechnology in engineering field
2. To prepare models to explain different concepts

And many more Course/topic based seminars:

1. Seminar by student on any relevant topic

8. SUGGESTED LEARNING RESOURCES

A. List of Books

Sr No.	Author	Title of Books	Publication
1	Sears And Zemansky	University Physics	Pearson Publication
2	Paul G Hewitt	Conceptual Physics	Pearson Publication
3	Halliday & Resnick	Physics	Wiley India
4	G Vijayakumari	Engineering Physics, 4e	Vikas-Gtu Students' Series
5	Arvind Kumar & Shrish Barve	How And Why In Basic Mechanics	Universities Press
6	Ncert	Physics Part 1 And 2	Ncert
7	Giancoli	Physics For Scientists And Engineers	
8	H C Verma	Concepts Of Physics	
9	Gomber & Gogia	Fundamentals Of Physics	Pradeep Publications, Jalandhar

B. List of Major Equipment/ Instrument

1. Redwood's Viscometer
2. Digital Vernier Calipers And . Digital Micrometer Screw Guage
3. Digital Travelling Microscope
4. Joule's Calorimeter
5. Searle's Thermal Conductivity Apparatus
6. Visible Light Spectrometer

C. List of Software/Learning Websites

1. www.physicsclassroom.com
2. www.physics.org
3. www.fearofphysics.com
4. www.sciencejoywagon.com/physicszone
5. www.science.howstuffworks.com

9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Dr. S. B. Chhag**, Lecturer in Physics, Science Deptt, Govt. Polytechnic, Rajkot
- **Ku. B. K. Faldu**, Lecturer in Physics, Science Deptt, Govt. Polytechnic, Ahmedabad
- **Shri D. V. Mehta**, Lecturer in Physics, Science Deptt, RCTI, Ahmedabad
- **Shri S. B. Singhania**, Lecturer in Physics, Science Deptt, Govt. Polytechnic, Ahmedabad
- **Dr. U. N. Trivedi,** Lecturer in Physics, Science Deptt, RCTI, Ahmedabad

Coordinator and Faculty Members From NITTTR Bhopal

- **Dr. P. K. Purohit**, Professor, Department of Applied Science, NITTTR, Bhopal

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT
COURSE CURRICULUM

Course Title: Basics Engineering Drawing
(Code: 3300007)

Diploma Programmes in which this course is offered	Semester in which offered
Automobile Engineering, Ceramic Engineering, Civil Engineering, Environment Engineering, Mechanical Engineering, Mechatronics Engineering, Metallurgy Engineering, Mining Engineering, Printing Technology, Textile Manufacturing Technology, Textile Processing, Transportation Engineering	**First Semester**
Chemical Engineering, Electrical Engineering, Fabrication Technology, Plastic Engineering	**Second Semester**

1 RATIONALE:

Engineering drawing is an effective language of engineers. It is the foundation block which strengthens the engineering & technological structure. Moreover, it is the transmitting link between ideas and realization. It is an attempt to develop fundamental understanding and application of engineering drawing. It covers knowledge & application of drawing instruments & also familiarizes the learner about Bureau of Indian standards. The curriculum aims at developing the ability to draw and read various drawings, curves & projections.

The subject mainly focuses on use of drawing instruments, developing imagination and translating ideas. Developing the sense of drawing sequence and use of drawing instruments effectively yields not only with productive preparation of computer aided graphics but also yields with effective industrial applications ranging from marking to performance of operations.

2 LIST OF COMPETENCIES:

The course content should be taught and implemented with the aim to develop different types of skills leading to the achievement of the following competencies:

i. **Prepare engineering drawings manually with given geometrical dimensions using prevailing drawing standards and drafting instruments. .**
ii. **Visualize the shape of simple object from orthographic views and vise versa.**

3. TEACHING AND EXAMINATION SCHEME:

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
2	0	4	6	70	30	40	60	**200**

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Theory Practice; **P** - Practical; **C** – Credit;
ESE - End Semester Examination; **PA** - Progressive Assessment.

4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Sub-topics
Unit – 1 **ENGINEERING DRAWING AIDS**	1.1 Use drawing equipments, instruments and materials effectively.	1.1 Drawing equipments, instruments and materials. (a) Equipments-types, specifications, method to use them, applications. (b) Instruments-types, specifications, methods to use them and applications. (c) Pencils-grades, applications, types of points and applications. (d) Other materials-types and applications.
Unit– 2 **PLANNING, LAYOUT AND SCALLING OF DRAWING**	2.1Follow and apply standard practice as per bureau of I.S. for planning and layout 2.2 Choose appropriate scale factor for the drawing as per given situation	2.1 I.S. codes for planning and layout. 2.2 Scaling technique used in drawing.
Unit– 3 **LINES, LETTERING AND DIMENSIONING**	3.1 Write annotations on a drawing where ever necessary. 3.2Choose appropriate line and dimensioning style for a given geometrical entity.	3.1 Different types of lines. 3.2 Vertical capital and lower case letters. 3.3 Inclined capital and lower case letters. 3.4 Numerals and Greek alphabets. 3.5 Dimensioning methods. (a) Aligned method. (b) Unilateral with chain, parallel, progressive and combined dimensioning.

Unit	Major Learning Outcomes	Sub-topics
Unit– 4 **GEOMETRIC CONSTRUCTION**	4.1 Develop the ability to draw polygons, circles and lines with different geometric conditions.	4.2 Geometric construction related with line like bisecting a line, to draw perpendicular with a given line, divide a line, etc. 4.3 Geometric construction related with angle like bisect an angle, trisect an angle, etc. 4.4 To construct polygon. a: Triangle b: Square / Rectangle. c: Pentagon with special method. d: Hexagon with special method. 4.5 To draw tangents. 4.6 Geometric construction related with circle & arc.
Unit–5 **ENGINEERING CURVES**	5.1 Able to draw engineering curves with proficiency and speed as per given dimensions.	5.2 Conic sections. (a) Concept and understanding of focus, directrix, vertex and eccentricity and drawing of conic sections. (b) Using various methods, understand construction of : i. Ellipse. ii. Parabola. iii. Hyperbola. 5.3 Cycloidal Curves(Cycloid, Epicycloid, Hypocycloid) 5.4 Involutes. (a) Involutes of a circle (b) Involutes of a polygon 5.5 Spiral (Archimedean spiral only).
Unit– 6 **PROJECTION OF POINTS, LINES AND PLANES**	6.1 Draw the projection of points, lines and planes with different conditions. 6.2 Find out true shape and size of a inclined line or plane	6.1 Reference planes, orthographic projections. 6.2 Concept of quadrant. 6.3 1st angle and 3rd angle projection and their symbols. 6.4 Projection of points. 6.5 Projection of lines – determination of true length and inclinations for following cases. (a) Line parallel to one or both the plane. (b) Line perpendicular to one of the plane. (c) Line inclined to one plane and parallel to another. (d) Line inclined to both the planes. 6.6 Projection of Planes. (a) Types of planes. (b) Projection of planes parallel to one of the reference planes. (c) Projection of plane inclined to one reference plane and perpendicular to another. (d) Projection of planes inclined to both reference planes. Note : Triangle, Square / rectangle, pentagon, hexagon and circle shape should be included in various plane problems.

Unit	Major Learning Outcomes	Sub-topics
Unit– 7 **ORTHOGRAPHC PROJECTIONS**	7. 1 Draw the orthographic views of object containing lines, circles and arc geometry. 7.2 Interpret given orthographic views and to imagine the actual shape of the component.	7.1 Types of projections-orthographic, perspective, isometric and oblique: concept and applications. 7.2 Various term associated with orthographic projections. (a) Theory of projection. (b) Methods of projection. (c) Orthographic projection. (d) Planes of projection. 7.3 Conversion of simple pictorial views into Orthographic views. Illustrative problems on orthographic projection. 7.4 B.I.S. code of practice. Note : (1) Problem should be restricted up to four views- Front view/Elevation, Top view/Plan and Side views only. (2) Use First Angle Method only.
Unit– 8 **ISOMETRIC PROJECTIONS**	8.1 Draw the isometric view from orthographic views of object/s containing lines, circles and arcs.	8.2 Isometric axis, lines and planes. 8.3 Isometric scales. 8.4 Isometric view and isometric drawing. 8.5 Difference between isometric projection and isometric drawing. 8.6 Illustrative problems limited to objects containing lines, circles and arcs shape only.

5. SPECIFICATION TABLE WITH HOURS & MARKS (THEORY):

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
1.	Engineering drawing aids.	0	00	00	02	02
2.	Planning, layout and scaling of drawing.	0	02	00	03	05
3.	Lines, lettering and dimensioning.	0	00	02	00	02
4.	Geometric construction.	3	00	03	07	10
5.	Engineering curves.	6	02	00	10	12
6.	Projection of points, lines and planes.	8	03	00	14	17
7.	Orthographic projections.	6	00	00	12	12
8.	Isometric projections.	5	00	02	08	10
	Total	**28**	**07**	**07**	**56**	**70**

Legends:
R = Remembrance; U = Understanding; A = Application and above levels.

NOTES:

a: If midsem test is part of continuous evaluation, unit number 4, 5 and 6 (For Unit 6, except projections of planes) are to be considered.
b:Ask the questions from each topic as per weightage of marks. Choice of questions must be given from the same topic.

6. SUGGESTED LIST OF EXERCISES/PRACTICAL/EXPERIMENTS

The exercises/practical/experiments should be properly designed and implemented with an attempt to develop different types of skills leading to the achievement of the competency. Following is the list of exercises/practical/experiments for guidance.

Ex. No.	Unit No.	Practical Exercises	Hours
1	1,2,3	**USE OF DRAWING INSTRUMENTS:** 1. Teacher will demonstrate- a: Use of drawing instruments. b: Planning and layout as per IS. c: Scaling technique. 2. Draw following. Problem – 1 Drawing horizontal, vertical, 30 degree, 45 degree, 60 & 75 degrees lines using Tee and Set squares/ drafter. Problem – 2 Types of lines. Problem – 3 Types of dimensioning. Problem – 4 Alphabets & numerical (Vertical & inclined as Per I.S.).	14
2	4	**GEOMETRIC CONSTRUCTION:** Drawing of set of lines with different conditions. (Two problems) Drawing Polygons. (Three Problems) Drawing circles and arcs with different geometric conditions and with line constraints. (Three problems)	06
3	5	**ENGINEERING CURVES – I:** Problem –1: Construction of ellipse using any two methods from arc of circle method, four centre method, rectangular method, eccentricity method and concentric circle method. Problem –2: Construction of parabola with any one method from rectangular method, tangent method and eccentricity method. Problem –3: Construction of hyperbola with any one method from eccentricity method and rectangular method. Problem –4: Construction of spiral. (Refer note c for dimensions).	04
4	5	**ENGINEERING CURVES – II:** Problem – 1: Construction of cycloid. Problem – 2: Construction of hypocycloid & epicycloids. Problem – 3: Construction of involute (circle).	04

		Problem – 4: Construction of involute (polygon). (Refer note c for dimensions).	
5	6	**PROJECTIONS OF POINTS AND LINES:** Draw projection of points-For 10 various conditions.(One problem) Draw projection of lines with different conditions. (Four problems) (Refer note c for dimensions).	06
6	6	**PROJECTIONS OF PLANE:** Draw projection of different planes with different conditions. (triangle, square / rectangular, pentagonal / hexagonal, and circular -one for each). (Four problems) (Refer note c for dimensions).	04
7	7	**ORTHOGRAPHIC PROJECTIONS**: Draw Orthographic projections of different objects. (Two problems) (Draw four views of each object). (Refer note c for dimensions).	08
8	8	**ISOMETRIC DRAWINGS:** Draw isometric drawings from given orthographic views (Three problems) (Refer note c for dimensions).	10
9	All	**PROBLEM BASED LEARNING:** Given the orthographic views of at least three objects with few missing lines, the student will try to imagine the corresponding objects, complete the views and draw these views in sketch book.	-
10	All	**SCHOOL WITHIN SCHOOL:** • Explain at least one problem for construction and method of drawing in sheet to all batch colleagues. Teacher will assign the problem of particular sheet to be explained to each batch student. • Each student will assess at least one sheet of other students (May be a group of 5-6 students identified by teacher can be taken) and will note down the mistakes committed by them. Student will also guide the students for correcting the mistakes, if any.	-

Notes :–

a: **Use both sides of sheet. For example, draw sheet number 2 on back side of sheet number 1, 4 on back of 3, and likewise.**

b: Theory & practice should be in first angle projections and IS codes should be followed wherever applicable.

c: The dimensions of line, axes, distances, angle, side of polygon, diameter, etc. must be varied for each student in batch so that each student will have same problems, but with different dimensions.

d: The sketchbook has to contain data of all problems, solutions of all problems and student activities performed. Students' activities are compulsory to be performed.

e: A hand out containing applicable standards from IS codes including title block as per IS standard should be given to each student by concerned teacher.

f: For 40 marks Practical Marks ESE, students are to be assessed for competencies achieved. Students are to be given data for practical ESE to prepare drawings.

7. LIST OF STUDENT ACTIVITIES:

Following is the list of student activities to be performed by each student individually:

Activity No.	Details of student activity
1	Sketch the combinations of set squares to draw angles in step of 15^0.(15^0, 30^0, 45^0, 60^0, 75^0, 90^0, 105^0, 120^0, 135^0, 150^0, 165^0, 180^0).
2	Solve all problems for all sheets number 1 to 8 in sketch book (with dimensions).
3	List the shapes you are observing around you in real life with place/item. (For ellipse, parabola and hyperbola).
4	Take two simple objects. Sketch isometric of them. Also draw orthographic projections of them (all views).
5	Take one circular shape. Assume one point on circumference and mark it. Roll that shape on flat and circular surface. Observe the path of point.
6	List at least two questions individually which you would like to ask for followings: a: Ellipse. b: Involute of circle. c: Perspective projections. d: Use of geometric constructions. e: Quadrants.

8. SUGGESTED LEARNING RESOURCES:

A. List of Books

Sr.No.	Title of Books	Author	Publication
1	Elements of Engineering Drawing.	N.D. Bhatt	Charotar Publishing House, Anand.
2	Engineering Drawing.	P.J.Shah	S.Chand, New Delhi.
3	Fundamentals of Engineering Drawing.	W.J.Luzzadar	Prentice-hall of India Pvt. Ltd.-New Delhi
4	Fundamentals of Drawing.	K.R.Gopalkrishna	Subhash Publications, Banglore.
5	Engineering Drawing	M.B.Shah, B.C.Rana	Pearsons.
6	Machine Drawing.	V. Laxminarayan & M.L.Mathur	Jain Brother, New Delhi.
7	Fundamentals of Engineering Drawing.	French & Vierck	McGraw-Hill

B. List of Major Equipments/ Instruments :

- Models- full and cut.
- Set of various industrial drawings being used by industries-up dated.
- Drawing equipments and instruments for class room teaching-large size.
- Drawing board-half imperial size.
- T-square or drafter (Drafting Machine).

- Set squires (45^0 and 30^0-60^0)
- Protector.
- Drawing instrument box (containing set of compasses and dividers).
- Drawing sheets.
- Drawing pencils.
- Eraser.
- Drawing pins / clips.
- Roller scale

C. List of Software/Learning Websites:

- rgpv-ed.blogspot.com/2009/02/**engineering-curves**.html
- http://www.slideshare.net/sahilsahil992/conic-section-1819818
- http://www.technologystudent.com/designpro/drawdex.htm
- http://www.engineeringdrawing.org/engg_curves/problem-3-8-engineering-curves/490/
- http://web.iitd.ac.in/~hirani/mel110-part3.pdf
- http://www.studyvilla.com/ed.aspx
- http://www.youtube.com/watch?v=a703_xNeDao
- http://www.youtube.com/watch?v=TCxTP_8ggNc
- http://www.youtube.com/watch?v=JpgFPZILTu8&feature=related
- http://www.youtube.com/watch?v=o1YPja2wCYQ&feature=related
- http://www.youtube.com/watch?v=dJyKV3Ay7vM&feature=fvwrel
- E-learning package from KOROS.
- E-learning package from Cognifront.
- CD with book-Engineering drawing, M.B. Shah-B.S. Rana (Pearson).
- Computer based learning material published by KOROS.

9. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof.K. H. Patel**. Head Dept.of Mech., Engg., Dr. S. & S. Gandhi College of Engineering and Technology, Surat,

- **Shri.H. R. Sapramer**, Lecturer in Mech. Engineering, Dr. J.N.Mehta Government Polytechnic, Amreli.

- **Prof.A.M. Talsaniya**, Lecturer in Mech. Engineering, Sir Bhavsinhji Polytechnic Institute, Bhavnagar.

Co-ordinator and Faculty Memberfrom NITTTR Bhopal

- **Prof. Sharad Pradhan**, Associate Professor, Dept. of Mech. Engg., NITTTR, Bhopal.

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM

Course Title: Organic Chemistry
(Code: 3320501)

Diploma Programmes in which this course is offered	Semester in which offered
Chemical Engineering, Textile Processing Technology	**Second Semester**

1. RATIONALE

Organic Chemistry is the foundation for Chemical Engineering, Textile Processing, Textile Manu., Plastic Engineering courses.
This course provides the basic knowledge of organic compounds and their chemical behavior. This course gives clarity to the students regarding the knowledge of aromatic, aliphatic and heterocyclic compounds & several inorganic salts with their structural formulas in detail. This course is designed in way that it may be useful in chemical industries as well as in textile field. Moreover it will be useful for the study of chemistry of dye stuff & intermediates, drugs & pharmaceutical, polymer science, plastic technology & the study of explosives materials it is an essential subject.
Thus good foundation in Basic Organic Chemistry will help the students in performing in a better way in their engineering field.

2. COMPETENCIES

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire the following competencies:

i. **Select proper organic compounds required for different application in their field of engineering.**
ii. **Use selected organic compounds in different engineering processes appropriately.**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**ESE**	**PA**	**ESE**	**PA**	
4	0	2	06	70	30	20	30	**150**

Legends: L-Lecture; **T** – Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** – Credit;; **ESE** - End Semester Examination; **PA** - Progressive Assessment.

Note: It is the responsibility of the institute heads that marks for **PA of theory** & **ESE and PA of practical** for each student are entered online into the GTU Portal at the end of each semester within the dates specified by GTU.

4. DETAILED COURSE CONTENTS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I CONCEPT OF ORGANIC CHEMISTRY:	1a. Classify the Organic compound 1b. Classify the functional group 1c. Explain nomenclature of organic compound 1d. Comprehend the concept of isomerism	1.1 Introduction 1.2 Classification of Hydrocarbons 1.4 Functional group classification of organic compound 1.5 IUPAC system of nomenclature. 1.6 Isomerism. 1.6.1 Structural Isomerism - Position Isomerism - Chain Isomerism - Mesmerism Isomerism - Functional Isomerism 1.6.2 Stereo Isomerism. - Optical isomerism - Geometrical Isomerism
Unit– II PURIFICATION OF ORGANIC COMPOUNDS	2a. Describe various methods of purification 2b. Explain purification of organic compound	2.1 Crystallization 2.2 Sublimation 2.3 Distillation 2.3.1 Simple distillation 2.3.2 Fractional distillation 2.3.3 Distillation under reduced pressure 2.3.4 Steam distillation 2.4 Tests of purification- M.P. & B.P. of organic compounds.
Unit– III DETECTION & ESTIMATION OF ELEMENTS	3a. Use different methods for detection and testing of elements 3b. Estimate the elements by different mrthods	3.1 Detection of C, H, N, halogens, S & P. 3.1.1 Lassaigne's Test for detection of N, Cl, B, I & S. 3.2 Estimation of C & H. 3.3 Estimation of Nitrogen by Duma's method. 3.4 Estimation of Nitrogen by Kjeldahl's method. 3.5 Estimation of halogens, sulphur and Phosphorous by Cariu's Method. 3.6 Problems based on methods of estimation.

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit– IV **STUDY OF ALIPHATIC COMPOUNDS**	4a. Differentiate aliphatic and aromatic compound 4b. Describe different methods of preparation and Uses of aliphatic compound	4.1 Preparation, Properties & Uses of following Compounds. 4.1.1 Alcohol, Aldehyde & Ketone (Methanol, Ethanol ,Acetaldehyde & Acetone.) 4.1.2 Carboxylic Acid (Acetic Acid & Oxalic Acid.) 4.1.3 Esters and ether (,Methy & Ethyl Acetate & Diethyl ether 4.1.4 Amines (Methylamine, Ethyl Amine).
Unit– V **STUDY OF AROMATIC COMPOUNDS**	5a. Explain the specific properties of aromatic compound 5b. Describe different methods of preparation and Uses of aromatic compound	5.0 Preparation, Properties & Uses of following Compounds. 5.1 Benzene & Toluene 5.2 Nitrobenzene & Aniline. 5.3 Phenol & Benzaldehyde 5.4 Benzoic Acid & Salicylic Acid. 5.5 Styrene. & Naphthalene
Unit– VI **BRIEF STUDY OF VARIOUS UNIT PROCESSES**	6a.Identify the different unit process 6b. Define various unit processes 6c.Enlist suitable reagents for each unit process	6.1 Study of the following unit processes: 6.1.1 Sulphonation 6.1.2 Nitration 6.1.3 Halogination 6.1.4 Diazotization 6.2 Reagents used for above unit processes.
Unit– VII **CARBOHYDRATES,SOAPS & DETERGENT**	7a. Classify carbohydrates 7b. Classify soaps and detergent 7c. Describe mechanism of cleansing action	7.1 Introduction: Carbohydrates and its classification with suitable Examples 7.2 Explain soaps and Detergent 7.3 Classification of soaps and detergent with suitable example of each class 7.4 Mechanism of cleansing action
Unit– VIII CHEMISTRY OF DYES & ITS CLASSIFICATION	8a. Explain difference between dyes & color 8b. Classify dyes in different ways	8.1 Define Dye. 8.2 Difference between Dye & Colour. 8.3 Explain- Chromogens, Chromophore & Auxoch 8.4 Classification of Dyes base on Structure. 8.5 Classification of Dyes based on method of application.

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
I	Concept Of Organic Chemistry:	06	2	2	3	07
II	Purification Of Organic Compounds:	06	2	2	3	07
III	Detection And Estimation Of Elements :	07	3	3	4	10
IV	Study Of Aliphatic Compounds:	10	3	3	4	10
V	Study Of Aromatic Compounds:	10	4	4	4	12
VI	Brief Study Of Various Unit Processes:	07	3	3	4	10
VII	Carbohydrates, Soaps And Detergents	06	2	2	3	07
VIII	Chemistry Of Dyes & Its Classification	04	2	2	3	07
	Total	**56**	**21**	**21**	**28**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as only general guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table.

6. SUGGESTED LIST OF EXERCICES/PRACTICALS

The practical/experiments should be properly designed and implemented with an attempt to develop different types of skills so that students are able to acquire above mentioned competencies:

Sr. No.	Unit No.	Practical Exercise	Approx Hours Required
1	All	Physically Observing of Organic Acid, Base, Phenol & Neutral Compounds.(Their physical state, Structural formula & Solubility).	04
2	II	Purification of a given organic compound by crystallization.	02
3	II	Purification of a given organic compound by Solvent Treatment method.	02
4	II,IV & V	Detection of Melting point of some Organic Solids by Thiele's Method.	04
5	II,IV & V	Detection of Boiling point of some Organic liquids by Semi micro method.	04
6	II,IV & V	Separation of some Organic Compounds (Acid + Phenol + Base) using solvent treatment method.	04
7	V, VI & VIII	Preparation of some compounds such as i) Nitrobenzene from Benzene	04
8	II , V& VI	Purification of some organic compounds by Sublimation method.	02
9	II	Detection of some Elements by Lassaigne's test.	02
10	IV & V	Practical are to be performed based on the organic spotting of the following compounds. Organic Qualitative Analysis i) Acetic Acid & Benzoic Acid (ii) Aniline & Nitrobenzene iii) Benzene & Acetone (iv) Chloroform & Phenol	04
		Total	**32**

NOTE: Minimum Ten Experiments should be performed by the students from the above given list OR any other experiments related to above topics

7. SUGGESTED LIST OF PROPOSED STUDENT ACTIVITIES

Following is the list of proposed student activities like:

- Library Survey regarding Molecular & Structural formulas of Different Organic Compounds.
- Group Discussion Regarding Purification of Several Organic Compounds.
- Challenging task related to purification of organic Compounds given by faculty.
- Oral presentation related to different unit processes.
- Library Survey regarding Qualitative Analysis of different Compounds.
- Study of Industries involved in the mfg. of some important Compounds.

8. SUGGESTED LEARNING RESOURCES

A. List of Books

Sr.No.	Title of Books	Author	Publication
1	A Textbook of organic chemistry	B.S. Bahl & Arun Bahl	S. Chand & Co., New Delhi.
2	A Textbook of organic chemistry	P.L.Soni	S. Chand & Co., New Delhi.
3	A Textbook of organic chemistry	O.P. Agrawal	Krishna Prakashan
4	A Textbook of organic chemistry	Bahl & Tuli	S. Chand & Co., New Delhi.
5	A Manual of Practical Engineering Chemistry	Sudha Jain & Shradha Sinha	S. Chand & Co., New Delhi.
6	Organic Chemistry	I.L. Finar	ELBS
7	Organic Chemistry	Robert Morrison & Boyd	Prentice Hall of India, New Delhi.

B. List of Major Equipment/ Instrument

- Glass wares
- Melting Point apparatus.
- Gas line & burners.
- Distillation Assembly.
- Chemicals & Reagents.
- Water / Send Bath.
- Evaporating Dishes etc.

9. COURSE CURRICULUM DEVELOPMENT COMMITTEE:

Faculty Members from Polytechnics

- **Prof. J.C.Patel,** I/C.Head, Science & Humanities Department, Dr. S.& S.S. Ghandhy College of Engineering Technology, Surat
- **Prof. Dr. P.R.Patel,** Head, Science & Humanities Department, N.G.Patel Polytechnic, Isroli, Bardoli
- **Prof. S.A.Nimakwala,** I/C.Head, Science & Humanities Department, Shri.K.J. Polytechnic, Bharuch.
- **Prof. R.R.Patel,** I/C.Head, Science & Humanities Department,G.P. Himmatnagar.

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- **Dr. Bashirulla Shaik,** Assistant Professor, Dept. of Applied Sciences
- **Dr. Abhilash Thakur,** Associate Professor, Dept. of Applied Sciences

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

CHEMICAL ENGINEERING MATERIALS
(Code: 3330501)

Diploma Programme in which this course is offered	Semester in which offered
Diploma in Chemical Engineering	3rd Semester

1 RATIONALE

For working in the industries related to chemical manufacturing, students requires the knowledge of various classes of material like metals and alloys, ceramics, polymers, composites, coatings, insulating materials, adhesives and lubricants for different applications. Study of Chemical Engineering Materials also has importance towards the understanding of properties of materials for construction of various equipments and piping systems. Properties of materials affect the life and performance of equipments to the large extent. Thus information of properties of these materials is important for students to ensure the minimum cost of products and safety in the plants.

2 COMPETENCY (Programme Outcome according to NBA Terminology):

The course content should be taught and implemented with the aim to develop different types of skills in the students so that they are able to acquire the following competencies:

- **Identify appropriate materials for chemical plant equipments, piping, insulation and lining.**

3 TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	100
3	2	0	5	70	30	00	00	

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

4 COURSE DETAILS

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit-I **Properties Of Materials**	Describe scope of material science Explain important properties of materials Select materials	1 Scope of material science 2 Definition and explanation of : Melting point, Boiling point, Specific heat, Thermal conductivity, Thermal expansion, Thermal insulation, Stresses, Strain, Yield stress, Fatigue,Creep 3 Principles of selection of materials
Unit-II **Corrosion and Its Prevention**	Define corrosion and describe it's types Control and prevent corrosion	1 Definition of corrosion 2 Types of corrosion: Direct corrosion, Electro-chemical corrosion, Galvanic corrosion, High temperature corrosion 3 Factors affecting corrosion rate 4 Methods for control and prevention of corrosion
Unit– III **Metals and Alloys**	Describe and compare ferrous metals and alloys Describe non-Ferrous metals and alloys Explain furnaces	1 Properties and uses of Cast iron, Wrought iron, Mild steel, Stainless steel 2 Comparison of ferrous metals and alloys 3 Properties and uses of metals: Aluminium, Zinc, Chromium, Nickel, Tin, Copper, Titanium, Tungsten, Platinum and Silver 4 Properties and uses of alloys : Duralumin, Brass, Bronze, Inconel, Hastalloy B and C, Invar,

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
		Y alloy 5 Purification of metals using Blast furnace and Arc furnace
Unit– IV **Ceramic Materials**	Describe ceramic materials Compare ceramic material	Ceramic materials 2 Composition, properties and uses of china clay, fire clay, bentonite 3 Classification, properties and uses of refractories 4 Composition, properties and uses of Soda lime glass, borosilicate glass, high silica glass, fibre glass, glass wool, form glass 5 Composition, properties and uses of Porcelain
Unit-V **Organic Materials**	Describe polymers Compare types of polymerization Describe and classify plastics, rubbers Explain vulcanizing of rubber	Definition and importance of Polymer 2 Addition and condensation Polymerization 3 Plastics : definition, classification, general properties and uses 4 Rubbers : definition, classification, general properties and uses 5 Compare natural and synthetic rubber 6 Vulcanizing of rubber

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit-VI **Protective Coatings and Insulations**	6a. Describe and classify paints 6b. Describe and classify Varnishes 6c. Describe and Classify insulations	Paints: classification and uses Ingredients of paints: their properties and importance Special types of paints and their applications Varnishes: classification and uses Ingredients of Varnishes Types of insulations Properties and applications of different :(i) Electric insulation (ii)Thermal insulation
Unit-VII **Composites, Lubricants and Adhesives**	Describe and classify composites Describe and classify lubricants Describe and classify adhesives	List of composite materials Properties and uses of Fiber reinforced plastics(FRP), Metal matrix composites(MMC), Ceramic matrix composites(CMC) Classification, properties and uses of Synthetic lubricants, Semisolid lubricants Adhesives: classification, properties and uses

5 SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (Theory)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Properties of Materials	4	2	3	2	07
II	Corrosion and its Prevention	6	2	4	4	10
III	Metals and Alloys	7	5	4	3	12
IV	Ceramic Materials	6	4	4	2	10
V	Organic Materials	5	3	3	2	08
VI	Protective coatings and Insulations	6	4	4	2	10
VII	Composites, Lubricants and adhesives	8	4	5	4	13
	Total	**42**	**24**	**27**	**19**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

6 SUGGESTED LIST OF PRACTICAL/EXERCISES

(Not Applicable)

7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like: course/topic based presentations, internet based assignments, and teacher guided self learning activities, MCQ/Quiz. These could be individual or group-based.

8. SPECIAL INSTRUCTIONAL STRATEGY (If Any)

1. Collecting and demonstrating samples of different materials
2. Following Tutorials exercises may be given to the students

S. No.	Unit No.	Topic on which Tutorial Exercises may be given	Approx. Hrs. Required
1	I	Principles of selection of materials	04
2	II	Control and prevention of corrosion	04
3	III	Comparison of properties of Ferrous metals and alloys	04
4	III	Comparison of properties of important Non-Ferrous metals and alloys	04

S. No.	Unit No.	Topic on which Tutorial Exercises may be given	Approx. Hrs. Required
5	IV	Comparison of properties of Refractories	04
6	V	Compounding of Plastic and Rubber	02
7	VI	Ingredients of Paints and varnishes	02
8	VI	Thermal insulations	02
9	VII	FRP	02
		Total	**28**

9. SUGGESTED LEARNING RESOURCES

A. List of Books:

S. No.	Title of Books	Author	Publication
1	Material science and processes	Hazarachaudhary S. K.	Indian book distribution co.
2	Engineering Materials	Rangwala S C, Rangwala K. S.	Charotar publishing house pvt. limited
3	Engineering Materials	Rajput R. K.	S.Chand and Co., New Delhi

B. List of Major Equipment/Materials

---- Nil ----

C List of Software/Learning Websites

i. web.iitd.ac.in/~suniljha/MEL120/L2_Engineering_Materials.pdf
ii. http://engineershandbook.com/Materials
iii. www.engineeringtoolbox.com/engineering-materials-properties-d_1225.html
iv. http://nptel.iitm.ac.in/courses.php

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics:

- **Prof. R. P. Hadiya**, Lecturer in Chemical Engineering, Government Polytechnic, Rajkot
- **Prof. Kajal J. Sareriya**, Lecturer in Chemical Engineering, Government Polytechnic, Rajkot
- **Prof. N. N. Hansalia**, Lecturer in Chemical Engineering, Government Polytechnic, Rajkot
- **Prof. Manish R. Nasit**, Lecturer in Chemical Engineering, Shri N. G. Patel Polytechnic, Isroli - Afwa

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof Bashir Shaikh**, Assistant Professor, Department of Applied Sciences.
- **Prof Shashi Kant Gupta,** Professor and Coordinator for State of Gujarat

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

MECHANICAL OPERATIONS
(Code: 3330502)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	3rd Semester

1. RATIONALE

The operations of chemical plants require use of material handling and size reduction equipments, screens, agitator, mixers, centrifuges, cyclones, filters and other mechanical separation equipments. Therefore students must have information about the principles, construction and working of these equipments so that they can plan for their efficient use in plants. In this course the students would also learn simple calculations to judge the performance of these equipments.

2. COMPETENCY (Programme Outcome according to NBA Terminology):

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competencies:

- **Plan and supervise operation of mechanical operation equipments.**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	200
4	0	4	8	70	30	40	60	

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

4. COURSE DETAILS

Unit	Major Learning Outcomes	Topics and Sub-topics
Unit – I Properties of Particulate Solids	1a. Differentiate Unit operation and Unit process	1.1 Fundamentals of Unit operation and Unit process
	1b. Describe specific properties of solids	1.2 Specific properties of solids : Particle density and Bulk density, diameter, sphericity, equivalent diameter, specific surface area, volume surface mean diameter, mass mean diameter, and shape factor
	1c. Calculate specific property parameters of solids	1.3 Calculation of particle diameter, sphericity, equivalent diameter, specific surface area, volume surface mean diameter, mass mean diameter, and shape factor, numbers of particles in solid
Unit – II Screen Analysis	2a. Explain Screen	2.1 Basics of Ideal and actual screen
	2b. Compare types of screen analysis	2.2 Types of screen analysis 2.2.1 Cumulative analysis 2.2.2 Differential analysis 2.3 Applications of screen analysis
	2c. Derive formula for effectiveness of screen 2d. Calculate capacity and effectiveness of screen	2.4 Capacity and effectiveness of screen 2.5 Derivation of formula for overall effectiveness of screen 2.6 Calculation of capacity and effectiveness of screen
	2e. Identify faults in screen	2.7 Faults in screening
	2f. Describe types of screening equipment	2.8 Types of screen: Trommel, Grizzlies, Vibrating screen
Unit – III Size Reduction	3a. Explain size reduction with applications	3.1 Principles of Size reduction and its application
	3b. Describe working of size reduction equipments	3.2 Classification, comparison and selection of size reduction equipments based on size reduction principle
	3c. Characterise the comminution products	3.3 Characteristics of comminution products
	3d. Explain energy and power requirement in comminution.	3.4 Energy and power required in comminution
	3e. Explain empirical laws of size reduction	3.5 Laws of size reduction: (i) Rittingers law (ii) Bond's law (iii) Kick's law
	3f. Compute the energy and power requirement for size reduction	3.6 Calculation of power required for size reduction using empirical laws
	3g. Calculate work index	3.7 Work index

Unit	Major Learning Outcomes	Topics and Sub-topics
	3h. Explain different size reduction equipment	3.8 Principle, construction and working of Jaw crusher, Gyratory crusher, Fluid Energy mill, Ribbon Blender, Roll crusher, and Ball Mill
	3i. Calculate angle of nip	3.9 Derivation of equation of angle of nip, Calculation of angle of Nip for Roll crusher
	3j. Calculate critical speed	3.10 Derivation of equation of critical speed of Ball mill and its calculations
	3k. Differentiate between open and close circuit grinding	3.11 Difference between open and close circuit grinding
Unit – IV Sedimentation	4a. Explain sedimentation 4b. Draw batch sedimentation curve	4.1 Fundamentals of sedimentation 4.2 Batch sedimentation 4.3 Inter phase height Vs time curve for Batch sedimentation
	4c. Describe principle of flocculation and thicker	4.4 Principle of flocculation 4.5 Principle, construction and working of Gravity thicker
	4d. Explain and compare settling	4.6 Fundamentals of free and hindered settling
	4e. Explain Tubular Centrifuge	4.7 Construction and working of Tubular centrifuge
	4f. Describe Cyclone separator 4g. Calculate Cut diameter and efficiency of cyclone	4.8 Principle, construction and working of Cyclone separator 4.9 Cut diameter and efficiency of cyclone
	4h. Explain Terminal settling velocity, Stoke's law, Newton's law	4.10 Terminal settling velocity Stoke's law and Newton's law
Unit –V Filtration	5a. Describe filtration 5b. Classify equipments for liquid-solid separation	5.1 Basics of filtration 5.2 Classification of equipments for liquid-solid separation
	5c. Explain types of filter	5.3 Principle, construction and working of filter press, leaf filter, rotary vacuum filter, cartridge filter
	5d. Characterise filter media	5.4 Filter media and its characteristics
	5e. Explain filter aids 5f. Describe method of application	5.5 Basics of Filter aids 5.6 Method of application
	5g. Differentiate constant rate and constant pressure filtration	5.7 Constant rate filtration and constant pressure filtration

Unit	Major Learning Outcomes	Topics and Sub-topics
	5h. Explain cake resistance, filter media resistance for various conditions	5.8 Brief description of specific cake resistance and filter media resistance for constant rate, constant pressure and vacuum filtration (without numerical)
	5i. Classify centrifugal equipments	5.9 Classification of centrifugal equipments
	5j. Explain batch centrifuge	5.10 Principle, construction and working of batch centrifuge
	5k. Compare centrifuge and filter press	5.11 Advantages and disadvantages of centrifuge over filter press
Unit –VI Separation of Solid Particles	6a. Define solid separation	6.1 Definition and application of solid separation
	6b. Describe factors affecting selection of equipment	6.2 Factors affecting selection of equipment for solid separation
	6c. Explain types of solid separation equipments	6.3 Working principle and construction of a) Jigging b) Elutriation c) Double cone classifier d) Electrostatic precipitator e) Magnetic separator f) Froth flotation cell
	6d. Explain differential settling methods	6.4 Differential settling methods, sink and float method
Unit VII Agitation and Mixing	7a. Describe agitation and mixing	7.1 Define agitation and mixing, give their applications
	7b. Classify impellers 7c. Compare various impellers	7.2 Classification of Impellers and brief explanation
	7d. Explain vortex formation and prevention	7.3 Vortex formation and swirling 7.4 Methods of Vortex prevention
	7e. Explain agitation vessel 7f. Derive equation for power consumption 7g. Calculate power consumption	7.4 Construction and working of agitation vessel 7.5 Derivation of equation for power consumption in agitation vessel 7.6 Calculations of power consumption in baffled and unbaffled tank
	7h. Describe flow number	7.7 Flow number
	7i. Explain factors affecting agitation	7.8 Factors affecting agitation
	7j. Explain purpose of mixing	7.9 Purpose of mixing solids and pastes
	7k. Describe factors for selection of equipments	7.10 Factors affecting selection of mixing equipments

Unit	Major Learning Outcomes	Topics and Sub-topics
	7l. Explain rate of mixing and mixing index 7m. Compute mixing index	7.11 Rate of mixing and mixing index for pastes & powder 7.12 Calculation of mixing index
	7n. Describe types of mixers	7.12 Construction and working of a) Ribbon blender b) Kneaders c) Pug mill d) Banbury mixer e) Muller mixer

5. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (Theory)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Properties of Particulate Solids	07	2	5	2	09
II	Screen Analysis	05	1	2	3	06
III	Size Reduction	10	2	5	5	12
IV	Sedimentation	06	2	3	2	07
V	Filtration	10	2	7	3	12
VI	Separation of Solid Particles	06	2	4	2	08
VII	Agitation and Mixing	12	2	6	8	16
Total		**56**	**13**	**32**	**25**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

6. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills **(Course Outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies **(Programme Outcomes).** Following is the list of practical exercises for guidance.

Note: Here only Course Outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of Programme Outcomes/Course Outcomes in affective domain as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain.

Sr. No.	Unit No.	**Practical/Exercise** (Course Outcomes in Psychomotor Domain according to NBA Terminology)	**Apprx. Hrs. Required**
1.	I	Measure volume surface mean diameter, mass mean diameter, number of particles using sieve shaker	4
2.	II	Carry out differential and cumulative screen analysis	4
3.	III	Test Rittinger's law for grinding in ball mill and measure critical speed	4
4.	III	Test Kicks law for crushing in jaw crusher	4
5.	III	Test Bond's law for crushing in roll crusher	4
6.	IV	Measure efficiency of cyclone separator	4
7.	IV	Determine rate of settling by sedimentation	4
8.	V	Measure cake resistance, filter media resistance in filter press.	4
9.	V	Measure rate of filtration, cake resistance, filter media resistance in basket centrifuge	4
10.	V	Measure rate of filtration in gravity filtration	4
11.	V	Measure rate of filtration in vacuum filtration	4
12.	VI	Measure efficiency of separation in froth flotation cell	4
13.	VII	Evaluate mixing index in double cone mixer	4
14.	VII	Measure power consumption in baffled and unbaffled agitation vessel	4
	Total		**56**

7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like:

1. Assignments
2. Technical Quiz/MCQ Test
3. Presentation on some course topic
4. I-net based assignments

8. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

1. Working of different equipment should be demonstrated using chart and models or with help of video/animation films.
2. Expert Lecture (by persons working in Industry) may be oragnised.
3. Visit to nearby industries where such equipment are being used may be arranged.

9. SUGGESTED LEARNING RESOURCES

A. List of Books:

Sr. No.	Title of Books	Author	Publication
1	Unit Operations of Chemical Engineering	McCabe and Smith	McGrawhill Publications, New Delhi
2	Introduction to Chemical Engineering	Badger W. L. and Banchero J. T	McGrawhill Publications, New Delhi
3	Unit Operation –I	Gavhane K. A.	Nirali Prakashan, Pune

B. List of Major Equipment/Materials

a. Sieve shaker – Sieve dia – 100 mm to 200 mm, no of sieve – 6-8, Opening – as per requirement (micro or coarse particle)
b. Laboratory Ball mill - 5kg capacity, Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
c. Jaw crusher – 10-50 kg/hr capacity, Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
d. Laboratory Roll crusher – 5-25 kg/hr capacity, Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
e. Agitation vessel setup – 20-50 liter capacity - Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
f. Cyclone separators – Product Particle as per requirement, Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
g. Froth flotation Cell, 5-15 kg/hr capacity, Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
h. Gravity filter
i. Vacuum Filter
j. Laboratory filter Press - Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
k. Basket centrifuge - Suitable for operation on 415V, 50Hz, 3 Phase, AC supply
l. Double cone mixer - Suitable for operation on 415V, 50Hz, 3 Phase, AC supply

C List of Software/Learning Websites

a. www.sciencedirect.com
b. www.cheresources.com
c. http://nptel.iitm.ac.in/courses.php
d. http://engineershandbook.com/unit.operations

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. P. K. Patel**, Lecturer in Chemical Engineering , Govt. Polytechnic Gandhinagar
- **Prof. M. R. Acharya**, Lecturer in Chemical Engineering, Govt. Polytechnic, Gandhinagar
- **Prof. R. P. Hadiya**, Lecturer in Chemical Engineering , Govt. Polytechnic Rajkot.

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof Bashir Shaikh**, Assistant Professor, Department of Applied Sciences.
- **Prof Shashi Kant Gupta,** Professor and Coordinator for State of Gujarat

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

FLUID FLOW OPERATION
(Code: 3330503)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	3rd Semester

1. RATIONALE

In almost every chemical plant fluids have to be handled and hence study of fluids at rest and in motion is important. The information about the basic concepts and principles of hydrostatics, hydrodynamics and their applications in handling various fluids like gases, vapors, liquids and slurries are provided in this course which is required for smooth and proper operation of fluid transportations machineries. Using these concepts power requirement for pumps, blowers and compressors can be determined and friction losses through pipes and fittings can also be calculated. Therefore this course is one of the important courses since it attempts to develop these skills in students.

2. COMPETENCY (Programme Outcome according to NBA Terminology):

The course content should be taught and implemented with the aim to develop different skills so that students are able to acquire following competency:

- **Maintain flow of different fluids in the chemical plants according to the process requirement.**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
4	0	4	8	70	30	40	60	200

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

4. COURSE DETAILS

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – I Fluid Statics and its Applications	1a. Define Ideal fluid and Real fluid 1b. Differentiate between fluid statics and dynamics	1.1. Ideal fluid and Real fluid 1.2. Fundamentals of fluid statics and dynamics
	1c. Classify the types of pressure	1.3. Definitions of pressure concept, Static head, Static pressure, Gauge pressure, Absolute pressure, Dynamic pressure, Total pressure, Vacuum(negative pressure)
	1d. Compare compressible and incompressible fluids	1.4. Compressible and incompressible fluids
	1e. Derive equation of pressure in static fluid	1.5. Derivation of equation of pressure in static fluid
	1f. Explain manometers 1g. Derive equation of pressure difference	1.6. Principle construction and working of Manometers with equation of pressure difference - Simple U tube manometer, Inclined manometer, Piezometer, Two fluid manometer, Micro-manometer
Unit– II Fluid–Flow Phenomena	2a. Explain velocity change across cross section	2.1 Velocity field, velocity gradient, shear stress and rate of shear
	2b. Explain effect of solid boundary	2.2 Boundary layer, it's separation and wake formation
	2c. Define steady state and unsteady state conditions	2.3 Steady state and unsteady state conditions
	2d. Describe types of viscosities	2.4 Viscosity : Absolute, Kinematic and Relative
	2e. Classify fluids	2.5 Classification of fluids : Newtonian and Non-Newtonian with examples
	2f. Describe Reynold's experiment	2.6 Reynold's experiment and Reynolds number, turbulent flow, laminar flow, transition flow
Unit– III Basic Equations of Fluid Flow	3a. Define velocities	3.1 Average velocity and mass velocity
	3b. Derive continuity equation	3.2 Continuity equation for mass balance in steady flow
	3c. Derive Bernoulli's equation and explain corrections	3.3 Bernoulli's equation and corrections in Bernoulli's equation like kinetic energy correction, correction for fluid friction, correction for Pump work
	3d. Use Hagen-Poiseuille's Equation	3.4 Hagen-Poiseuille's Equation
Unit– IV Friction in	4a. Describe roughness of pipe	4.1 Roughness of pipe

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Flowing Fluid	4b. Explain hydraulic radius and equivalent diameter	4.2 Hydraulic radius and equivalent diameter
	4c. Compare skin and form friction	4.3 Skin friction and form friction
	4d. Use friction factor chart	4.4 Friction factor chart
	4e. Calculate friction losses	4.5 Friction from changes in velocity or direction (a) Friction loss from sudden expansion of cross section (b) Friction loss from sudden contraction of cross section 4.6 Friction loss in fittings and valves
Unit– V Transportation of fluid	5a. Compare pipe and tube	5.1 Introduction of pipe and tube
	5b. Describe fittings & joints	5.2 Types and uses of fittings and joints
	5c. Describe valves	5.3 Construction and working of various types of valves like (a) Gate valve (b) Globe valve (c) Check valves (d) Control valve
	5d. Classify pumps	5.4 Classification of pumps
	5e. Explain pumps	5.5 Construction and working of centrifugal, reciprocating and rotary pump
	5f. Explain characteristics of centrifugal pump 5g. Calculate NPSH, head and power	5.6 Developed head and power requirement in centrifugal pump
		5.7 NPSH, Suction lift and Cavitation in centrifugal pump
		5.8 Characteristic curves of Centrifugal pump
		5.9 Numerical based on NPSH, efficiency, head and power
	5h. Explain construction, working and uses of fluid moving machineries	5.10 Construction, working and uses of Compressor, Fan, Blower, Vacuum pump and Jet ejectors
Unit– VI Flow Measurement	6a. Describe methods of flow measurement	6.1 Methods of flow measurement
	6b. Classify flow measuring devices	6.2 Classification of flow measuring devices
	6c. Explain flow meters	6.3 Construction, working principles and application of flow meters like Rotameter, Orifice meter, Venturi meter, Pitot tube, weirs, Coriolis meter, Magnetic meter, Ultrasonic meter
	6d. Derive equation of flow rate	6.4 Derivation of equation of flow rate through Orifice meter, Venturi meter, Pitot tube and weirs
	6e. Solve simple numerical	6.5 Numerical of Orifice meter, Venturi meter

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit– VII Conveying and Fluidization	7a Explain conveying	7.1 Pneumatic and Hydraulic conveying with industrial applications
	7b Explain Fluidization	7.2 Fluidization and its industrial applications
	7c Explain Porosity	7.3 Porosity of static bed, Porosity of fluidized bed, Minimum porosity
	7d Describe minimum fluidization velocity	7.4 Minimum fluidization velocity
	7e Explain relation between bed pressure drop and bed height	7.5 Relation of bed pressure drop and bed height with graph

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fluid Statics and its Applications	06	02	03	02	07
II	Fluid–Flow Phenomena	06	02	03	02	07
III	Basic Equations of Fluid Flow	07	02	06	02	10
IV	Friction in Flowing Fluid	07	02	06	02	10
V	Transportation of Fluid	12	04	07	04	15
VI	Flow Measurement	12	03	07	04	14
VII	Conveying and Fluidization	06	02	03	02	07
	Total	**56**	**17**	**35**	**18**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

6. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills **(Course Outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies (Programme Outcomes). Following is the list of practical exercises for guidance.

Note: Here only Course Outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in affective domain** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain.

Sr. No.	**Unit No.**	**Practical/Exercise** (Course Outcomes in Psychomotor Domain according to NBA Terminology)	**Approx. Hrs Required**
1.	II	Identify types of flow by using Reynolds's apparatus	4
2.	II	Measure absolute and kinematic viscosity using Oswald viscometer	4
3.	III	Use Bernoulli's apparatus for mechanical energy balance	4
4.	III	Estimate viscosity of water using Hagen-Poiseuille's equation	4
5.	IV	Measure friction losses through pipe, fittings and valves	4
6.	IV	Measure friction losses through packed bed	4
7.	V	Measure pressure developed by reciprocating pump	4
8.	V	Measure head developed by centrifugal pump	4
9.	V	Measure friction losses through fittings and valves	4
10.	VI	Measure flow through pipe using venturimeter	4
11.	VI	Measure flow through pipe using orifice meter	4
12.	VI	Measure flow through pipe using rotameter	4
13.	VI	Measure flow through open channel using notches	4
14.	VII	Measure minimum fluidization velocity through fluidized bed	4
		Total	**56**

7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like: course/topic based presentations, internet based assignments, and teacher guided self learning activities, MCQ/Quiz. These could be individual or group-based.

8. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

i. Working of different equipment and fluid transport systems should be demonstrated using chart and models or with help of video/animation films.
ii. Expert Lecture (by persons working in Industry) may be oragnised.
iii. Visit to nearby industries where such fluid flow operations are in use may be arranged.

9. SUGGESTED LEARNING RESOURCES

(A) List of Books:

Sr. No.	Title of Books	Author	Publication
1	Unit Operations of Chemical Engineering	McCabe, Warren L., Julian C. Smith	McGraw Hill Publication, New York 2004 (Seventh Edition)
2	Introduction to Chemical Engineering	L.Badger, Julius T. Banchero	McGraw Hill Publication, New York 2004 (Seventh Edition)
3	Unit Operations of Chemical Engineering Vol-I	Chattopadhyay, P.	Khanna Prakashan, New Delhi, 1996
4	A text book of Fluid Mechanics	Khurmi, R.S.	S. Chand Publication, New Delhi 2002
5	Unit Operation –I	Gavhane, K.A.	Nirali Prakashan, Pune 2009

B. List of Major Equipment/Materials with Major Specification

i. Venturimeter assembly for fluid flow measurement(Minimum flow rate – 05 lit/min, mercury manometer)
ii. Orifice meter assembly for fluid flow measurement(Minimum flow rate – 05 lit/min, mercury manometer)
iii. Rota meter assembly for fluid flow measurement(Minimum flow rate – 05 lit/min, minimum 1 in. transparent tube)
iv. V Notch, Rectangular Notch assembly for flow measurement in open channel (Minimum notch size 5 cm)
v. Reynold's Experiment setup for studying types of flow (Minimum pipe dia. –0.5 in transparent pipe)
vi. Bernoullies experiment setup for mechanical energy balance in flowing fluid with transparent channel of at least 1 in ID.
vii. Reciprocating Pump Assembly with pump & motor of minimum 0.25 HP
viii. Centrifugal Pump Assembly with pump & motor of minimum 0.25 HP
ix. Fluidized bed setup made of glass pipe with minimum 2 in ID
x. Friction through Pipes, Fittings and Valves setup (0.5 in ID pipe with elbow, Tee, Square, Reducer, Enlarger, Glob valve, Gate valve)
xi. Packed bed setup to measure friction losses with minimum 2 in ID transparent pipe
xii. Oswald viscometer and stopwatch

C List of Software/Learning Websites

i. http://www.nzifst.org.nz/unitoperations/flfltheory.htm

ii. http://books.google.co.in/books?id=K4almhE5BoAC&pg=PP1&lpg=PP4&ots=1XDNGSxMsY&dq=Unit+Operation-1+nirali+Prakashan+published+year

iii. http://www.chemicalprocessing.com/whitepapers/fluid-handling/

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. J. R. Vadher**, Lecturer in Chemical Engineering, Govt. Polytechnic, Gandhinagar
- **Prof. M. R. Acharya**, Lecturer in Chemical Engineering, Govt. Polytechnic, Gandhinagar
- **Prof. P. M. Gadhiya**, Lecturer in Chemical Engineering, Govt. Polytechnic, Rajkot
- **Prof. N. N. Hansalia**, Lecturer in Chemical Engineering, Govt. Polytechnic, Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof Bashir Shaikh**, Assistant Professor, Department of Applied Sciences.
- **Prof Shashi Kant Gupta,** Professor and Coordinator for State of Gujarat

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

INDUSTRIAL STOICHIOMETRY

(Code: 3330504)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	3rd Semester

1. RATIONALE

Industrial Stoichiometry provides the fundamental information to determine the material and energy balances for all types of unit operations and unit processes across the equipment and overall chemical plant. Material and energy balance calculations are of prime importance for design and also for conservation of mass and energy to reduce the losses and cost that enhances overall economy of plant. The unit conversions, material and energy balance are the essential part in the practice of other courses such as mechanical operations, fluid flow, heat Transfer, mass transfer etc. Thus this course is a core course for chemical engineers and should be learned sincerely by students.

2. COMPETENCY (Programme Outcome according to NBA Terminology):

The course should be taught and implemented with the aim to develop different types of skill so that students are able to acquire following competency:

- **Determine material and energy balance for different unit operations and processes.**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	100
3	2	0	5	70	30	00	00	

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

4. COURSE DETAILS

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – I Unit Systems	1a. Explain importance of process calculation	1.1 Introduction to process calculation
	1b. Define different unit systems	1.2 Dimensions and systems of units 1.3 Fundamental quantities of units, Derived quantities
	1c. Explain the importance of physical quantities of Units.	1.4 Definition and units of force, volume, pressure, work, energy, power, heat
	1d. Convert units among different systems	1.5 Unit conversions in FPS, MKS and SI systems
Unit– II Basic Chemical Calculations	2a. Calculate important physical quantities	2.1 Definition and calculations of mole, atomic weight, molecular weight, equivalent weight, specific gravity and API gravity
	2b. Calculate composition of mixtures and solutions	2.2 Composition of solid, liquid by weight % and mole % 2.3 Morality, normality, morality, gm/lit and related simple numericals
Unit– III Ideal Gas Law	3a. Derive ideal gas law. 3b. State reference conditions	3.1 Concept of ideal gas 3.2 Derivation of ideal gas law 3.3 Definition of STP and NTP 3.4 Dalton's law and Amagat's law
	3b. Calculate important quantities for ideal gas mixture	3.5 Derive relation between mole%, volume% and pressure% of ideal gases 3.6 Calculation of average molecular weight, density, mole%, weight% in gas mixture in SI/MKS systems
Unit– IV Material Balance In Processes Without Chemical Reactions	4a. Explain law of conservation of mass	4.1 Law of conversation of mass
	4b. Calculate mass balance of important unit operations at steady state condition	4.2 Brief description and simple material balance calculation of drying, distillation, absorption, mixing, crystallization, evaporation 4.3 Single stage material balance calculation of leaching and extraction
	4c. Describe recycling and by passing operations	4.4 Brief idea regarding recycling and by passing operation
Unit– V Material Balance In Processes	5a. Explain basic concepts of material balance with chemical reaction	5.1 Definition: Limiting reactant, Excess reactant, conversion, yield and selectivity

Unit	**Major Learning Outcomes (**Course Outcomes in Cognitive Domain according to NBA terminology)	**Topics and Sub-topics**
Involving Chemical Reactions	5b. Calculate mass balance with chemical reaction	5.2 Simple numerical for finding yield, conversion and composition 5.3 Simple calculation of material Balance based on reaction.
Unit– VI Energy Balance	6a. Calculate heat capacity, specific heat, heat capacity of gas mixture and liquid mixture	6.1 Heat capacity and specific heat 6.2 Mean heat capacity of gases 6.3 Heat capacity of gas mixture and liquid mixture 6.4 Calculations of heat capacity by integral equation up to three terms
	6b. Explain concepts of sensible heat and latent heat	6.5 Brief explanation of sensible Heat and latent heat of fusion, sublimation, vaporization
	6c. Calculate standard heat of formation and heat of reaction	6.6 Calculations of standard heat of formation from heat of combustion data 6.7 Calculations for heat of reaction from heat of formation and heat of combustion data
Unit– VII Combustion	7a. Describe combustion	7.1 Introduction of combustion
	7b. Describe calorific values	7.2 Types of fuels 7.3 Calorific values of fuels 7.4 Proximate and ultimate analysis of solid fuel
	7c. Calculate calorific value and air requirement for combustion	7.5 Numericals related to calorific values of fuel from composition 7.6 Numericals related to air Requirement and composition of flue gases.

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Unit Systems	3	2	2	2	06
II	Basic Chemical Calculations	5	2	2	4	08
III	Ideal Gas Law	5	2	2	4	08
IV	Material Balance in Process without Chemical Reactions	8	0	6	7	13
V	Material Balance in Process Involving Chemical Reactions	7	2	3	7	12
VI	Energy Balance	8	2	4	8	14
VII	Combustion	6	2	2	5	09
Total		**42**	**12**	**21**	**37**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

6. SUGGESTED LIST OF PRACTICAL/EXERCISES

Not Applicable

7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities: Tutorials, group assignments based on mass and energy balance of equipments like heat exchanger, boilers, distillation column, evaporator, dryer, reactors, absorption column, Use of MS-Excel in solving numerical.

8. SPECIAL INSTRUCTIONAL STRATEGY (If Any)

i. More numerical examples should be discussed in the class to make concepts clear. Home Assignment should given to students on similar type of numerical for more practice.
ii. Video lecture from NPTEL websites may be shown to class for better understanding of the concepts.
iii. Video/animation films may be shown for explaining abstract concepts.
iv. Quizzes may be organised in the class by dividing it into groups to create an environment of competition.
v. Tutorial sessions may be organised as given in following table

Sr. No.	Unit No.	Topics/Sub Topics on which Numerical may be given during Tutorial Sessions	Approx. Hrs. Required
1	I	Systems of Units and Conversions	02
2	II	Numericals based on composition of mixtures and solutions	03
3	III	Numericals based on Ideal gas law and calculation of composition of gas mixture	03
4	IV	Numericals based on mass balance for important unit operations	06
5	V	Numericals based on mass balance involving chemical reactions	04
6	VI	(a) Numericals based on heat capacity and heat change (b) Numericals based on heat of formation and heat of reaction	06
7	VII	Numericals on calorific values of fuel, theoretical air requirement and composition of flue gases	04
		Total	**28**

9. SUGGESTED LEARNING RESOURCES

A. List of Books:

S. No.	Title of Books	Author	Publication
1	Stoichiometry	Bhatt B. I. and Vora S. M.	Tata-McGraw Hill, New Delhi, Year-2007
2	Process Calculation	Gavhane K. A.	Nirali Prakashan, Pune, Year-2012
3	Basic Principles and Calculations in Chemical Engineering	Himmelablau David M.	PHI Learning, New Dehli, Year-2003

B. List of Major Equipment/Materials

Nil.

C. List of Software/Learning Websites

i.Basic Principles & Calculations in Chemical Engg (CD Rom)
ii.www.ocw.mit.edu

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. Harsh B. Shukla**, Lecturer in Chemical Engineering, Shri K.J. Polytechnic, Bharuch
- **Prof. Rakesh R. Vasava**, Lecturer in Chemical Engineering, Shri K.J. Polytechnic, Bharuch
- **Prof. Mukesh B. Dhangar**, Lecturer in Chemical Engineering, Shri N. G. Patel Polytechnic, Isroli-Afwa

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof Bashir Shaikh**, Assistant Professor, Department of Applied Sciences.
- **Prof Shashi Kant Gupta,** Professor and Coordinator for State of Gujarat

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

Course Curriculum

CHEMICAL PROCESS TECHNOLOGY-I
(Code: 3330505)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	3rd Semester

1. RATIONALE

The importance of this subject arises from the need of providing comprehensive and balanced understanding of essential link between chemistry and the chemical industry. It is vital to develop simple but meaningful flow diagram for each chemical product which a student can understand. This course develops skill for arranging and understanding treatment, reaction and separation steps in a flow diagram for variety of chemicals including acids, chloro-alkalies, cement, lime, coal, coal chemicals, plastics, dyes and intermediates, pharmaceutical products, soap and detergents and many other products. Diploma holders utilize this skill to read and recognize each step of process flow diagrams during their job. The area of job may be production, R and D, design, technical services, project development, sales and marketing etc. Thus it is a key course every chemical engineer should develop mastery over it.

2. COMPETENCIES (Programme Outcome according to NBA Terminology):

The course content should be taught and implemented with the aim to develop different types of skills so that student is able to acquire following competencies.

- **Prepare flow charts for manufacturing important chemicals in plants.**
- **Prepare important chemicals in laboratory**

3. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits **(L+T+P)**	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**ESE**	PA	**ESE**	**PA**	**150**
4	0	2	06	70	30	20	30	

Legends: L - Lecture; **T -** Tutorial/Teacher Guided Student Activity; **P -** Practical; **C -** Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

4. COURSE DETAILS

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
Unit – I Acid And Alkali	**1a.** Classify chemical Industries	1.1 Scope and classification of chemical Industries
	1b. Describe properties and uses	1.2 Properties and uses of Sulphuric acid, HCL, soda ash and caustic soda
	1c. Prepare flow diagram and Explain manufacture	1.3 Manufacture of:(i) sulphuric acid by DCDA process (ii) Hydrochloric acid (iii)soda ash by Solvay process (iv)caustic soda byelectrolytic process
	1d. Explain major engineering problems	1.4 Major engineering problems of sulphuric acid and soda ash manufacturing
Unit– II Cement And Lime	2a. Describe cement and lime	2.1 Introduction of cement and lime **2.2** Properties and uses of cement and lime 2.3 Types of cement
	2b. Prepare flow diagram and explain manufacture	**2.4** Manufacture of Portland Cement and lime
	2c. Explain major engineering problems	**2.5** Major Engineering problems of cement industry
Unit– III Metallurgical Industries	3a. Describe various ores	3.1 Iron ores, bauxite and copper pyrites
	3b. Explain manufacture with neat figure	3.2 Production of pig iron by Bessemer process, Aluminum from bauxite; and extraction of copper from copper pyrites
Unit– IV Coal And Coal Chemicals	4a. Describe coal & coal chemicals	4.1. Types of coal and coal chemicals
	4b. 4c. Explain coal processes	4.2. Coking of coal 4.3. Distillation of coal tar 4.4. Gasification of coal 4.5. Hydrogenation of coal
Unit– V Polymers	5a. Classify polymers	5.1 Classification of polymers
	5b. Differentiate thermosetting and thermoplastic polymer	5.2 Thermosetting and thermoplastic polymers
	5c. Prepare flow diagram and explain manufacture	5.3 Manufacture of (i) Polyethylene by Philips process (ii)Polyvinyl chloride (iii)Phenol formaldehyde (iv)Nylon 6,6 (v) Polyester Fibre
Unit– VI **Dyes And Intermediates**	**6a** Explain dye	6.1. Definition & applications of dye
		6.2. Classification of dyes
	6b Construct flow diagram	6.3. Manufacture of

Unit	Major Learning Outcomes (Course Outcomes in Cognitive Domain according to NBA terminology)	Topics and Sub-topics
	and explain manufacture	(i) Aniline by reduction of nitrobenzene, (ii) Anthraquinone 6.4. from phthalic anhydride, 6.5. Vat dye and 6.6. Reactive dye
Unit– VII Miscellaneous	**7a.** Describe soap and Detergent	7.1 Soap and detergent
	7b. Prepare flow diagram and Explain manufacture	7.2 Manufacture of (i) soap by 7.3 continuous hydrolysis and 7.4 saponification (ii) Linear Alkyl 7.5 Benzene(LAB)
	7c. Describe explosives and propellants	7.6 Explosives - Ammonium 7.7 nitrate, TNT and RDX **a.** Important Propellants

5. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Acids-Alkali	14	04	09	04	17
II	Cement and Lime	07	02	05	02	09
III	Metallurgical Industries	07	03	04	02	09
IV	Coal and Coal chemicals	05	02	04	01	06
V	Polymers	08	02	05	03	10
VI	Dyes and Intermediates	08	02	05	03	10
VII	Miscellaneous	07	03	04	02	09
	Total	56	18	36	17	70

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

6. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of practical skills **(Course Outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies (Programme Outcomes). Following is the list of practical exercises for guidance.

Note: Here only Course Outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in affective domain** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain.

S. No.	Unit No.	Practical/Exercise (Course Outcomes in Psychomotor Domain according to NBA Terminology)	Apprx. Hrs. Required
1	I	Standardize sulfuric acid solution	02
2	I	Standardize hydrochloric acid solution	02
3	I	Standardize sodium hydroxide solution	02
4	II	Prepare hydrated lime	02
5	III	Beneficiate ores	02
6	IV	Determine calorific value of coal	02
7	V	Prepare phenol formaldehyde	02
8	VI	Identify some polymers using simple tests	02
9	VI	Prepare nitrobenzene	02
10	VI	Prepare indigo dye	02
11	VI	Prepare vat dye	02
12	VI	Prepare reactive dye	02
13	VII	Prepare soap	02
14	VII	Prepare detergent	02
		Total	**28**

7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like: course/topic based presentations, internet based assignments, teacher guided self learning activities, and MCQ/Quiz. These could be individual or group-based.

8. SPECIAL INSTRUCTIONAL STRATEGIES (If Any)

i. More examples of Flow Charts should be discussed in the class to make concepts clear. Home Assignment should be given to students on preparing flow charts for more practice.
ii. Video/animation films may be shown for explaining abstract concepts and manufacturing process in industries.
iii. Samples of detailed flow charts from Industries may be collected and students may be asked to interpret them.

9. SUGGESTED LEARNING RESOURCES

A. List of Books:

S. No.	Title of Books	Author	Publication
1	Outlines of Chemical Technology, 3rd edition	M. Gopala Rao, Marshall Sittig	Affiliated East West Press (Pvt) Ltd-New Delhi
2	Shreve's Chemical Process Industries, 5th edition	Austin G.T.	McGraw Hill publication –New Delhi
3	Chemical Technology -Vol. I and II, 2nd edition	G.N. Pandey and Shukla	Vani Books Company -Hyderabad
4	A Text Book on Petrochemicals, 2nd edition	Rao B. K. B.	Khanna Publishers – New Delhi

B. List of Major Equipment/Materials

(i) Glassware: Conical flask, burette, pipette, round bottom flask, measuring cylinder, beaker (ii) Glass Assembly: Round bottom flask, reaction vessel, condenser, separating vessel(iii) Burner (iv) Weight balance (minimum 0.1gm) (v) Heating and cooling bath

C List of Software/Learning Websites

i. http://www.epa.gov/sectors/sectorinfo/sectorprofiles/chemical.html
ii. www.emis.vito.be/sites/default/Bref_**cement**_and_**lime_production**.pdf
iii. www.docbrown.info/page04/Mextract.htm
iv. http://www.goiit.com/posts/show/0/content-general-principles-of-extraction-of-metals-804401.htm
v. http://www.contentshoppe.com/images/eLearning/sample2.swf
vi. http://www.petrochemistry.net/coal-chemicals.html
vii. http://www.auroma.in/propertiescoal.pdf

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. R P Hadiya**, Lecturer in Chemical Engineering, Govt. Polytechnic, Rajkot
- **Prof. S K Charola**, Lecturer in Chemical Engineering, Sir BPTI, Bhavnagar
- **Prof. N N Hansalia**, Lecturer in Chemical Engineering, Govt. Polytechnic, Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

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GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: PROCESS HEAT TRANSFER
(Course Code: 3340501)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	4th Semester

1. RATIONALE

In almost every chemical plant heat transfer takes place (sometimes it is intentional while sometimes it is unintentional). Study of heat transfer at steady state and unsteady state is therefore important. The knowledge of the basic concepts and principles of heat transfer helps smooth and proper operation of various heat exchangers, evaporators and condensers. Using the concepts of conduction, convection and radiation heat losses through pipes, equipments and storage tanks can be estimated. Hence the course has been designed to develop this competency and its associated cognitive, practical and affective domain learning outcomes.

2. COMPETENCY

The course should be taught and curriculum should be implemented with the aim to develop required skills so that students are able to acquire following competency:

- **Supervise operation and maintenance of various heat transfer equipments.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Classify Modes of heat transfer
ii. Derive equations of steady state heat transfer through wall, cylinder and sphere
iii. Explain shell and tube heat exchangers
iv. Explain heat transfer with phase change
v. Calculate radiation based on radiation laws

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	200
4	0	4	8	70	30	40	60	

Legends: L - Lecture; **T -** Tutorial/Teacher Guided Student Activity; **P -** Practical; **C -** Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Fundamental of Heat Transfer	1a. Define Heat Transfer & write its' importance	1.1 Definition and importance of heat transfer in process Industries
	1b. Classify Modes of heat transfer	1.2 Modes of heat transfer (a) Conduction (b) Convection (c) Radiation
	1c. Differentiate steady state and unsteady state heat transfer	1.3 Steady state and unsteady state heat transfer
Unit – II Heat Transfer by Conduction	2a. Explain Fourier's Law	2.1 Fourier's law of heat conduction with Concepts of (a) Heat transfer rate (b) Heat flux (c) Temperature gradient
	2b. Describe thermal conductivity.	2.2 Thermal conductivity and its variation with temp.
	2c. Derive equations of steady state heat transfer through wall, cylinder and sphere 2d. Calculate heat transfer rate	2.3 Steady state (S.S.) heat conduction through composite wall 2.3.1 S.S. heat conduction through composite cylinder up to three layers 2.3.2 S.S. heat conduction through composite sphere up to three layers 2.4 Simple problems by direct use formula
	2e. Explain Thermal Conductivity of solids, liquids and gases	2.5 Thermal Conductivity of solids, liquids and gases
	2f. Describe insulation 2g. Calculate critical radius of insulation	2.6 Hot and cold Insulation (a) Optimum thickness of insulation (b) Lagging of steam pipe 2.7 Derivation of equation for critical radius of insulation and calculations
Unit – III Heat Transfer by Convection	3a. Describe types of convection	3.1 Types of Convection 3.1.1 Free convection 3.1.2 Force convection
	3b. Explain Newton's Law	3.2 Newton's Law of convective heat transfer
	3c. Derive equation of overall heat transfer coefficient	3.3 Individual and Overall heat transfer coefficient
	3d. Calculation for convection	3.4 Simple Problems of Convection
Unit – IV Heat exchangers	4a. Classify heat exchanger 4b. Describe Double pipe heat exchanger 4c. Explain shell and tube heat exchangers 4d. Describe plate type heat exchanger 4e. Describe finned type exchanger 4f. Explain heat transfer in different medium.	4.1 Types of heat exchanger based on flow pattern, function and construction 4.2 Double pipe heat exchanger (a) Counter current (b) Co-current 4.3 Shell and tube heat exchanger : (a) 1-1 Pass (b) 1-2 Pass (c) 2-4 Pass 4.4 Plate type heat exchanger 4.5 Finned type(extended surface) heat exchanger

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		4.6 Heat transfer in agitated vessels
	4g. Derive equation and Calculate L.M.T.D.	4.7 L.M.T.D. : derivation of equation and simple calculations
	4h. Calculate overall heat transfer co-efficient and area of heat exchangers	4.8 Overall heat transfer co-efficient of heat exchangers and heat exchanger area
Unit – V Heat Transfer with Phase Change	5a. Explain heat transfer with phase change	5.1 Heat transfer with phase change
	5b. Explain dimensionless groups	5.2 Significance of dimensionless groups (a) Prandtl No. (b) Reynold No. (c) Grashoff No. (d) Nusselt No.
	5c. Describe boiling	5.3 Phenomena of Boiling (a) Pool and Nucleate boiling
	5d. Describe condensation and condensers	5.4 Phenomena of Condensation (a) Drop wise and film wise Condensation (b) Commonly used Condensers
Unit – VI Thermal Radiation	6a. Explain radiation facts	6.1 Fundamental facts of radiation
	6b. Define radiation terms	6.2 Concepts of radiation (a) Emission of radiation (b) Wavelength of radiation (c) Emissive power (d) Black body (e) Gray body (f) White body (g) Opaque body (h) Monochromatic wave length
	6c. Describe radiation laws	6.3 Radiation laws (a) Kirchhoff's Law (b) Plank's Law (c) Stefan Boltzmann Law (d) Wein's law
	6d. Calculate radiation based on radiation laws	6.4 Simple calculations of radiation between black surfaces
Unit – VII Evaporation	7a. Define evaporation	7.1 Introduction of evaporation
	7b. Explain characteristics of liquid	7.2 Characteristics of liquid for evaporation
	7c. Differentiate single and multi effect evaporation	7.3 Single and multi effect evaporation with flow arrangement
	7d. Classify evaporators	7.4 Types of evaporators (a) Short tube evaporator (b) Agitated film evaporator (c) Long tube vertical evaporators (i) Forced circulation (ii)Upward flow [Climbing film] (iii)Downward flow [Falling film] (iv) Triple Effect Evaporator
	7e. Explain evaporator capacity	7.5 Evaporator capacity and economy
	7f. Solve simple evaporation problem	7.6 Direct use of formula for solving simple evaporation problems
	7g. Describe duhring's rule	7.7 Duhring's rule and its importance.

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamentals of Heat Transfer	2	1	2	0	3
II	Heat Transfer by Conduction	12	3	4	7	14
III	Heat Transfer by Convection	6	2	2	4	8
IV	Heat Exchangers	12	4	4	7	15
V	Heat Transfer with Phase Change	8	2	3	5	10
VI	Thermal Radiation	8	2	3	5	10
VII	Evaporation	8	2	3	5	10
Total		**56**	**16**	**21**	**33**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note*: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes*** *(as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical/Exercise (Outcomes in Psychomotor Domain)	Apprx. Hrs. Required
1	II	Determine the thermal conductivity of Metal Rod	4
2	II	Determine the thermal conductivity of composite wall	4
3	III	Determine critical radius of insulating material	4
4	III	Determine the specific heat of Air	4
5	IV	Determine the overall heat transfer co-efficient in Agitated vessel	4
6	IV	Determine the overall heat transfer co-efficient for air to water heat exchanger	4
7	IV	Determine the liquid-liquid overall heat transfer co-efficient for shell and tube heat exchanger	4
8	IV	Determine the overall heat transfer co-efficient for	4

S. No.	Unit No.	Practical/Exercise (Outcomes in Psychomotor Domain)	Apprx. Hrs. Required
		horizontal double pipe heat exchanger.	
9	IV	Determine the overall heat transfer co-efficient for vertical double pipe heat exchanger.	4
10	V	Calculate the rate of condensation in Drop-wise condensation	4
11	V	Calculate the rate of condensation in Film-wise condensation	4
12	VI	Determine the emissivity using Stefan Boltzmann apparatus	4
13	VII	Determine economy of open pan evaporator.	4
14	VII	Study and compare different types of Evaporators.	4
Total Hours			**56**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

i. Prepare course/topic based presentation for seminars,
ii. Visit websites of reputed companies making heat exchangers.
iii. Teacher guided self learning activity
iv. Organise MCQ/Quiz.

9. SPECIAL INSTRCTIONAL STRATEGY (If Any)

i. Animated videos and drawings/models of heat exchangers and heat exchange phenomenon should be shown

10. SUGGESTED LEARNING RESOURCES

A. List of Books:

Sr. No.	Title of Books	Author	Publication
1	Unit Operations of Chemical Engineering	McCabe, Warren L., Julian C. Smith	McGraw Hill Publication, New York 2004 (Seventh Edition)
2	Introduction to Chemical Engineering	L.Badger, Julius T. Banchero	McGraw Hill Publication, New York 2004 (Seventh Edition)
3	Engineering heat transfer	Gupta & Prakash	Nem Chand & Brothers, New Delhi, 1999 (Seventh Edition)
4	Process heat transfer	D.Q.Kern	Tata McGraw Hill Publication, New Delhi, (Reprint 2008)
5	Unit Operation –II	Gavhane, K.A.	Nirali Prakashan, Pune 2009
6	Introduction to chemical engineering	Ghosal Salil k.	Tata McGraw Hill Publication, New Delhi, (Reprint 2006)

B. List of Major Equipment/Materials

i. **Thermal conductivity metal rod apparatus** : Bar-445 mm, Dia 25mm, test length of bar 175 mm, 9 thermocouples on bar and 4 on insulation, Nichrome heater 400 watt, Cooling jacket 90 mm dia, Temp. Indicator 0-200 ^{0}C, V-meter 0-200 V, A-meter 0-2 Amp

ii. **Thermal conductivity composite wall apparatus :** Heater Assembly-1000W, Round coil, Sandwiched, Dia-300mm; Test Specimen-Dia. 300mm, MS 20mm, Asbestos 15 mm, Wood 10mm; 8 nos. J type thermocouple, 8 Channel Digital Temperature Indicator; Assembly shall be covered with Wooden Chamber

iii. **Critical radius of insulating material apparatus :** Heater 500 W Ni-Cr 500 mm length, Test specimen MS, Dia 50 mm,500mm; Insulation over pipe; J thermocouple 12 nos., Digital temperature Indicator; The whole assembly shall be covered with wooden chamber

iv. **Specific heat of air apparatus :** 2 inch Cylindrical test section, 0.5 HP air blower, 3 phase 440 V Air heater, U-tube manometer with orifice; Thermocouples

v. **Agitated vessel:** Tank- 10 litre SS 304 ID 200mm, Height 300mm , 1.5 mm thick, Cover –SS 304, 3 mm thick; Baffles – 3 mm thick, 225 mm length, 15 mm width 4 nos., Coil- Copper, 3000 mm, ID 10 mm, OD 12.7 mm 8 turns; Heater 1 KW; Agitator- turbine, shaft 10 mm dia, speed 150 rpm max

vi. **Double pipe heat exchanger :** Inner tube SS304 -1000mm × 25mm; Outer tube – SS304, 1000mm × 25mm, 25 mm glass wool with SS304 cover; Hot and cold water tanks - inner SS304, outer MS, 50Litre, Cold water tank, Heater 3 KW; Pumps -2 nos. monoblock 0.5 HP SS304; Rotameter – 1-10 lpm, Glass tube, float SS 316

vii. **Shell and tube heat exchanger :** 1-1 pass; Shell- ID 150 mm SS, 4 baffles with 180 mm spacing, glass wool insulation, Tubes – copper 19 nos., ID 9.5 mm, 900 mm Length; Tanks -2 nos.100 litre HDPE; Pumps- 0.25 HP; Rotameters – 2nos. 1.5-15 lpm; Thermocouple -4 Nos., Digital temp. Indicator – 0-100^{0}C

viii. **Air to water heat exchanger :** Finned tube OD 20 mm ID 16 mm; 8 fins per inch, OD 45 mm; Water supply 20 lpm, Temp indicator 0-200 ^{0}C, Water inlet and drain, 0.5 HP blower for air flow, Orifice for 2 inch pipe, Butterfly valve

ix. **Emissivity apparatus:** aluminium plates, of equal dimensions. Ni-Cr heaters sandwiched in Mica sheets one plate blackbody another natural finish, Dia. 160 mm, thickness 12mm, heater 500W, Digital temp. Indicator

x. **Open Pan Evaporator :** Pan-Hemispherical SS 304 500mm dia, 3mm thick, Jacket- MS 525 mm dia, 3mm thick; Lagging- glasswool 40 mm with SS sheat cladding, 12.5 mm steam trap

C List of Software/Learning Websites

i. www.unitoperation.com

ii. www.nptel.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. D. H. Joshi,** Lecturer in Chemical Engineering, Government Polytechnic, Gandhinagar
- **Prof. M R Acharya,** Lecturer in Chemical Engineering, Government Polytechnic, Gandhinagar
- **Prof. N. N. Hansalia,** Lecturer in Chemical Engineering, Government Polytechnic, Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur.** Associate Professor, Department of Applied Sciences
- **Dr. Bashirullah Shaikh,** Assistant Professor, Department of Applied Sciences

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: MASS TRANSFER-I
(Course Code: 3340502)

Diploma Programmes in which this course is offered	Semester in which offered
Chemical Engineering	4th Semester

1. RATIONALE

The operations which involve changes in composition of solutions, are known as the mass-transfer operations. Mass transfer operations are required for preliminary purification of raw materials or final separation of products from by-products. Mass transfer operations are major and important activity in most of the chemical plants. Hence the course has been designed to develop the following competency and its associated cognitive, practical and affective domain learning outcomes.

2. COMPETENCY

The course should be taught and curriculum should be implemented with the aim to develop required skills so that students are able to acquire following competency:

- **Supervise operation of various equipments for, the mass-transfer operations in chemical process plants.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Discuss fundamentals of mass transfer operation.
ii. Evaluate diffusivity of gases by using empirical equation and explain effect of pressure and temperature on diffusivity.
iii. Explain Equilibrium and resistance concept related to mass transfer at fluid surface
iv. Calculate numerical for absorption based on material balance
v. Solve problem based on material balance with different condition on ternary diagram
vi. Explain various equipment uses for liquid extraction
vii. Explain different states of operation and equipment used for leaching.
viii. Discuss various membrane types and membrane modules

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	200
4	0	4	8	70	30	40	60	

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes (Outcomes in cognitive domain)	Topics and Sub-topics
Unit – I **Fundamental of Mass Transfer**	1a. Describe Importance of ass transfer operation	1.1 Introduction of Mass transfer operations
	1b. Classify mass transfer operations based on direct contact of two immiscible phases 1c. Explain Membrane separation operations	1.2 Operations based on direct contact of two immiscible phases 1.3 Membrane separation operations
	1d. Distinguish direct and indirect operations 1e. Describe selection of appropriate separation method	1.4 Direct and indirect operations 1.5 Choice of separation method
	1f. Explain fundamental design principles of Mass Transfer	1.6 Fundamental design principles of Mass Transfer
Unit – II **Molecular Diffusion in Fluids**	2a. Differentiate Molecular and Eddy diffusion 2b. Calculate the rate of diffusion in Fluids 2c. Distinguish Molar flux, diffusivity and concentration gradient in Fluids 2d. Apply the diffusion principal in Fluids	2.1 Molecular and Eddy diffusion 2.2 Rate of diffusion in Fluids 2.3 Molar flux, diffusivity and concentration gradient in Fluids 2.4 Applications of diffusion in Fluids.
	2e. Derive diffusivity equation 2f. Describe the effect of various factors on diffusivity 2g. Explain molecular diffusion in fluids for laminar flow	2.5 Derivation of diffusivity equation ($D_{AB}=D_{BA}$) 2.6 Effect of concentration, Temperature and pressure 2.7 on diffusivity 2.8 General equation for steady state molecular diffusion in fluids for laminar flow
	2h. Describe Molecular diffusion in gases 2i. Derive Equation for Steady state diffusion 2j. Evaluate diffusivity of gases using empirical equation	2.9 Molecular diffusion in gases 2.10 Derive Equation for Steady state diffusion of (a) Component A through non diffusing B and simple numerical (b) Equimolar counter current diffusion of A and B with simple numerical Empirical equation of diffusivity of gases
Unit – III **Interphase Mass Transfer**	3a. Explain Equilibrium 3b. Describe Diffusion between phases 3c. Describe various mass transfer coefficients using resistance concept 3d. Distinguish mass transfer co-efficients	3.1 Concept of equilibrium 3.2 Diffusion between phases (two resistance concept) 3.3 Local and overall two phases mass transfer co-efficient and their uses 3.4 Average overall mass transfer co-efficient
	3e. Define stage, stage efficiency and cascade	3.5 Stage and stage efficiency and types of Cascade
Unit – IV	4a. Apply concept of absorption	4.1 Industrial application of Absorption

Unit	Major Learning Outcomes (Outcomes in cognitive domain)	Topics and Sub-topics
Gas Absorption	4b. Describe the physical properties of gases 4c. Explain Raoults law	4.2 Equilibrium solubility of gases in liquids and effect of temperature and pressure. 4.3 Ideal solution and Raoult's law
	4d. Select appropriate solvent	4.4 Solvent for absorption
	4e. Explain Material balance in different condition 4f. Select liquid-gas ratio for absorber	4.5 Material balance for one component transfer 1. counter current flow 2. co-current flow 3. counter current multistage operation 4.6 Minimum liquid-gas ratio for absorber
	4g. Define various Efficiencies	4.7 Real Tray & Tray efficiency- point efficiency, Murphy efficiency, Overall Tray efficiency
	4h. Explain tray tower and packed tower 4i. Evaluate various packing	4.8 Tray tower and packed tower 4.9 HETP
	4j. Calculate absorption based on material balance	4.10 Raoult's law and material balance applied in gas absorption
Unit – V **Liquid Extraction**	5a. Apply the liquid extraction	5.1 Industrial application of Liquid Extraction
	5b. Describe the three component system 5c. Explain equilibrium using triangular co-ordinates 5d. Describe the effect of temperature and pressure	5.2 Equilibrium for three component system 5.3 Equilateral triangular co-ordinates system 5.3.1 System of three liquids-one pair partially Soluble 5.3.2 System of three liquids-two pair partially Soluble 5.4 Effect of temperature and pressure on solubility
	5e. Select appropriate solvent	5.5 Criteria for choice of solvent
	5f. Distinguish various types of extraction 5g. Describe the material balance for various stages 5h. Calculate Material balance in different conditions	5.6 Single stage extraction and multistage cross current extraction on ternary diagram 5.7 Material balance for single stage, multistage- cross current/counter current system 5.8 Problems based on material balance
	5i. Define Various equipment use in liquid extraction	5.9 Equipment Single stage extractor, agitated vessel, flow mixer and settler, spray tower, packed tower and centrifugal extractor
Unit – VI **Leaching**	6a. Describe Industrial applications	6.1. Industrial applications of leaching
	6b. Prepare solids Explain the factors affecting leaching	6.2. Preparation of solid 6.3. Temperature of leaching
	6c. Describe different states of operation and equipments	6.4. Methods of operation and equipment for (a) Unsteady state operation I. In place operation II. Heap leaching III. Percolation tanks

Unit	Major Learning Outcomes (Outcomes in cognitive domain)	Topics and Sub-topics
		IV. Filter press leaching V. Agitated vessel VI. Leaching by Shanks system (b) Steady state operation I. Leaching during grinding II. Leaching in door type agitator III. Leaching in door balanced tray thickener IV. Continues counter current decantation with flow sheet V. Leaching of vegetable seeds 1. Rotacel 2. Kennedy extractor 3. Bollman extractor 4. Continuous horizontal extractor
	6d. Explain Material balance	6.5. Material balance for single stage system
Unit – VII **Membrane Separation**	7a. Describe Membrane Separation Process	7.1 Introduction and Basic Principle of Membrane Separation
	7b. Classify membrane process	7.2 Types of Membrane Processes
	7c. Describe advantages and disadvantages 7d. Uses membrane separation processes	7.3 Advantages and disadvantages of membrane processes 7.4 Various applications of membrane separation.
	7e. Draw the diagram of various membrane modules	7.5 Various types of membrane and membrane Modules with diagram a. Plate and frame b. Tubular c. Spiral wound d. Hollow fiber

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Fundamental of Mass Transfer	04	03	02	00	05
II	Molecular Diffusion in Fluids	07	02	04	03	09
III	Interphase Mass Transfer	05	02	02	02	06
IV	Gas Absorption	11	02	04	08	14
V	Liquid Extraction	10	02	03	08	13
VI	Leaching	11	02	03	08	13
VII	Membrane Separation	08	02	04	04	10
Total		**56**	**15**	**22**	**33**	**70**

Legends: R = Remember; U= Understand; A= Apply and above levels (Bloom's revised taxonomy)
Note: This specification table shall be treated as only as a guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

***Note**: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes (**as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical/Exercise (Outcomes in Psychomotor Domain)	Approx. Hrs. Required
1	II	Determine diffusivity of gas-liquid system at room temperature	4
2	II	Determine diffusivity of gas-liquid system with respect to temperature	4
3	II	Determine diffusivity of liquid-liquid system at room temperature	4
4	II	Determine diffusivity of liquid-liquid system at different temperature	4
5	IV	Find out rate of absorption in a tray or packed tower	4
6	V	Determine the efficiency of single stage extraction	4
7	V	Determine the efficiency of two stage cross current extraction	4
8	V	Determine the efficiency of continuous counter current extraction	4
9	V	Prepare ternary diagram for a system of three liquids	4
10	VI	Obtain tie-line data for Acetic Acid, Benzene and water	4
11	VI	Measure recovery of salt using sand-salt mixture in single stage leaching	4
12	VI	Measure recovery of salt using sand-salt mixture in two stage leaching	4
13	VI	Calculate efficiency of Leaching by shanks system	4
14	VII	Study and Compare different types of membrane module with detailed diagram.	4
Total Hrs			**56**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Visit nearby industries and observe the working of mass transfer equipments and collect their specifications

ii. Visit the website of reputed mass transfer equipment manufacturers and prepare a report on these equipments.

9. SPECIAL INSTRUCTIONAL STRATERGY (if any)

i. Show animated videos and drawings of mass transfer equipment

10. SUGGESTED LEARNING RESOURCES

A. List of Books:

Sr. No.	Title of Books	Author	Publication
1	Mass Transfer Operations	Robert E. Treybal	Mc Graw- Hill, 3rd Edition, 1981
2	Unit Operation of Chemical Engineering	McCabe, Warren L., Julian C. Smith	McGraw Hill Publication, New York 2004, 7th Edition
3	Separation Process Principles	Ernest J. Henley, J. D. Seader, D. Keith Roper	Wiley India, 2nd Edition, 2005
4	Unit Operations-II	K. A. Gavhane	Nirali Prakashan, Pune, 2009
5	Unit Operations of Chemical Engineering, Volume-1	P. Chattopadhyay	Khanna Publishers, New Delhi, 1995
6	Chemical Engineering, Volume-2	Coulsion and Richardson	Butterworth-Heinemann; 5th Edition, 2002
7	Introduction to Chemical Engineering	L.Badger, Julius T. Banchero	McGraw Hill Publication, New York, 7th Edition, 2004

B. List of Major Equipment/ Instrument with Broad Specifications

i. **Gaseous diffusion system:**
Thermostatic bath 2 litre; Temperature controller 0-100 ^{0}C; Vernier 0-100 mm(0.1 mm resolution); Magnetic stirrer with heater 2 MLH; Air blower 0.25 HP

ii. **Liquid diffusion system:**
1 liter glass beaker, Magnetic stirrer 1 MLH, electrical conductivity sensor & meter to measure conductivity in MHO

iii. **Packed column absorber :**
75 mm ID, 1 m Glass column, Rasching ring packing; CO_2 cylinder with pressure regulator and rotameter; NaOH circulation system with pump, sump and rotameter

iv. **Continuous extractor :**
Glass column ID 75mm, OD 87mm, Height 1000mm; Supply tanks(three)-SS 304, 40 litre; Rotameters(two)-0.3 to 3 lpm-Glass tube, SS316 float; 0.25 HP motor with SS 304/316 shaft and blades

v. **Leaching apparatus :**
Leaching bag-Polypropylene; Glass column Dia. 40 mm, height 400mm with SS 304 cap at both end; Solvent tank SS304-25 litre with 1 KW immersion heater; Collection tank SS 304, 30 litre; Pump- MOC-Polypropylene, 15 lpm flow rate

vi. **Glass Separating funnels**
-250ml, 500ml ; **Burettes**-25 ml, 50 ml; **Pipettes** - 10 ml, 25 ml; **Conical flasks**- 250 ml, 500 ml; **Beakers** - 250 ml, 500 ml

C . List of Software/Learning Websites

i. www.unitoperation.com
ii. www.nptel.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. Harsh B. Shukla**, Lecturer in Chemical Engineering, Shri K.J. Polytechnic, Bharuch
- **Prof. Upasana T. Singh**, Lecturer in Chemical Engineering, Shri K.J. Polytechnic, Bharuch
- **Prof. Jatin. R. Vadher**, Lecturer in Chemical Engineering, Govt. Polytechnic, Gandhinagar.

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur**. Associate Professor, Department of Applied Sciences
- **Dr. Bashirullah Shaikh**, Assistant Professor, Department of Applied Sciences

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: CHEMICAL PROCESS TECHNOLOGY-II
(Code: 3340503)

Diploma programme in which this course is offered	Semester in which offered
Chemical Engineering	4th Semester

1. RATIONALE

This course provides the essential link between chemistry and the chemical industry. It is vital to develop the comprehensive understanding about the fundamental knowledge and manufacturing process for various chemical products. This course develops the skill to understand and arrange the treatment, reaction and separation steps in a flow diagram of chemical production process. Hence the course has been designed to develop this competency and its associated cognitive, practical and affective domain learning outcomes.

2. COMPETENCY

The course should be taught and curriculum should be implemented with the aim to develop required skills so that students are able to acquire following competency:

- **Prepare flow diagram for the manufacturing of various chemical products**.

3. COURSE OUTCOME

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- Explain Manufacture of Vegetable oil, Sugar from sugar-cane, Starch from maize and Dextrin from starch
- Describe manufacturing of pulp and paper industries with major engineering problems
- Prepare flow diagram and Explain manufacturing of fuel gases
- Prepare flow diagram and Explain manufacturing of Ethyl alcohol by fermentation, lactic acid from corn sugar, citric acid from molasses and vinegar by Frings' method
- Explain manufacturing of rubber chemicals
- Explain manufacturing of various pharmaceutical products.
- Describe manufacturing process of pesticides
- Explain Production of bromine from sea water

4 TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	200
4	0	4 0	208 06	70 70	30 30	40 20	60 30	

Legends: L -Lecture; **T** -Tutorial/Teacher Guided Student Activity; **P** -Practical; **C** - Credit; **ESE**-End Semester Examination; **PA** -Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I **Natural Product Industries**	1a. Define oil and fat	1.1 Basics of oil and fat
	1b. Describe physical properties of oil	1.2 Physical properties of oil
	1c. Describe carbohydrates	1.3 Introduction to Carbohydrates
	1d. Draw flow diagram explain manufacturing process of (i)Vegetable oil (ii) Hydrogenated products of oil (iii) Sugar from sugar-cane (iv) Starch from maize (v) Dextrin from starch	1.4 Manufacturing Process of (i) Vegetable oil (ii) Hydrogenated products of oil (iii) Sugar from sugar-cane (iv) Starch from maize (v) Dextrin from starch
	1e. Distinguish chemicals available from the sea	1.5 Chemicals from sea
	1f. Draw flow diagram describe manufacturing process of bromine from sea water.	1.6 Production of bromine from sea water
Unit – II Pulp and Paper Products	2a. Explain pulp and paper	2.1. Fundamentals of Pulp and paper
	2b. Distinguish methods of pulp production 2c. Describe various steps of pulp production 2d. Draw flow diagram explain manufacturing of paper using Fourdrinier machine	2.2. Methods of pulp production 2.3. Sulphate (Kraft) pulp process 2.4. Manufacturing of paper using Fourdrinier machine
	2e. Identify major engineering problems of paper manufacturing	2.5. Paper manufacturing
Unit – III **Fuel and Industrial Gases**	3a. Classify fuels 3a1. List types, sources, uses of fuels	3.1 Fuels:
	3b. List types, sources, uses of industrial gases	3.2 Important industrial gases: types, sources, uses
	3c. Draw flow diagram explain manufacturing process of fuel gases	3.3 Production of fuel gases (i) producer gas (ii) water gas (iii) coke oven gas (iv) natural gas
	3d. Describe industrial electrolytic process	3.4 Industrial electrolytic processes
	3e. Describe Cryogenic for producing industrial gases	3.5 Cryogenic
Unit – IV Fermentation Industries	4a. Classify fermentation 4a1.List types of fermentation	4.1. Fermentation
	4b. Draw flow diagram explain manufacturing (i) Ethyl alcohol by fermentation (ii) Lactic acid from corn sugar	4.2. Manufacture of (i) Ethyl alcohol by fermentation (ii) Lactic acid from corn sugar (iii) Citric acid from molasses

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	(iii) Citric acid from molasses (iv) vinegar by Frings'method	(iv) vinegar by Frings' method
	4c. Describe use of biotechnology in chemical engineering	4.3. Biotechnology in Chemical Engineering
Unit – V **Rubber Chemicals**	5a. Define rubber 5b. Describe production of natural rubber 5b1.List properties and uses of natural rubber 5c. Classify synthetic rubbers 5c1. List uses of synthetic rubber	5.1 Fundamentals of rubber 5.2 Natural rubber 5.3 Synthetic rubbers
	5d. Explain compounding procedure for rubber	5.4 Compounding of rubber
	5e. Draw flow diagram for manufacturing of (i) styrene butadiene rubber (ii) poly butadiene rubber (iii) chloroprene (iv) nitrile rubber	5.5 Manufacturing of (i) styrene butadiene rubber (ii) poly butadiene rubber (iii) chloroprene (iv) nitrile rubber
Unit – VI **Pharmaceuticals**	6a. Classify pharmaceutical products on the basis of use (with examples)	6.1. Pharmaceutical products
	6b. Distinguish Important drugs	6.1. Important Drugs (i) Antipyretic (ii) Anaesthetic (iii) Analgesic (iv) Anti-malarial (v) Anti-TB drugs (vi) Antibiotics (vii) Antihistamine (viii) Vitamins
	6c. Draw flow diagram and explain manufacturing of (i) Antibiotics, (ii) Aspirin, (iii) Paracetamol	6.3(i) Antibiotics, (ii) Aspirin, (iii) Paracetamol
Unit-VII **Pesticides**	7a. Describe the important Pesticides	7.1 Important pesticides: (i) Algiscide, (ii) Bactericide, (iii) Fungicide, (iv) Herbicide, (v) Insecticide (vi) Biopesticide
	7b. Formulate pesticides	7.2 Formulation of Pesticide
	7c. Draw block diagram and explain manufacturing of (i) methyl bromide (ii) 2-4 Dichlorophenoxy acetic acid	7.3 Manufacturing process of (i) methyl bromide (ii) 2-4 Dichlorophenoxy acetic acid

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
1.	Natural Product Industries	11	04	06	04	14
2.	Pulp and Paper Products	06	02	04	01	07
3.	Fuel and Industrial Gases	08	03	05	02	10
4.	Fermentation Industries	08	02	06	02	10
5.	Rubber Chemicals	08	02	06	02	10
6.	Pharmaceuticals	09	04	06	02	12
7.	Pesticides	06	02	03	02	07
	Total	**56**	**19**	**36**	**15**	**70**

Legends:R = Remember; U= Understand; A= Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note*: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes*** ***(****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical/Exercise (Outcomes' in Psychomotor Domain)	Approx. Hrs. Required
1	I	Estimate Acid value in oil sample	04
2	I	Estimate iodine value in oil sample	04
3	I	Prepare starch from maize	04
4	I	Extract vegetable oil from seed	04
5	I	Prepare Glycerine	04
6	I	Estimate NaCl content in sea water	04
7	II	Prepare pulp from bamboo	04
8	III	Estimate moisture, volatile matter and ash content in fuel	04
9	IV	Prepare alcohol	04
10	IV	Prepare citric acid	04

11	IV	Prepare vinegar	04
12	V	Analyse rubber products	04
13	VI	Prepare Aspirin	04
14	VI	Prepare Paracetamole	04
Total Hours			**56**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

i. Prepare course/topic based presentations for seminars
ii. Visit websites of reputed process plant industries

9. SPECIAL INSTRUCTIONAL STRATEGY (If Any)

i. Arrange visit to nearby industries
ii. Show vides/animation films/photographs of different process plants.
iii. Give internet based assignments
iv. Give mini projects on preparing feasibility report for preparing different chemicals on commercial scale.

10. SUGGESTED LEARNING RESOURCES

A. List of Books

Sr. No.	Title of Books	Author	Publication
1	Outlines of Chemical Technology	M. Gopala Rao, Marshall Sittig	Affiliated East West Press (Pvt) Ltd-New Delhi, 3rd edition
2	Shreve's Chemical Process Industries,	Austin G.T.	McGraw Hill publication – New Delhi, 5th edition
3	Chemical Technology -Vol. I and II	G.N. Pandey and Shukla	Vani Books Company -Hyderabad, 2nd edition
4	A Text Book on Petrochemicals	Rao B. K. B.	Khanna Publishers, New Delhi, 2nd edition

B. List of Major Equipment/ Instrument with Broad Specifications

i. Glassware: Conical flask, burette, pipette, RBF, measuring cylinder, beaker
ii. Glass Assembly: RBF, reaction vessel, condenser, separating vessel
iii. Burner
iv. Weight balance (minimum 0.1gm)
v. Heating and cooling bath

C. List of Software/Learning Websites

i. www.epa.gov/sectors/sectorinfo/sectorprofiles/chemical.html
ii. www.naturalproductsexpoindia.com/
iii. www.andritz.com/pulp-and-paper/pp-pulp-production.htm
iv. ewww.linde-gas.com/en/products_and_supply/gases_fuel/index.htm

v. http://chemistry.about.com/od/biochemistry/a/carbohydrates.htm
vi. www.azom.com/article.aspx?ArticleID=3580
vii. www.iisrp.com/WebPolymers/00Rubber_Intro.pdf
viii. http://www.niehs.nih.gov/health/topics/agents/pesticides/
ix. http://levine.sscnet.ucla.edu/papers/imbookfinal09.pdf

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. R. P. Hadiya**, Lecturer, Chemical Engineering, Govt. Polytechnic-Rajkot
- **Prof. S. K. Charola**, Lecturer, Chemical Engineering, Sir BPIT-Bhavnagar
- **Prof. N. N. Hansalia**, Lecturer, Chemical Engineering, Govt. Polytechnic-Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur**. Associate Professor, Department of Applied Sciences,
- **Dr. Bashirullah Shaikh**, Assistant Professor, Department of Applied Sciences,

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: POLLUTION CONTROL & EFFLUENT TREATMENT
(Code: 3340504)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	4th Semester

1. RATIONALE

Study of environmental pollution, related to the chemical industry is must to understand various types of pollutions and its preventive and control majors. The study of this course would help engineers in operating diverse pollution control equipments for controlling gaseous, water and land pollution. They have to perform sampling and analysis of samples from various sources in the industry. Hence the course has been designed to develop this competency and its associated cognitive, practical and affective domain learning outcomes.

2. COMPETENCY

The course should be taught and curriculum should be implemented with the aim to develop required skills so that students are able to acquire following competency:

- **Perform sampling, analysis and treatment of pollutants to control pollution**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Define & classify pollution and pollutant - (Air , Water , solid)
ii. Describe removal of pollutants by applying various treatment methods
iii. Identify Sources of Pollution
iv. Conduct Environmental audit and ISO 14001

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	70	30	20	30	

Legends: L -Lecture; **T** -Tutorial/Teacher Guided Student Activity; **P** -Practical; **C** - Credit; **ESE**-End Semester Examination; **PA** -Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I **Basics of Environmental Pollution**	1a. Define pollution and pollutant	1.1 Introduction of pollution and pollutants
	1b. Classify pollutants & pollution	1.2 Types of pollution and pollutants
	1c. Identify Sources of Pollution	1.3 Sources of air, water, noise, radioactive and land pollution
	1d. Explain Effect of pollution	1.4 Effects of air, water, noise, radioactive and land pollution
Unit – II **Air Pollution**	2a. Explain Sampling of air pollutants 2b. Distinguish gaseous and particulate pollutants	2.1 Ambient air sampling 2.2 Sampling of gaseous air pollutants and particulate pollutants
	2c. Describe Construction and working of Particulate control equipments	Particulate control equipments 2.3 Gravity Settling Chamber, Cyclone separator, Fabric Filter, Wet Scrubber and Electrostatic Precipitator
	2d. Describe Thermal incineration 2e. List Methods for control of Sulfur dioxide emission 2f. Apply control methods for gaseous air pollutants from Sulfur. 2g. Apply control methods for gaseous air pollutants from Nitrogen Oxides. 2h. Apply control methods for carbon monoxide 2i. Describe removal of pollutants by applying control methods for hydrocarbons	2.4 Thermal incineration 2.5 Methods for control of Sulfur dioxide emission 2.5.1 Extraction of sulfur from fuels 2.5.2 Hydrodesulphurization of coal 2.5.3 Desulphurization of fuel oils 2.5.4 Desulphurization of flue gases by Dry processes(using metal oxides and activated carbon) and wet processes(wet scrubbing methods) 2.6 Methods for control of Nitrogen Oxides 2.6.1 Absorption of NOx 2.6.2 Adsorption of NOx 2.6.3 Catalytic reduction 2.7 Control of carbon monoxide 2.8 Control of hydrocarbons
Unit – III **Water Pollution**	3a. Explain characteristics of water	characteristics of water 3.1 Dissolved oxygen, BOD,COD, VM, Suspended Matter, Dissolved solids, pH
	3b. Distinguivish Waste water sampling methods	3.2 Water sampling methods 3.2.1 Grab sampling 3.2.2 Composite sampling
	3c. Describe removal of pollutants by applying Waste water treatment methods	3.3. Waste water treatment methods 3.3.1 Primary treatment 3.3.1.a Pretreatment 3.3.1.b Sedimentation 3.3.1.c Floatation

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		3.3.2 Secondary treatment 3.3.2.a Aerobic process 3.3.2.b Anaerobic process: Activated sludge process and trickling filter
	3d. Describe removal of pollutants by applying various treatment methods on suspended solids 3e. Describe removal of pollutants by applying various treatment methods on dissolved solids 3f. List treatment methods for dissolved solids 3g. Describe facultative ponds 3h. Explain oxidation and disinfection	3.4 Suspended solids treatment methods 3.4.4 Microstraining 3.4.5 Coagulation 3.4.6 Filtration 3.5 Dissolved solids and treatment methods 3.5.4 Ion exchange 3.5.5 Reverse Osmosis 3.5.6 Electrolysis 3.6 Facultative ponds 3.7 Chemical oxidation/Disinfection
	3i. .Explain Sludge processing	3.8 Thickening, Digestion, Conditioning, Dewatering, Oxidation and ultimate sludge removal
	3j. Describe Effluent treatment plant drawing schematic block diagram	3.9 Effluent treatment plant- ETP
	3k. List out norms of GPCB for potable water	3.10 Norms of GPCB for potable water
Unit – IV Solid Waste Management	4a. Define solid waste 4b. Classify solid waste	4.1. solid waste
	4c. Explain all methods of solid Waste Disposal	4.3. Methods of solid waste disposal 4.3.1 Open Dumping 4.3.2 Sanitary Land filling 4.3.3 Incineration 4.3.4 Compositing 4.3.5 Reuse, recovery and recycling
Unit – V Environmental audit and ISO 14001	5a. Describe Procedure for Environmental Audit	5.1 Environmental audit 5.1.1 Procedure for environmental audit
	5b. List ISO 14001 norms 5c. Describe Procedure for applying ISO 14001 norms	5.2 ISO 14001 5.2.1 Benefits of ISO 14001 5.2.2 ISO 14001- Assessment process

6. SUGGESTED SPECIFICATIONTABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Environmental Pollution	08	06	08	00	14
II	Air pollution	14	04	10	08	22
III	Water pollution	12	04	10	06	20
IV	Solid Waste Management	04	02	03	02	07
V	Environmental audit and ISO 14001	04	02	02	03	07
Total Hrs		**42**	**18**	**33**	**19**	**70**

Legends: R = Remember; U= Understand; A= Apply and above levels (Bloom's revised taxonomy)
Note: This specification table shall be treated as a guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES / PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note*: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

Sr. No.	Unit No.	Practical/Exercise (Outcomes' in Psychomotor Domain)	Approx. Hrs. Required
1	I	Prepare detail charts of various Pollutants and sources of pollution	02
2	II	Remove suspended Impurities from air using cyclone system	02
3	II	Remove suspended Impurities from air using fabric filter	02
4	III	Determine hardness (Temporary and Permanent hardness) of given water sample	02
5	III	Determine COD of the given effluent sample	02
6	III	Measure suspended particles in liquids using Turbidity	02

Sr. No.	Unit No.	Practical/Exercise (Outcomes' in Psychomotor Domain)	Approx. Hrs. Required
		meter	
7	III	Determine hydrogen ion concentration (pH) of sample using pH meter.	02
8	III	Determine BOD of given sample	04
9	III	Determine Dissolved Oxygen in effluent sample	02
10	III	Determine total dissolved solids in given effluent sample using heat treatment	02
11	III	Determine chloride concentration in given effluent sample using heat treatment	02
12	IV	Remove suspended solid by coagulation.	02
13	IV	Prepare chart for treatments of different solid waste	02
14	V	Prepare Environmental Audit report for any Chemical Industry	04
Total Hrs			**32**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Visit to websites of different manufacturer of effluent treatment equipments and prepare a report.
ii. Visit to websites of pollution control boards of different states/countries and study their norms and regulations

9. SPECIAL INSTRUCTIONAL STRATEGY (If any)

i. Show video film of an ETP and on other pollution control measures.
ii. Arrange visit to nearby solid waste disposal site/segregation plant/incinerator
iii. Arrange visit to nearby Pollution Control Board/Effluent treatment plants

10. SUGGESTED LEARNING RESOURCES

A. List of Books

S. No.	Title of Books	Author	Publication
1	Environmental Pollution control	Rao C. S.	New age international Pvt. Limited, 2nd edition
2	Pollution Control in Process Industries	Mahajan S. P.	Tata Mc GrawHill, New Delhi, 21st reprint, 2008
3	Text Book of Environmental Pollution and Control	Dr. Bhatia H. S.	Galgotia Publication, 1st edition, New Delhi
4	Environmental Engineering	Pandey G. N., Carney G. C.	Tata Mc GrawHill, New Delhi

B. List of Major Equipment/Materials

i. **Glassware:** Titration set up, crucible, beaker
ii. **pH meter**: pH range-2.00 to +16.00, Resolution: 0.01, Accuracy: ±0.02, mV range: ±1999 mV, Temperature range: -10 to +105°C
iii. **Turbidity mete range:** 0 - 10,000 NTU, Principle of Operation-Nephelometric, Ratio (Color Correction): Full Time ON or OFF, Accuracy: ± 2% of reading plus 0.01 NTU (0 to 1000 NTU), Response Time: less than 6 seconds ,Sample Size: 30 ml
iv. **Incubator (BOD set up):** Chamber volume:285.0 ltrs, range :+50C to 600C, controller accuracy:+/-0.50C set value of temp., PID Control: microprocessor based PID controller
v. **Cyclone separator:** 20" diameter cyclone dust collector,3" carbon steel straight wall and a 38" carbon steel cone tapering to an 8" x 8" discharge, 3" inlet and 3" exhaust. Splits in the middle for easy clean out
vi. **Weighing machine :** Digital min. measurement 1 microgram

C. List of Software/Learning Websites

i. http://www.cosmolearning.com/courses/fundamentals-of-environmental-pollution-and-control-401/video-lectures/
ii. http://www.answers.com/topic/air-pollution
iii. https://en.wikipedia.org/wiki/Water_pollution
iv. http://www.water-pollution.org.uk/causes.html
v. http://www.acsregistrars.com/iso14001.asp

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. N. N. Hansalia**, Lecturer in Chemical Engineering, Government Polytechnic, Rajkot
- **Prof. (Mrs.) K. J. Sareriya**, Lecturer in Chemical Engineering, Government Polytechnic, Rajkot
- **Prof. (Mrs.) Parul K. Patel**, Lecturer in Chemical Engineering, Government Polytechnic, Gandhinagar

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. Abhilash Thakur**, Associate Professor, Dept. of Applied Sciences
- **Prof. Bashirulla Shaik**, Assistant Professor, Dept. of Applied Sciences

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: SAFETY AND HAZARD MANAGEMENT IN CHEMICAL INDUSTRY
(Code: 3340505)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	4th Semester

1. RATIONALE

Chemical Industries are known as the most dangerous and hazardous industries since long. Varieties of conditions are present in chemical industries which may lead to different type of industrial accidents. Bhopal MIC leak accident is a world famous industrial accident which also happened in a chemical plant of Union Carbide Company in which thousands died and many got different diseases. Most of the industrial accidents are due to the human error or ignorance and responsible for the major losses to the industries and humanity. Use and handling of certain chemicals is also found to be dangerous as it may lead to health hazards. It is therefore essential for the technician to know about hazards, accidents, safe handling of chemicals, and operation of plant equipment and transportation of chemicals. Hence the course has been designed to develop this competency and its associated cognitive, practical and affective domain learning outcomes.

2. COMPETENCY

The course should be taught and curriculum should be implemented with the aim to develop required skills so that students are able to acquire following competency:

- **Handle chemicals and operate chemical plant safely**

3. COURSE OUTCOME

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Explain Indian and International Safety standards.
ii. Identify the causes of accident and explain various engineering control methods
iii. Explain storage, handling and transportation of hazardous materials.
iv. Classify fire extinguishing agents and methods
v. Explain risk assessment methods.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	150
3	0	2	5	70	30	20	30	

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Introduction to Industrial Safety and Hazards	1a. Describe importance of safety in Industry	1.1 Importance of Industrial Safety
	1b. Classify the hazards	1.2 Types of hazard (a) Chemical hazard (b) Thermal hazard (c) Electrical hazard (d) Mechanical hazard (e) Vibrational hazard (f) Biological hazard (g) Radioactive hazard
	1c. Explain Indian and International safety standards	1.3 Safety and health Standards 1.3.1 Indian Standards & codes for safety & health 1.3.2 International standard: OHSAS 18001
Unit – II Chemical hazards and Their Control	2a. Classify chemical hazards & their control 2b. Explain occupational diseases and poisoning 2c. Apply preventive measures of diseases	2.1 Classification of Chemical Hazards and their control 2.2 Chemicals as a cause of occupational diseases and poisoning 2.3 Prevention of diseases due to chemical effect
	2d. Describe safety aspects in plant layout 2e. Identify different colour codes for chemical plants	2.4 Safety aspects in plant layout, Ventilation and lighting 2.5 Color codes and symbols for safety in chemical plants (a) Classification of Color codes and symbols (b) Color codes for gas cylinders (c) Color codes for pipelines
	2f. Classify Personal Protective Devices 2g. List Personal Protective Devices in each	2.6 Personal Protective Devices (PPDs) (a) Non respiratory (b) Respiratory
Unit – III Safe Handling of Hazardous Chemicals	3a. Discuss characteristics of hazardous chemicals	3.1 Important characteristics and chemical reaction of 3.2 hazardous chemicals like (a) Chlorine (b) Nitric Acid (c) Ammonia (d) Carbon Monoxide (e) Caustic Soda (f) Phosphoric Acid

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		(g) Sulfuric Acid (h) HCl
	3b. Handle hazardous chemicals for Storage, Handling & Transportation	3.2 Storage, Handling & Transportation of hazardous chemicals
Unit – IV Fire Hazards and their Prevention	4a. Describe Fire hazards 4a1. List the causes of Fire hazards	4.1.Fire hazards & their causes
	4b. Explain fire triangle	4.2.Fire Triangle
	4c. Describe Classes of fire	4.3.Classes of fire
	4d. Describe fire extinguishers 4e. List types of extinguishers 4f. Describe Construction and working of fire extinguishers 4g. Describe Methods of their applications for fire extinguishers	4.4. Fire extinguishers 4.4.1 Classes of fire & types of extinguishers 4.4.2 Construction and working of fire extinguishers 4.4.3 Methods of their applications
Unit – V Hazard Identification and Risk Assessment	5a. Explain hazard identification methods	5.1 Hazard identification methods : a) Hazard Operability study (HAZOP), b) Hazard Analysis (HAZAN)
	5b. List risk assessment methods 5b1Explain risk assessment methods	5.2 Risk Assessment methods: a) Failure mode and effect analysis (FMEA) b) Fault Tree analysis (FTA) c) Event Tree analysis (ETA)

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Introduction to Industrial Safety and Hazards	06	4	4	2	10
II	Chemical hazards and Their Control	14	10	8	6	24
III	Safe Handling of Hazardous Chemicals	06	4	4	2	10
IV	Fire Hazards and their Prevention	06	4	4	2	10
V	Hazard Identification And Risk Assessment	10	8	6	2	16
Total		**42**	**30**	**26**	**14**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as only a general guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note*: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

Sr.No.	Unit No.	Practical/Exercise (Outcomes' in Psychomotor Domain)	Apprx. Hrs. Required
1	I	Prepare a chart of Indian safety standards	02
2	I	Identify different hazards in a given chemical plant	02
3	II	Identify different chemical hazards in a given chemical plant	02
4	II	Identify colour codes for pipelines	02
5	II	Identify colour codes for gas cylinders	02
6	II	Identify different safety symbols for chemical industry	02
7	II	Demonstrate Personal Protective Devices	02
8	III	Prepare a handouts of safe handling practices for hazardous chemicals	04

Sr.No.	Unit No.	Practical/Exercise (Outcomes' in Psychomotor Domain)	Apprx. Hrs. Required
1	I	Prepare a chart of Indian safety standards	02
2	I	Identify different hazards in a given chemical plant	02
9	IV	Demonstrate Fire triangle and classes of fire	02
10	IV	Demonstrate construction and working of different fire extinguishers	04
11	V	Apply HAZOP method using a case study	02
12	V	Apply Risk Assessment method for a chemical plant	02
Total Hrs			**28**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities:

i. Study of Fire extinguishers / Visit of a nearby fire station
ii. Study of personal protective equipments / visit to nearby industry
iii. Preparation of Material Safety Data Sheet of hazardous materials
iv. Visit to websites of reputed fire and safety equipment suppliers and study of features of their equipment/instruments/tools.

9. SPECIAL INSTRUCTIONAL STRATEGY (IF ANY)

i. Show different video/Animated films about functioning of different safety equipment/fire prevention equipment
ii. Discuss case studies of major industrial disasters/accidents and cause for them.

10. SUGGESTED LEARNING RESOURCES

A. List of Books

Sr. No.	Title of Books	Author	Publication
1	Manual of Chemical Technology, Chemtech-I	D.Venkateswarlu, K.R.Upadrashta, K.D. Chandrasekaran	Chemical Engineering Education Development Centre, IIT, Madras, 1975
2	Fundamentals of Industrial Safety & Health	Dr. K. U. Mistry	Siddharth Prakashan, Ahmadabad
3	Chemical Process Safety: Fundamentals with application	Daniel A. Crowl, Joshef F. Louvar	3rd Edition, 2011, Prentice Hall, USA,
4	Industrial Safety Management	N. K. Tarafdar, K. J. Tarafdar	Dhanpatrai and Co.Ltd., New-Delhi, 1st Edition, 2012
5	Industrial safety management	L M Deshmukh	Tata McGraw Hill, New Delhi, 2006
6	Industrial Safety, Health & Environment management	Sunil S. Rao, R.K. Jain	Khanna Publishers, New Delhi, 2006

B. List of Major Equipment/Materials

i. Fire Extinguishers

– CO_2 type, A, B, C type, Dry chemical powder type

Foam type- 9 litre, operation-inverted, ISS-933, Class B fire

ii. Water type-CO_2 gas pressure, 9 litre, operation-upright, ISS-940, Class A fire

iii. DCP type- 1,2,5 or 10 Kg, operation-upright, ISS-2171, Class B and C fire

iv. Soda acid type-9 litre, operation-inverted or upright, ISS-934, Class B and C fire

v. Respiratory & Non-respiratory personal protective devices:

vi. Safety goggles, face screens, Industrial safety helmets, hairnets and fire fighters helmets, Earplugs, earmuffs, Gloves, Safety boots and shoes with protective toecaps and penetration-resistant, Apron, Chemical suit

C List of Software/Learning Websites

i. https://www.osha.gov
ii. https://www.iso.org
iii. https://www.bis.org.in
iv. http://www.iffco.nic.in/applications/brihaspat.nsf
v. http://sp.ehs.cornell.edu/lab-research-safety/laboratory-safety-manual/Pages/ch8.aspx

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. Mukesh B. Dhangar**, Lecturer in Chemical Engineering, Shri N. G. Patel Polytechnic, Isroli – Afwa.
- **Prof. Manish R. Nasit**, Lecturer in Chemical Engineering, Shri N. G. Patel Polytechnic, Isroli – Afwa
- **Prof. Nitin N. Hansalia**, Lecturer in Chemical Engineering, G. P. Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur,** Associate Professor, Department of Applied Sciences
- **Dr. Bashirullah Shaikh**, Assistant Professor, Department of Applied Sciences

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: INDUSTRIAL MANAGEMENT
(COURSE CODE 3350501)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5th Semester

1. RATIONALE

Diploma chemical engineer has to manage the production as a responsible chemical technician and first line supervisor in the industries. They have to apply principles and techniques of management to utilize the human resources and manage the processes and operations in best possible way. They have to optimize the resource utilisation and apply the managerial aspects in cost reduction and different problem solving activities. Hence the course has been design to develop these competencies and its associated cognitive, practical and effective domain learning out comes.

2. LIST OF COMPETENCY

The course should be taught and implemented with the aim to develop required skills in the students so that they are able to acquire following competency

- **Apply managerial skills to enhance efficiency of production.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Manage human resources using system and organization concepts
ii. Manage Inventory applying concepts of material management
iii. Control and monitor production by applying management techniques
iv. Plan and implement projects applying management techniques
v. Perform and use value analysis for cost reduction

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	100
3	0	0	3	70	30	00	00	

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit I Concept of System and Management	1a. Explain concepts of system 1a.1 State Types of systems	1.1 Definition of system
		1.2 Types of systems
		1.3 System parameters
		1.4 System variable
		1.5 System behavior
	1b. Discuss management and Explain its functions	1.6 Fundamentals of management
		1.7 Functions of management
Unit II Organization Structure and Organizational Dynamics	2a. Describe management structure 2b. Explain various factors for structure 2c. Describe various management processes	2.1 Definition, Goals, Factors considered in formulating structure
		2.2 Division of labor, Scalar and functional processes, Span of control, Delegation of authority, Centralization and Decentralization
	2d. Classify the organization 2e. Apply SWOT analysis of organizational structure 2f. Explain factors affecting Organizational culture	2.3 Types, advantages, disadvantages, flexibility and applications of organization structure
		2.4 Organizational culture and factors affecting organization culture
	2g. Discuss moral and relate it with productivity 2h. Identify factors affecting job satisfaction	2.5 Moral: factors affecting moral
		2.6 Relationship between moral and productivity
		2.7 Effect of high and low moral
		2.8 Job satisfaction, factors influencing job satisfaction
Unit III Material Management	3a. Discuss importance of material management	3.1 Definitions, Functions, Importance of material management, Relationship with other departments
	3b. Explain purchase procedure and system	3.2 Objectives of purchase, Purchase systems, Purchase procedure, Terms and various forms used in purchase department
	3c. Classify stores 3c.1 List out various functions of storekeeping 3d. Compare methods of storekeeping	3.3 Functions of storekeeping classification of stores as centralized and decentralized with their advantages, disadvantages and application
	3e. Describe functions of storekeeper 3f. List Types of records types of storage equipment	3.4 Functions of store keeper, Types of records maintained by store, various types of storage equipment, Codification of stores
	3g. Discuss Objectives of inventory control and derive expression for EOQ 3h. Distinguish inventory analysis and inventory models	3.5 Definition of inventory control, objectives of inventory control, Derivation of expression for EOQ, ABC analysis, other modern methods of analysis 3.6 Inventory models such as Willson's model, Replenishment model, Two bin model

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit IV Management Techniques	4a. Explain objectives and applications of PPC and CPM , PERT	4.1 Meaning, features, objectives of (1) PPC(Production, planning and control) (2) CPM(Critical path method) (3) PERT(Programme Evaluation and Review Technique)
	4b List out functions of PPC	4.2 Functions of PPC with necessary forms used in it
	4c Calculate critical ratio using Gantt charts	4.3 Types of productions, Calculation of Economic Batch Quantity (EBQ), Critical ratio scheduling and Gantt charts
	4d. Draw network diagram and determine its critical path	4.4 Different terms used in network diagram by CPM/PERT
	4e. Determine floats and explain crashing of network	4.5 Draw network diagram for a real life project containing 10-15 activities, Computation of LPO, EPO 4.6 Determination of critical path on network
		4.7 Floats, its types and determination of floats 4.8 Crashing of network and its application
	4f. Describe concept of value analysis with its importance and various method	4.9 Concept of value analysis, important methods used in value analysis, VA flow diagram
Unit V Factory Act and Laws	5a. Describe various provisions of Factory act and its important provisions	5.1 Factory act and its important provisions
		5.2 Workman Compensation Act its important provisions
		5.3 Industrial Dispute Act and its important provisions

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Concept of System and Management	4	02	05	00	7
II	Organization Structure and Organizational Dynamics	08	05	06	03	14
III	Material Management	13	07	07	07	21
IV	Management Techniques	13	06	07	08	21
V	Factory Act and Laws	04	03	02	02	7
Total		**42**	**23**	**27**	**20**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)
Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

i. Course/topic based presentation
ii. Group discussion

8. SPECIAL INSTRCTIONAL STRATEGY (If Any)

i. Give real life or fabricated case studies related to different managerial problems faced in chemical industries and ask students to identify reasons for problem and suggest probable solutions. Have Group Discussions on these solutions.
ii. Show motivational videos related to human resource management.
iii. Use role play method to teach proper methods of dealing patiently with difficult subordinates/colleagues/ Seniors.

9. SUGGESTED LEARNING RESOURCES

A. List of Books:

Sr. No.	Title of Books	Author	Publication
1	Factory Management & business organization	A.S Despande	Vora & Co. Publishers Pvt. Ltd., Mumbai, 1962
2	Business organization & management	M.C.Shukla	S. Chand & Co., New Delhi, 1970
3	Industrial Engineering & Management	O. P. Khanna	Dhanpat Rai Publications, New Delhi, 1980
4	CPM & PERT principles and Applications	L.S.Srinath	3rd Edition Affiliated East-West Press Private Limited, New Delhi, 1971

B. List of Software/Learning Websites

i. www.idc.iitb.ac.in/~chakku/dm/06_Pert%20cpm.ppt
ii. www.clib.dauniv.ac.in/E-Lecture/PERT-CPM.pdf
iii. www.pitt.edu/~super7/30011-31001/30961.ppt
iv. www.newagepublishers.com/samplechapter/001386.pdf
v. www.unesco.org/education/aladin/paldin/pdf/course02/unit_14.pdf
vi. www.du.ac.in/fileadmin/DU/Academics/course_material/EP_08.pdf

10. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. J. R .Vadher,** Lecturer in Chemical Engineering, Sir B.P.T.I Bhavnagar
- **Prof. S. K. Charola,** Lecturer in Chemical Engineering, Sir B.P.T.I Bhavnagar,
- **Prof. P. H. Shukla,** Lecturer in Chemical Engineering, Sir B.P.T.I Bhavnagar
- **Prof. N. N. Hansalia,** Lecturer in Chemical Engineering G. P. Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur.** Associate Professor, Department of Applied Sciences
- **Dr. Bashirullah Shaikh,** Assistant Professor, Department of Applied Sciences

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: MASS TRANSFER-II
(COURSE CODE: 3350502)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5th Semester

1. RATIONALE

Diploma Chemical engineer have to supervise the preliminary purification of raw materials or final separation of products from by-products. They have to deal with changes in composition of solutions known as the mass-transfer operations. The large numbers of towers used for petroleum refining are examples of mass transfer operations. A substantial number of the unit operations of chemical engineering are concerned with the problem of changing the compositions of solutions and mixtures through methods involving chemical reactions. Hence the course has been design to develop these competencies and its associated cognitive, practical and effective domain learning out comes.

2. LIST OF COMPETENCY

The course should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following competency:

- **Perform separation operations for purification of raw materials and products**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Operate equipments for gas-liquid operations.
ii. Perform distillation operations.
iii. Calculate the product rate and number of trays for binary distillation.
iv. Calculate various terms associated with humidity.
v. Operate drying systems.
vi. Use the concept of adsorption and ion exchange.
vii. Operate various crystallisers.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	200
4	0	4	8	70	30	40	60	

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Equipment for Gas Liquid Operations	1a. Describe importance of Gas-Liquid operations 1b. Classify equipments for Gas-Liquid operations 1c. Describe construction of equipments with diagram of 1.3 & 1.4 1d. Explain working principle and operation of equipments with sketches of 1.3 & 1.4	1.1 Importance of Gas-Liquid operations
		1.2 Classification of equipments for Gas-Liquid operations
		1.3 Gas dispersed 1.3.1 Sparged vessel 1.3.2 Mechanically Agitated Vessel 1.3.3 Tray tower 1.3.3.1 Types of trays 1.3.3.2 Operating problems in tray tower 1.3.3.3 Tray efficiency 1.4 Liquid dispersed 1.4.1 Venturi scrubber 1.4.2 Wetted wall column 1.4.3 Spray tower 1.4.4 Packed tower and its operating problems
	1d. Distinguish different types of packing with diagram	1.5 Types of packing (a) Random (b) Regular
Unit – II Distillation	2a Describe applications	2.1 Distillation as a versatile separation method
	2b Describe the steps to Plot VLE, Constant pressure, Constant temperature equilibria	2.2 Vapor Liquid Equilibria 2.2.1Constant pressure equilibria 2.2.2 Constant temperature equilibria
	2c Explain Relative volatility and laws - Raoult's, Henry's 2c.1 State their uses	2.3 Relative volatility 2.4 Raoult's law, Henry's law, and their uses
	2d Differenetiate azeotropes	2.5 Maximum and minimum boiling azeotropes
	2e Explain -Flash vaporisation, Differential distillation, Continuous rectification 2f Calculate amount and composition for Flash vaporization 2g Calculate product composition for Differential distillation	2.6 Flash vaporization 2.6.1 Material balance 2.6.2 Calculation of amount and composition 2.7 Differential distillation 2.7.1 Derivation of Rayleigh's equation 2.7.2 Calculation of product composition 2.8 Continuous rectification of binary solution 2.8.1 The fractionation operation 2.8.2 Overall material and enthalpy balances
	2f. Apply McCabe-Theile method for multistage tray tower for enriching and stripping section 2f.1 Calculate product rates, minimum reflux ratio and number of trays for the given data	2.9 McCabe and Thiele method for enriching and stripping section 2.9.1 Introduction of Feed and Location of the feed tray 2.9.2 Total reflux ratio, Minimum reflux ratio, Optimum reflux ratio 2.9.3 Calculations of product rates, minimum reflux ratio and number of trays
	2g. Compare distillation techniques viz (a) Steam distillation (b)Vacuum and molecular distillation (c)Azeotropic and extractive distillation	2.10 Important distillation techniques (a) Steam distillation (b)Vacuum and molecular distillation (c)Azeotropic and extractive distillation
	2h. Distinguish Reboilers	2.11 Reboilers and their use

Unit – III Humidification	3a. Analyse the VLE for a pure substance	***Humidification:*** 3.1 Vapor-pressure curve 3.2 Saturated and unsaturated vapor-gas mixtures
	3b. Explain the concepts of Absolute humidity, Relative saturation, Percentage saturation, Dew point, Dry bulb temperature, Wet bulb temperature, Adiabatic saturation temperature, Humid volume, Humid heat, Enthalpy	3.3 Concept of Absolute humidity, Relative saturation, Percentage saturation, Dew point, Dry bulb temperature, Wet bulb temperature, Adiabatic saturation temperature, Humid volume, Humid heat, Enthalpy
	3c.Evaluate the property of air using DBT and WBT 3e.1 Calculate –absolute humidity, relative saturation, percentage saturation for the given process data	3.4 Calculations of absolute humidity, relative saturation, percentage saturation
	3d. Draw psychometric chart 3d.1 List Purposes of contact of gas with pure Liquid	3.5 Psychometric charts for Air-Water system 3.6 Purposes of contact of gas with pure Liquid
	3e. Explain construction and working with diagram	3.7 Equipments 3.7.1 Cooling towers 3.7.2 Spray chambers 3.7.3 Spray ponds
Unit – IV Drying	4a. Discuss drying equilibrium and related concepts 4a.1 Define and calculation of Moisture content, Equilibrium and free moisture, Bound and unbound moisture 4a.2 Calculate - Moisture content, Equilibrium and free moisture, Bound and unbound moisture from the given data	4.1 Drying equilibrium 4.1.1 Insoluble solids 4.1.2 Hysterisis 4.1.3 Soluble solids 4.1.4 Definitions and calculation of Moisture content, Equilibrium and free moisture, Bound and unbound moisture
	4b. Classify drying & drying equipments	4.2 Batch and continuous drying 4.3 Classification of drying equipment
	4c. Describe construction and working of Drier equipments	4.4 Construction and working of following Drier equipment • Tray drier • Tunnel drier • Vacuum drier • Rotary drier • Spray drier • Fluidized bed drier • Pneumatic drier
	4d. Describe drying rate characteristics for batch drying with sketches 4d.1 Derive equation for drying time for constant rate period and falling rate period	4.5 Drying rate curve for batch drying 4.6 Derivation of equation for drying time for constant rate period and falling rate period
	4e. Calculate drying time	4.7 Calculation of drying time

Unit – V Adsorption & Ion-Exchange	5a. Define and state uses of Adsorption	***Adsorption & Ion-Exchange:*** 5.1 Definition and industrial application of Adsorption
	5b. Classify Adsorption and adsorbents 5b.1State Commonly used adsorbents	5.2 Types of adsorption 5.3 Nature of adsorbents 5.4 Commonly used adsorbents
	5d. Analyse Adsorption Equilibria 5d.1 Describe Effect of temperature on adsorption and Heat of adsorption	5.5 Adsorption Equilibria 5.5.1 Single gases and vapours 5.5.2 Adsorption hysteresis 5.2.3 Effect of temperature on adsorption and Heat of adsorption
	5e. Apply Freudlich's equation for single stage and multi stage cross-current operation 5e.1Describe adsorption from dilute and concentrated solution	5.6 Adsorption from liquids 5.6.1 Adsorption from dilute solution 5.6.2 The Freundlich's equation 5.6.3 Adsorption from concentrated solutions 5.6.4 Material balance and Freundlich's equation for single stage and multistage cross-current operation
	5f. Describe construction and working of Higgins contactor, Pressure swing adsorber	5.7 Higgins contactor 5.8 Pressure swing adsorber
	5g. Appreciate concepts of Ion Exchange 5g.1 List Applicationv of Ion Exchange	5.9 Ion-Exchange 5.9.1 Principles 5.9.2 Application 5.9.3 Equilibria 5.9.4 Rate of ion exchange
Unit –VI Crystallisation	6a. State Industrial applications of crystallization	***Crystallisation:*** 6.1 Industrial applications of crystallization
	6b. Explain equilibria mechanism for crystallisation 6b.1 State the methods to get Super saturation	6.2 Equilibria and yields 6.3 Super saturation and methods to get it 6.4 Nucleation 6.5 Crystal growth
	6c. Explain working principle and operation of Crystallization Equipment with sketch 6c.1Describe construction of Crystallization Equipment	6.6 Crystallization Equipment 6.6.1 Vacuum crystallizer 6.6.2 Swenson walker crystallizer 6.6.3 Draft tube-baffle crystallizer
	6d. State and explain Meir's theory	6.7 Meir's theory
	6e. Calculate the crystal yield	6.8 Crystallization with and without seeding 6.9 Calculations of crystal yield
	6f. List steps to Prevent caking of crystals	6.10 Caking of crystals and it's prevention

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (Theory)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Equipment for Gas Liquid Operations	6	2	3	2	7
II	Distillation	15	5	7	7	19
III	Humidification	8	2	4	4	10
IV	Drying	10	4	4	5	13
V	Adsorption & Ion-Exchange	10	4	4	4	12
VI	Crystallization	7	3	3	3	9
Total		**56**	**20**	**25**	**25**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)
Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills ***(outcomes in psychomotor and affective domain)*** so that students are able to acquire the competencies/course outcomes. Following is the list of practical exercises for guidance.

Note*: outcomes in psychomotor domain are listed here as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical/Exercise (Outcomes in psychomotor domain)	Apprx. Hrs. Required
1	I	Demonstrate principle, construction and working of equipments for gas–liquid operations with models	4
2	I	Prepare vapour liquid equilibria curve at atmospheric pressure for Benzene-Xylene	4
3	II	Carry out simple distillation in glass assembly	4
4	II	Find out the effect of vacuum on distillation of liquid	4
5	II	Carry out continuous rectification in packed column	4
6	II	Find out amount of steam required in steam distillation	4
7	III	Find out the property of atmospheric air with the help of wet bulb and dry bulb temperature	4
8	III	Set desired conditions of humid air in humidity control cabin	4
9	IV	Prepare drying curve of moist sand and moist limestone	4
10	IV	Find out equilibrium moisture content and drying time of wet solid	
11	V	Characterize industrial adsorbents and observe their samples	4

S. No.	Unit No.	Practical/Exercise (Outcomes in psychomotor domain)	Apprx. Hrs. Required
12	V	Remove colour impurities from water using charcoal	4
13	VI	Find out the yield of crystals from saturated solution without seeding	4
14	VI	Find out the yield of crystals of from saturated solution with seeding	4
Total			**56**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

i. Visit nearby industries and observe the working of mass transfer equipments.
ii. Visit the website of reputed mass transfer equipment manufacturers and prepare a report on these equipments.
iii. Prepare chart/ Model of mass transfer equipments.
iv. Quiz, Debate

9. SPECIAL INSTRUCTIONAL STRATERGY (If Any)

i. Animated videos and drawings of equipments

10. SUGGESTED LEARNING RESOURCES

(A) List of Books:

S. No.	Title of Books	Author	Publication
1	Mass Transfer Operations	Robert E. Treybal	Mc Graw- Hill, 3rd Edition, 1981
2	Unit Operation of Chemical Engineering	McCabe, Warren L., Julian C. Smith	McGraw Hill Publication, New York 2004, 7th Edition
3	Unit Operations-II	K. A. Gavhane	Nirali Prakashan, Pune
4	Unit Operations of Chemical Engineering, Volume-I	P. Chattopadhyay	Khanna Publishers, New Delhi, 1995
5	Chemical Engineering, Volume-2	Coulsion and Richardson	Butterworth-Heinemann; 5^{th} Edition, 2002
7	Introduction to Chemical Engineering	L.Badger, Julius T. Banchero	McGraw Hill Publication, New York, 7^{th} Edition, 2004

B. List of Major Equipment/Materials

i. Distillation Assembly : 2000 ml round bottom flask, 1000 ml collection flask, joints, adapter with ¾ neck, simple/coiled glass condenser, thermometer pocket
ii. Packed column : Heating mantle - single phase 240 v AC, 15 amp, max 250 ^{0}C, 2litre Flask, Column- MS and Borosil glass, ID-58 mm, OD-62 mm, Packing-100 mm glass, 400 mm MS, 50 mm glass,12 mm dia rasching ring, Condenser- shell MS, tube Copper, Rotameter-0.5-5 LPH
iii. Steam distillation setup : Distillation kettle - MOC-MS, dia-150 mm, height 300mm; jacket dia 175 mm height, height 300 mm, pressure gauge, steam relief valve, steam feed line with valve, drain valve, steam trap on jacket outlet, 25 mm glass wool insulation with MS cladding; Condenser – MS shell, tube copper dia-150 mm,

height 250; Steam generator inner SS 304, outer MS dia 180 mm, height 270 mm; 25,5litre collecting beaker

iv. VLE apparatus : Heating mantle with 1 litre flask, dimmerstat, digital temp indicator, air and water cooled condenser, mounted on wooden and MS frame, thermocouples

v. Humidity cabin : Double walled thick gauge chamber SS 304, heater 500 W; Cooling circuit with compressor, expansion valve, condenser and refrigerant; Steam generator SS 304; Control panel with digital temperature indicator, low water level indicator, solenoid valve

vi. Tray dryer : Temp range 50-100/200, thick MS chamber, digital temp indicator and controller, Air circulation by induction motor, Tray about 80×40×3 cm

vii. Batch crystallizer : Jacket 325 mm round, 155 mm deep, 3mm thick, annulus 22.5 mm; 25 mm thick glass wool insulation, Aluminium cladding; motor-stirrer 10mm rod, speed regulator

viii. Benzene, Toluene, Xylene, Sand, Limestone, silica gel, Charcoal, boric acid, Sodium sulphate, Potassium permanganate

C List of Software/Learning Websites

i. www.unitoperation.com
ii. http://nptel.ac.in/courses/index.php?subjectId=103103035
iii. http://1rv07ch.files.wordpress.com/2010/05/lecture1-introduction2mass-transfer.pdf
iv. http://www.msubbu.in/ln/mt/
v. http://chemeng.ir/download/Mass-Transfer/Mass_Transfer_Operations_-_Robert_Treybal_chemeng.ir.pdf
vi. http://serve.me.nus.edu.sg/arun/file/teaching/ME6203_2013_Mujumdar.pdf

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. Harsh B. Shukla**, Lecturer in Chemical Engineering, Shri K.J. Polytechnic, Bharuch
- **Prof. Upasana T. Singh**, Lecturer in Chemical Engineering, Shri K.J. Polytechnic, Bharuch
- **Prof. Parul K Patel**, Lecturer in Chemical Engineering, Govt. Polytechnic, Gandhinagar
- **Prof. N. N. Hansalia**, Lecturer in Chemical Engineering, Government Polytechnic,
- Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur.** Associate Professor, Department of Applied Sciences
- **Dr. Bashirullah Shaikh,** Assistant Professor, Department of Applied Sciences

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: PETROLEUM REFINING & PETROCHEMICAL TECHNOLOGY
(COURSE CODE: 3350503)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5th semester

1. RATIONALE

The development of refining and petro-chemical industries in the country has made it compulsory for the chemical engineers to get acquainted with important aspects of petroleum refining and petrochemical technology. Every diploma chemical engineer has to invariably handle the vast consumption of petroleum products, their diversity and increasing applications. Diploma holders have to apply the relevant concepts for operating petroleum refinery or petrochemical plant in a smooth and safe manner. These may also helpful in marketing and quality check of petro products. Hence, this course has been designed to develop such competency and skills.

2. LIST OF COMPETENCY

The course should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following competency:

- **Operate petroleum refinery and petro-chemical plant**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Characterize crude petroleum and petroleum refinery
ii. Fractionate crude petroleum into useful fractions
iii. Measure important physical properties of petroleum products
iv. Apply refinery processes to maximize desired petro products
v. Use treatment techniques to purify petro products
vi. Manufacture widely used petrochemicals

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	150
4	0	2	6	70	30	20	30	

Legends: L - Lecture; **T -** Tutorial/Teacher Guided Student Activity; **P -** Practical; **C -** Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Basics of Petroleum and Refinery	1a. Describe the reserves of Crude Petroleum oil in India 1a.1State basics occurrence of Petroleum 1a.2 Classify Petroleum 1a.3Describe history of Petroleum	1.1 Occurrence and history of Petroleum 1.2 Crude Petroleum oil reserves in India 1.3 Composition of Petroleum 1.4 Classification of Petroleum
	1b. Explain basics of refineries and–products 1b.1State types of Refineries 1b.2Describe Refinery processes-Physical and Chemical changes	1.5 Refineries development in Gujarat and India 1.6 Types of Refineries 1.7 Refinery processes 1.7.1 Physical changes 1.7.2 Chemical changes 1.8 Refinery products
Unit – II Fractionation of Petroleum	2a. Describe primary treatment of crude	Primary treatment of crude : 2.1 Dehydration and Desalting of crude oil 2.2 Pipe still heater
	2b. Describe distillation of crude and crude residue	2.3 Atmospheric distillation of crude 2.4 Vacuum distillation of crude residue
	2c. Identify Physical properties of petroleum products fractions and measure- (Units of measure)	2.5 Physical properties of petroleum products and its measurements : 2.5.1 Petrol 2.5.2 Diesel 2.5.3 Kerosene 2.5.4 Lubricant oil 2.5.5 CNG and LPG 2.5.6 Grease
Unit – III Refinery Processes	3a. Compare Cracking methods 3a.1 Describe the Purpose of cracking & Effect of temperature and pressure on Cracking	3.1 Cracking 3.1.1 Purpose of cracking 3.1.2 Effect of temperature and pressure on Cracking Cracking methods 3.1.3 Thermal cracking 3.1.4 catalytic cracking 3.1.5Fluidised bed catalytic cracking
	3b.Explain need of Reforming 3b.1 Differentiate thermal and catalytic reforming 3b.2 Identify effect of important parameters on reforming 3b.3 Explain Pt catalyst-Reforming	3.2 Reforming 3.2.1 Purpose of Reforming 3.2.2 Differentiate thermal and catalytic reforming 3.2.3 Platforming(Pt catalyst-Reforming)
	3c. Explain in brief refinery processes -Hydrotreating, Hydrocracking, Delayed coking , Visbreaking	3.3 Other important refinery processes 3.3.1 Hydrotreating 3.3.2 Hydrocracking 3.3.3 Delayed coking 3.3.4 Visbreaking
Unit – IV Treatment Techniques	4a. State the purposes of sulphur removal 4a.1 Explain methods of sulphur removal - Doctor's sweetening, Catalytic desulfurization ,	4.1 Purposes and methods of sulphur removal 4.2 Doctor's sweetening 4.3 Catalytic desulfurization 4.4 MEROX treatment

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	MEROX treatment	
	4b. Explain Treatment of Kerosene by liquid SO_2 extraction	4.5 Treatment of Kerosene by liquid SO_2 extraction
	4c. Distinguish solvent extraction processes – Furtural, Phenol, Duo sol	4.6 Solvent extraction processes 4.6.1 Furtural extraction method 4.6.2 Phenol extraction method 4.6.3 Duo sol extraction process
	4d. Describe Purpose of dewaxing 4e. Compare dewaxing Techniques	4.7 Purpose of dewaxing Dewaxing Techniques 4.8 Dewaxing without solvent 4.9 Dewaxing with solvent 4.9.1 Ketone dewaxing and propane dewaxing
Unit – V Petrochemicals	5a. Describe in brief development of petrochemical industry in Gujarat and in India	5.1 Development of petrochemical industry in Gujarat and in India
	5b. Draw flow chart for manufacturing of - C1 compounds- Methanol and Formaldehyde -C2 compounds - Ethylene dichloride ,Vinyl chloride and Ethylene Oxide - C3 compounds- Polypropylene.Propylene oxide -Chemicals from aromatics- Linear Alkyl Benzene Phenol by benzene sulfonate process	5.2 Manufacturing of important C1 compounds 5.2.1 Methanol 5.2.2 Formaldehyde
		5.3 Manufacturing of important C2 compounds 5.3.1 Ethylene dichloride 5.3.2 Vinyl chloride 5.3.3 Ethylene Oxide
		5.4 Manufacturing of important C3 compounds 5.4.1 Polypropylene. 5.4.2 Propylene oxide
		5.5 Chemicals from aromatics 5.6 Manufacture of Linear Alkyl Benzene 5.7 Manufacture of Phenol by benzene sulfonate process

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Petroleum and Refinery	6	4	2	2	8
II	Fractionation of Petroleum	8	4	4	2	10
III	Refinery Processes	10	5	5	3	13
IV	Treatment Techniques	14	6	6	5	17
V	Petrochemicals	18	8	7	7	22
Total		**56**	**27**	**24**	**19**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills ***(outcomes in psychomotor and affective domain)*** so that students are able to acquire the competencies/course outcomes. Following is the list of practical exercises for guidance.

Note*: outcomes in psychomotor domain are listed here as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical/Exercise (outcomes in psychomotor domain)	Apprx. Hrs. Required
1	I	Prepare a detail chart of modern refinery	2
2	I	Prepare a detail chart of petrochemical products	2
3	II	Determine flash point by Penskey Martin method	2
4	II	Determine fire point by Penskey Martin method	2
5	II	Measure softening point and drop point of Grease	2
6	II	Measure Aniline point of lubricating oil	2
7	II	Determine penetration number of Grease	2
8	II	Determine Carbon residue by Ram's bottom method	2
9	II	Determine Carbon residue by conradson method	2
10	II	Measure smoke point of kerosene	2
11	II	Measure cloud point lubricating oil	2
12	II	Measure pour point lubricating oil	2
13	II	Measure initial & final boiling point of any petroleum product	2
14	II	Measure Viscosity of lube oil by Redwood /Saybolt/Engler viscometer	2
		Total	**28**

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

i. Course/topic based presentation
ii. Market survey of various petrochemical products of different manufacturers and their comparison based on their specification, composition and cost
iii. MCQ/Quiz

9. SPECIAL INSTRCTIONAL STRATEGY (IF ANY)

i. Lecture and demonstration of Animated videos of refinery and petrochemical plant
ii. Arrange an industrial visit to nearby petrochemical indusrty
iii. Mini project

10 SUGGESTED LEARNING RESOURCES

A. List of Books:

Sr. No.	Title of Books	Author	Publication
1	Modern Petroleum Refining Processes	B. K.Bhaskar Rao	Oxford and IBH, 2007
2	Outlines of chemical Technology	M. Gopala Rao, Marshall Sittig	3rd Edition East-West press pvt. Ltd, Delhi
3	Shreve's Chemical Process Industries	Austin G.T.	McGraw Hill publication – New Delhi, 5th edition
4	A Text on Petrochemicals	B.K.Bhaskar Rao	2nd Edition, Khanna Publishers, Delhi, 1998
5	Petroleum Refinery Engineering	W.L.Nelson	McGraw Hill, Newyork, 1958

B. List of Major Equipment/Materials (With major specifications):

i. Penskey Martin Apparatus: Electrical heating with gas test jet and electric heater with energy regulator. Assembly is resting in air bath which is covered with dome shape metal top. The cup is fitted with insulated handle and locking arrangement. The round shaped heater with different temperature regulation system suitable for operation on 220 Volts AC mains.
ii. Cleaveland Flash and Fire Point Apparatus: The apparatus consists of a cup, heating plate, thermometer clip and test flame attachment with swivel joint for passing over liquids.
iii. Softening point and drop point Apparatus: Ring and Ball Apparatus with electric motorised stirrer and electric heater,concealed hot plate with temperature regulator.
iv. Drop Point Apparatus - hand operated stirrer, consists of brass sleeve and case with metal cup and a glass boiling tube with cork fitted to a bath (Beaker) is provided .
v. Penetrometer : A rack, pinion and pointer assembly, dial is graduated from 0-400 in on tenth millimeter sub division. Two samples containers made of Aluminium, round dial fitted on a Aluminium painted stand having adjustable penetration needle, holder sample container and transfer dish.
vi. Ram's bottom Apparatus: It consists of a solid metal bath having 6 walls to accommodate cocking bulbs with heating elements around the bath, the temperature may be controlled by a Pyrometer depending upon the type supplied, 6 cocking bulbs are supplied with apparatus.
vii. Conradson Apparatus: The Apparatus consists of Spun Sheet Iron Crucible 25cc capacity, sheet iron hood and sheet iron block on a stand with triangular wire bridge.

viii. Cloud and pour point Apparatus: It consists of a main cooling bath made of stainless steel sheet and stand unit with drain plug and cover with provision for fitting thermometer and a filling aperture for adding freezing mixture. A glass jar for containing oils, jacket, disc and gasket.

ix. Distillation Apparatus: The instrument consists of metal shield fitted with asbestos board to support distillation flask with height adjustable device. It has slide for vapour tube and lining having glass window for clear view of inside objects. The condenser bath is provided with Mild Steel black painted stand. Electrically operated on 220 volts AC mains.

x. Red wood viscometer: Made of stainless steel bath big enough to accommodate 3 cups Redwood No.I and 2 cups of Redwood No.II. Oil cups fitted with Precision jets of Stainless Steel. Temperature is controlled by energy regulator.

xi. Saybolt Viscometer: Stainless Steel bath with oil cup which is centrally placed in a water bath. The bath has a lid which contains a Water Cooling Tube, Two handle with Two Stirrer Blades, Thermometer socket, Straight heater, Stirring is done by turntable arrangement.

xii. Engler Viscometer: It consists of Stainless steel water bath having oil cup with double walled lid. The water bath with stirring device mounted on stand. A thermometer clip to the water bath and the oil cup lid has a thermometer socket. The bath is fitted with 500 watts heater. It is supplied with wooden or ebonite valve to fit jet. It can operate on 220 Volts AC mains.

xiii. Materials**:** Petrol, Diesel, Kerosene, Lube oil, Grease, Aniline

C List of Software/Learning Websites

i. www.personal.psu.edu/jun3/blogs/assignments/Oil%20Refinery.pdf
ii. http://nptel.ac.in/courses/103103029/pdf/mod2.pdf
iii. www.processengr.com/ppt_presentations/oil_refinery_processes.pdf
iv. http://www.exxonmobil.com/Europe-English/Files/Simple_Guide_to_oil_refining.pdf
v. http://www.kau.edu.sa/Files/0001216/files/4354_Important%20Petrochemical%20Processes.pdf
vi. http://www.kau.edu.sa/Files/0053956/Subjects/Chapter%201%20petro.pdf
vii. http://e-lib.dede.go.th/mm-data/Bib11162.pdf
viii. http://chemicalsbestpractices.sap.com/Files/2_SAP_In_The_Chemical_Industry/
ix. 2_2_Chemical_Subindustries/SAP_Petrochemicals_Overview.pdf
x. http://nptel.ac.in/courses/103103029/pdf/mod3.pdf

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. D. H. Joshi,** I/C H. O. D. in Chemical Engineering, Government Polytechnic, Valsad
- **Prof. P. D. Chaudhary,** Lecturer in Chemical Engineering, Government Polytechnic, Valsad
- **Prof. N. N. Hansalia,** Lecturer in Chemical Engineering, Government Polytechnic, Rajkot
- **Prof. Mrs K. J. Sareriya,** Lecturer in Chemical Engineering, Government Polytechnic, Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. Dr. Abhilash Thakur.** Associate Professor, Department of Applied Sciences
- **Prof. Dr. Bashirullah Shaikh,** Assistant Professor, Department of Applied Sciences

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: UTILITIES AND INSTRUMENTATION IN CHEMICAL PLANT
(COURSE CODE: 3350504)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5th Semester

1. RATIONALE

Diploma chemical engineer has to ensure smooth and proper operation of utilities and auxiliaries' plants such as steam, compressed air, instrumental air, inert gases, DM water and chilled water. These utilities are essential for manufacturing different chemical products. Use of measuring devices for the measurement of parameters like temperature, pressure, flow, level, viscosity, specific gravity, humidity are necessary for controlling chemical plant for producing materials of desired quality and to maintain plant safety. Hence the course has been design to develop these competencies and its associated cognitive, practical and effective domain learning out comes.

2. COMPETENCY

The course should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following competency:

- **Operate different utility plants and various types of instruments**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Use various methods for water softening and purification
ii. Operate different types of steam generators
iii. Operate compressors, blowers for handling air and inert gases
iv. Use Refrigeration for Various applications
v. Measure temperature, pressure, flow, level and viscosity
vi. Operate various control valves and control systems

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	200
4	0	4	8	70	30	40	60	

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I **Water as Basic Utility**	1a. Explain role of Utilities in Chemical Plant 1a.1 List various utilities in chemical plant & uses	1.1 List and use of various utilities in chemical plant
	1b. List sources of Water	1.2 Sources of water
	1c. Differentiate types of Water	Types of Water 1.3 Hard & Soft water 1.4 Boiler Feed water and demineralized water
	1d. Compare Softening processes of water	1.5 Methods of water softening processes • Lime soda process (Hot & Cold) • Zeolite process • Ion exchange process • Phosphate process
	1e. Explain the process of Purification of water from raw water with sketches.	1.6 Purification of water • Screening • Sedimentation • Coagulation • Filtration • Sterilization
Unit – II **Steam, Air & Inert Gases**	2a. Explain uses of utilities - Steam, Air & Inert Gases	Utilities : 2.1 Use of Steam, Air & Inert Gases as utilities
	2b. Define properties of steam	2.2 Properties of steam • Enthalpy • Wet steam • Saturated Steam • Superheated steam • Specific volume of steam
	2c. Label the different part of steam generator 2d. Classify steam generator 2e. Select steam generator 2f. compare steam generators 2g. List the Factors affecting selection of Boiler	2.3 Steam Generator : Classification , comparison , components 2.4 Factors affecting selection of Boiler
	2f. Describe construction and Working of Locomotive Fire tube boiler ,Lancashire boiler	2.6 Construction and working of (a) Locomotive Fire tube boiler (b) Lancashire boiler
	2g. Discuss utility air	2.7 Utility air • Compressed Air • Blower Air • Fan Air • Instrumental air
	2h. Describe the working principle, application ofAir compressors – (a) Reciprocating Air compressors (b) Multistage compressors (c) Rotary compressors	2.11 Types of Air compressors • Reciprocating Air compressors • Multistage compressors • Rotary compressors

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	2i. Describe properties of Inert gases	2.12 Inert gas - Nitrogen, Argon
Unit – III **Refrigeration**	3a. Explain the working principle of refrigeration	3.1 Concept of refrigeration
	3b. Distinguish methods of Refrigeration	3.2 Methods of Refrigeration • Ice Refrigeration • Evaporative Refrigeration • Vapor Refrigeration System
	3c. Describe COP and TOR of refrigeration	3.3 COP and TOR of refrigeration
	3d. Use primary and secondary Refrigerants	3.4 Types of Primary Refrigerants • Ammonia • Halo Carbons (Freon of Different type) • HFC (Hydro Fluorocarbon) 3.5 Types of secondary Refrigerants • Water • Brine 3.6 Selection of Refrigerants
Unit – IV **Basics of Instrumentation**	4a. Classify instruments in chemical plant	4.1 Importance of instrumentation in chemical plant 4.2 Classification of instruments
	4b. Describe Basic elements of instruments	4.3 Basic elements of instruments
	4c. Compare Static and Dynamic Characteristics of instruments	4.4 Static and Dynamic Characteristics of instruments
	4d. Differentiate First and second order system	4.5 First order system and second order system
Unit- V **Measuring Devices**	5a. Explain Temperature scale	5.1 Different Temperature scale
	5b. Compare thermometers 5b.1Explain Principle, Construction & Working of : Mercury in glass, Bi-metallic , pressure spring , resistance thermometers	5.2 Definition of thermometer 5.3 Principle, Construction & Working of : Mercury in glass thermometer, Bi-metallic thermometer, pressure spring thermometer, resistance thermometer,
	5c. Describe Principles of thermoelectricity and See-back effect, Peltier effect and Thomson effect	5.4 Principles of thermoelectricity 5.5 See-back effect, Peltier effect and Thomson effect
	5d. Describe principle, construction, working range, lead wires of thermocouple and Thermowells	5.6 Industrial thermocouple: their principle, construction, working range, lead wires 5.7 Thermowells in details
	5e. Explain principle, construction, and working of Radiation and optical Pyrometers	5.8 Radiation and optical Pyrometers
	5f. Differentiate pressure gauges	**1.** Pressure gauges - diaphragm, Bourdon tube gauge, Dead weight Gauge, Strain gauge
	5g. Describe principle,	5.10 Target meter, Vortex Shredding meter,

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	construction, and working of Target meter, Vortex Shredding meter, Turbine meter	Turbine meter
	5h. Classify and explain level measuring devices	5.11 Classify: Liquid level measuring devices 5.12 Direct level measuring devices • Probe and tape • Sight glass • Floats 5.13 Indirect level measuring devices. • Air trap box method • Diaphragm box method • Bellow system • Differential pressure manometer
	5i. Compare viscosity measurement methods	5.14 Viscosity measurement by • Capillary tube method • Rotating cylinder method • Torsion viscometer
	5j. Explain principle, construction, and working	5.15 measurement of • Specific gravity by hydrometer • Humidity by hygrometer • pH by pH meter
Unit – VI **Control Valves, Control Loops & Control System**	6a. Explain Function of relays and interlocks	6.1 Function of relays and interlocks
	6b. Explain schematic control loops for -Temperature control -Pressure control - Flow control - Level control	6.2 Control loops • Temperature control • Pressure control • Flow control • Level control
	6c. Describe process control modes with sketches	6.6 Process control modes : P , P+I , P+I+D, ON -OFF
	6d. Explain uses of PLC and DCS System	6.7 PLC and DCS system

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Water as Basic Utility	7	3	3	3	9
II	Steam, Air & Inert Gases	14	6	6	6	18
III	Refrigeration	7	3	3	3	9
IV	Basics of Instrumentation	4	2	2	1	5
V	Measuring Devices	18	7	8	7	22
VI	Control Valves, Control Loops & Control System	6	2	2	3	7
Total		**56**	**23**	**24**	**23**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as only general guideline for students and teachers. The actual distribution of marks in the question paper may vary from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills ***(outcomes in psychomotor and affective domain)*** so that students are able to acquire the competencies/course outcomes. Following is the list of practical exercises for guidance.

Note*: outcomes in psychomotor domain are listed here as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

Sr. No.	**Unit No.**	**Practical/Exercise** (Major outcomes in psychomotor domain)	**Apprx. Hrs. Required**
1	**I**	Operate water treatment in water treatment plant	**4**
2	**I**	Treat water using lime soda process	**4**
3	**II**	Generate steam in laboratory using baby boiler	**4**
4	**II**	Operate and test the working of air compressor	**4**
5	**III**	Demonstrate different refrigeration cycles	**4**
6	**V**	Measure Temperature by thermometer and thermocouple	**4**
7	**V**	Measure Temperature by Bi-metallic thermometer	**4**
8	**V**	Measure Pressure by mechanical pressure gauge	**4**
9	**V**	Measure gas flow rate	**4**
10	**V**	Measure level using direct method	**4**
11	**V**	Measure viscosity by capillary tube method	**4**
12	**V**	Measure specific gravity by Hydrometer	**4**
13	**V**	Measure humidity by Hair hygrometer	**4**
14	**V**	Measure pH by pH meter	**4**
15	**VI**	Prepare a chart of components of DCS system	**4**
16	**VI**	Demonstrate working of control valves and actuators using chart	**4**
	Total (perform any practical for total 56 hours so that most units are covered)		**64**

8. SUGGESTED LEARNING RESOURCES

(A) List of Books:

S. No.	Title of Books	Author	Publication
1	Industrial instrumentation,	Donald P. Eckman.	JohnWilley and Sons, New York, 2004
2	Industrial Instrumentation & Control	S. K. Singh	3rd edition Tata-McGrawHil, 1987
3	Process Instrumentation and Control	A P Kulkarni	15th Edition, April 2011, Nirali Prakashan, Pune
4	Unit operation of chemical Engineering.	McCabe, Warren L., Julian C. Smith	McGraw Hill Publication, New York 2004, 7th Edition
5	Plant utilities	D. B. Dhone	2nd Edition, 2012 Nirali Prakashan, Pune
6	Process System Analysis & Control	Donald R. Coughnour.	2nd edition, 1991, McGraw Hill Publication, Newyork

B. List of Major Equipment/Materials

i. Bi metallic thermometer – Metal Brass/Invar, Range – 40 ^{o} F 800 ^{o} F, 1 % span

ii. Thermo Couple – Thermocouple Wire: Pt/Rh or Fe/Constantan or Copper/Constantan, Range – Suitable to Material used, Lead Wire- Copper/Constantan, with suitable sheathing, with milivoltmeter, 1.5% accuracy

iii. Burdon Pressure Gauge – Arc Length – 270^{o}, Brass or Bronze or Copper or SS, Range 0-14 Kg/cm^{2}

iv. Gas Flow measurement Assembly

v. Level Measurement Assembly

vi. Capillary tube viscometer – Oswald viscometer

vii. Hair hygrometer

viii. Hydrometer

ix. Digital pH meter - Range 1-14 pH

C List of Software/Learning Websites

i. http://nptel.ac.in/courses/103103037/

ii. http://www.silbert.org/MSA_WT_Manual.pdf

iii. http://ppuchem.blogspot.in/2013/02/unit-1-notes.html

iv. http://www.tecmaservice.it/pdf/wika_%20brochure_chimica.pdf

v. http://www.npti.in/Download/Thermal/BoP/13%20Sulakshana%20Sule.pdf

vi. http://www.isu.edu/estec/ic-ed-modules/Module-10-Flow-Measurement.pdf

vii. http://www.betterbricks.com/sites/default/files/operations/om_of_boilers_final.pdf

viii. http://solve.nitk.ac.in/dmdocuments/electrical/DCS_write_up.pdf

ix. https://www.idc-online.com/technical_references/pdfs/instrumentation/

   a. Industrial_Instrumentation%20-%20Flow.pdf

9. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

i. Course/topic based presentation
ii. Explore internet and visit websites of different chemical industries/supplier of plants and prepare reports on latest trends in utilities.
iii. MCQ/Quiz

10. SPECIAL INSTRCTIONAL STRATEGY (If Any)

i. Show animated and real videos/pictures of different plants
ii. Demonstrate different measuring instruments/sensors in class.
iii. Industrial visit of plant consisting water treatment plant and Boilers, Refrigeration and Control system
iv. Arrange lectures of persons from industry.

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Ms. Yamini S. Patel,** Lecturer in Chemical Engineering, Government Polytechnic, Gandhinagar
- **Mr. M. R. Acharya,** Lecturer in Chemical Engineering, Government Polytechnic, Gandhinagar
- **Prof. N. N. Hansalia,** Lecture in Chemical Engineering ,Government Polytechnic, Rajkot

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur.** Associate Professor, Department of Applied Sciences
- **Dr. Bashirullah Shaikh,** Assistant Professor, Department of Applied Sciences

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM

COURSE TITLE: CHEMICAL ENGINEERING THERMODYNAMICS (COURSE CODE: 3350505)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	5th Semester

1. RATIONALE

Diploma Chemical engineer has to deal with the laws of thermodynamics which are applied to flow and non-flow processes in the plant to evaluate heat effects and energy transformation calculation accompanying physical and chemical changes, for calculating temperature change and to determine power generation efficiencies of engines and power plants. Understanding of basic concepts and application of thermodynamics are therefore necessary for chemical engineers. Hence the course has been design to develop these competencies and its associated cognitive, practical and effective domain learning out comes.

2. LIST OF COMPETENCY

The course should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following competency:

- **Solve the problems related to heat and work requirements for physical and chemical changes.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

i. Distinguish systems, functions, properties and processes
ii. Explain various laws of Thermodynamics
iii. Implement the first law of thermodynamics for non-flow & flow process.
iv. Access the PVT behaviour of the fluids.
v. Calculate the effects of heat changes during chemical reaction.
vi. Apply the concepts of second law of thermodynamics.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	100
3	2	0	5	70	30	00	00	

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Introduction and Basic Concept	1a. Describe scope of thermodynamics 1.1 Define System, functions, properties Process and surrounding 1b. Explain the System, functions, properties , Process and surrounding with examples of chemical engineering field 1c. Differentiate systems, functions, properties and processes 1d. Describe Extensive and intensive properties 1e. Explain importance of Force, Pressure, Work and Energy physical quantities, phase rule and zeroth law of thermodynamics 1f. Solve simple problems on -Force, Pressure, Work and Energy physical quantities, phase rule and laws of thermodynamics	1.1 Scope and limitations of thermodynamics 1.2 System, functions, properties Process and surrounding 1.2.1 System-Homogeneous and heterogeneous, Closed and open, State of System 1.2.2 Properties -Extensive and intensive 1.2.3 Function -State and Path function 1.2.4 Process -Reversible and irreversible process 1.3 Force, Pressure, Work and Energy 1.4 Steady state, Equilibrium state and Phase rule 1.5 Temperature and zeroth law of thermodynamics 1.6 Ideal gas temperature scale 1.7 Simple examples (numerical)on Force, Pressure, Work and Energy physical quantities, phase rule and laws of thermodynamics
Unit – II First Law of Thermodynamics	2a. Explain first law and energy - Internal Energy, Enthalpy and Heat capacity concepts with examples of chemical engineering 2b. Apply first law for non-flow & flow process of chemical engineering 2c. Solve simple problems on first law and energy - Internal Energy, Enthalpy and Heat capacity	2.1 First law of thermodynamics 2.2 Internal Energy, Enthalpy and Heat capacity 2.3 First law for non-flow processes and flow processes of chemical engineering 2.4 Simple numerical on first law and energy - Internal Energy, Enthalpy and Heat capacity
Unit – III PVT Behavior	3a. Explain PVT behaviour of pure fluids 3b. Distinguish Ideal gas Processes 3c. Compare equations of state for real gases 3d. Solve simple problems on Ideal gas Processes, Equation of state for real gases,	3.1 PVT behavior of pure fluids 3.2 Ideal gas and equation of state 3.3 Ideal gas Process : 3.3.1 Constant Volume process 3.3.2 Constant Pressure process 3.3.3 Constant Temperature process 3.3.4 Adiabatic Process 3.3.5 Polytropic Process 3.4 Equation of state for real gases 3.4.1 Vander Waals Equation 3.4.2 Virial Equation 3.4.3 Compressibility charts 3.5 Simple examples(numerical)

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – IV Heat Effects	4a. Explain the heat effects of chemical reactions 4b. Apply Hess's law of constant heat summation 4c. Calculate heat of reaction and temperature of reaction 4d. Solve simple problems on heat Effects in chemical reactions	4.1 Heat effects accompanying chemical reactions: 4.1.1 The standard heat of reaction 4.1.2 The standard heat of combustion 4.1.3 The standard heat of formation 4.2 Hess's Law of constant heat summation 4.3 Effects of temperature on heat of reaction 4.4 Temperature of reaction 4.5 Simple numerical
Unit – V Second Law of Thermodynamics	5a. Discuss limitation of first law 5b. Compare different statements of Second law 5c. Describe the concepts of Heat reservoir, Heat engine and Heat pump 5d. Explain entropy 5e.Explain carnot cycle and thermodynamic temperature scale 5f. Calculate entropy changes 5g. Explain the concept of entropy and irreversibility 5h. Solve simple problems on Second law	5.1 Limitations of first law 5.2 Statements of Second law 5.3 Heat reservoir, Heat engine and Heat pump 5.4 Concept of Entropy 5.5 Carnot cycle and thermodynamic temperature scale 5.6 Calculation of Entropy change during 5.6.1 Phase change 5.6.2 Ideal gas processes 5.6.3 Adiabatic mixing 5.6.4 Isothermal mixing 5.6.5 Chemical reaction 5.7 Clausius Inequality 5.8 Mathematical statement of Second law 5.9 Entropy and Irreversibility 5.10 Simple numerical

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (Theory)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Mark
I	Introduction and Basic Concept	07	3	4	5	12
II	First Law of Thermodynamics	06	3	3	4	10
III	PVT behavior	09	5	5	5	15
IV	Heat Effects	07	4	4	4	12
V	Second Law of Thermodynamics	13	7	7	7	21
Total		**42**	**22**	**23**	**25**	**70**

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills ***(outcomes in psychomotor and affective domain)*** so that students are able to acquire the competencies/course outcomes. Following is the list of practical exercises for guidance.

Note*: outcomes in psychomotor domain are listed here as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

----------NIL----------

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

i. Course/topic based presentation
ii. MCQ/Quiz

9. SPECIAL INSTRCTIONAL STRATEGY (IF ANY)

Give as many simple numerical problems to students as possible in class itself and help them to solve if they get stuck.

10. SUGGESTED LEARNING RESOURCES

A. List of Books:

Sr. No.	Title of Books	Author	Publication
1	Chemical Engineering Thermodynamics	K. V. Narayanan	PHI publishers
2	Introduction to Chemical Engineering Thermodynamics	J. M. Smith H.C. Vanness M. M. Abott	Tata McGraw Hill
3	Thermodynamics	C.P.Arora	Tata McGraw Hill
4	Chemical Engineering Thermodynamics	Y. V. C. Rao	Universities Press
5	Chemical Process Principles Vol.2	A.Hougen K.M.Watson R.A.Ragatz	Asia Publications
6	Textbook of Engineering Thermodynamics	R. K. Rajput	Laxmi Publication
7	Chemical Engineering Thermodynamics	R. B . Varia	Atul Prakashan
8	Applied Thermodynamics	P. B. Joshi	Nirali Prakashan

B. List of Major Equipment/Materials

----------**Nil** ----------Theoretical Approach)

C. List of Software/Learning Websites

i. www.unitoperation.com
ii. www.nptel.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. Manish R. Nasit,** Lecturer in Chemical Engineering, N. G. Patel Polytechnic, Isroli - Ahwa.
- **Prof. Mukesh B. Dhangar,** Lecturer in Chemical Engineering, N. G. Patel Polytechnic, Isroli-Ahwa.
- **Prof. R. P. Hadiya,** Lecturer in Chemical Engineering, Government Polytechnic, Rajkot.

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. Abhilash Thakur.** Associate Professor, Department of Applied Sciences
- **Prof. Bashirullah Shaikh,** Assistant Professor, Department of Applied Sciences

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: FERTILIZER TECHNOLOGY
(COURSE CODE: 3360501)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	Sixth

1. RATIONALE

Indian economy is dominated by agriculture sector. Synthetic fertilizers are must for producing good crops. Hence it is needed to provide comprehensive and balanced understanding of essential link between chemistry and the synthetic fertilizer industry. It is therefore vital for chemical engineers to understand for each fertilizer product, its flow diagram for Industry production. For this purpose chemical engineers should have skills for arranging treatment, reaction and separation steps in a flow diagram for variety of fertilizers including Nitrogenous fertilizers, Phosphatic fertilizer, Potash Fertilizer, Complex fertilizer and Bio fertilizers is essential. Hence this course is designed to achieve this objective.

2. COMPETENCY

The course content should be taught and curriculum should be implemented with the aim to develop required skills in the students so that they are able to acquire the following competencies:

- **Supervise the different stages in fertiliser production.**

3. COURSE OUTCOMES (COs)

The theory should be taught and practicals should be carried out in such a manner that students are able to acquire different learning outcomes in cognitive, psychomotor and affective domain:

i. Use reactions and unit operations steps in manufacturing of various fertilizers
ii. Characterize fertilizers on the basis of different properties.
iii. Identify engineering problems in fertilizer manufacturing.
iv. Handle the fertilizers.
v. Select appropriate synthesis fertilizer.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**ESE**	**PA**	**ESE**	**PA**	**150**
4	0	2	06	70	30	20	30	

Legends: L – Lecture, **T** -Tutorial/Teacher Guided Student Activity, **P –** Practical, **C –** Credit, **ESE** - End Semester Examination, **PA** -Progressive Assessment

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
Unit – I Overview of Fertilizers	1a. Justify the need for synthetic fertilizer 1b. Categorize fertilizers 1c. Explain role of essential elements for plant growth	1.1 Synthetic fertilizers, Classification of fertilizers 1.2 Role of essential Elements in plant Growth, 1.3 Macro elements and Micro elements
	1d. Select the relevant fertilizers for the different types of crops	1.4 Application of fertilizers considering Nutrient 1.5 Balance and types of crop
Unit – II Nitrogeneous Fertilizers	2a. Describe different properties of Ammonia 2b. Prepare synthesis path for manufacturing synthesis gas 2c. Differentiate various Ammonia converter 2d. Differentiate various Ammonia manufacturing process 2e. Describe the engineering problems of ammonia manufacturing	2.1 Ammonia: Physical, chemical properties and applications 2.2 Synthesis gas by Catalytic partial oxidation Steam Hydrocarbon reforming 2.3 Ammonia converters: Single bed and multi-bed converter 2.4 Manufacturing of ammonia by Linde Ammonia concept process 2.5 M. W. Kellogg process and Haldor Topsoe process 2.6 Storage and Transportation of Ammonia
	2f. Describe various properties of Nitric Acid 2g. Estimate concentration of Nitric acid 2h. Describe the problems in manufacturing of Nitric Acid	2.7 Nitric acid: Chemical, physical properties and applications 2.8 Manufacturing of Nitric Acid by Pressure ammonia oxidation process and Intermediate pressure ammonia oxidation process 2.9 Concentration of Nitric acid by $Mg(NO_3)2$
	2i. Describe various properties of Urea 2j. Describe the major engineering problems of Urea Manufacturing	2.10 Urea : Physical, chemical properties 2.11 Manufacturing of Urea by Stamicarbon's CO_2 stripping process, Montecatini Solution recycle process Toyo-Koatsu total recycle process
	2k. Describe the manufacturing process of Ammonium Nitrate	2.12 Manufacturing of Ammonium nitrate by Prilling process, Ammonium sulphate from Ammonium carbonate and gypsum Ammonium chloride from Ammonium sulphate and sodium chloride

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
Unit –III Phosphatic Fertilizer	3a. Describe various physical and chemical properties Phosphorus and Phosphoric acid 3b. Describe the manufacturing process of Phosphorus by Electric furnace method 3c. Describe the manufacturing process of phosphoric acid by Wet Process 3d. Describe the manufacturing Strong Sulphuric Acid Leaching Hydrochloric Acid Leaching Electric Furnace Process	3.1 Physical, chemical properties and applications of Phosphorus and Phosphoric acid 3.2 Manufacturing of elemental phosphorous by Electric furnace method 3.3 Manufacturing phosphoric acid by Wet Process 3.4 Strong Sulphuric Acid Leaching Hydrochloric Acid Leaching Electric Furnace Process
Unit –IV Potassic Fertilizers	4a. Describe physical and chemical properties 4b. Explain manufacturing of Potassium Chloride from sylvinite 4c. Describe the of Preparation of Potassium nitrate, Potassium sulphate	4.1 Physical, chemical properties and uses of Potassium Chloride, Potassium nitrate, Potassium sulphate 4.2 Manufacturing of potassium chloride from sylvinite 4.3 Preparation of Potassium nitrate, Potassium sulphate
Unit –V Complex Fertilizer and Bio Fertilizer	5a. Explain the manufacturing of complex fertilizers with sketches 6a. Justify the need for biofertilizers and its benefits 6b. Describe the Nitrogen fixing and Phosphate solubilising biofertilizers 6c. Explain preparation a biofertilizers	5.1 Manufacturing of NPK, Ammonium Sulphate Phosphate (ASP), Calcium Ammonium Nitrate(CAN) 6.1 Types of Biofertilizers 6.2 Biofertilizers Nitrogen-fixing biofertilizers Phosphate-solubilizing biofertilizers 6.3 Preparation of a biofertilizers

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (Theory)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total
1	Overview of Fertilizers	06	02	04	02	08
2	Nitrogeneous Fertilizers	22	06	09	06	21
3	Phosphatic Fertilizers	10	03	06	03	12
4	Potassic Fertilizers	06	03	05	03	11
5	Complex Fertilizers and Bio Fertilizers	12	06	06	06	18
	TOTAL	56	20	30	20	70

Legends: R = Remember**, U** = Understand**, A=** Apply and above Level (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED PRACTICAL / EXERCISES

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

***Note**: Here only outcomes mainly in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes (**as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical/Exercise (Outcomes in Psychomotor Domain)	Approx. Hours Required
1	I	Prepare chart for fertilizer classification with chemical formula and nutrient content	02
2	I	Estimate nutrient content (% N, %P_2O, % K_2O) in different fertilizers from their chemical formula	02
3	II	Estimate percentage of Nitrogen in Ammonium chloride by substitution method	02
4	II	Estimate percentage of Nitrogen in Ammonium sulfate by substitution method	02
5	II	Estimate percentage of Nitrogen in Ammonium chloride by back titration	02
6	II	Estimate percentage of Nitrogen in Ammonium sulphate by back titration	02
7	II	Analysis of Urea by Formaldehyde method	02
8	II	Estimate percentage of Nitrogen in Ammonium Chloride/Sulphate by Kjeldhal's method	02
9	II	Estimate biuret content in Urea sample by colour comparison	02
10	III	Estimate percentage of Nitrogen in DAP by Formaldehyde method	02
11	III	Estimate percentage of Nitrogen in DAP by Kjeldhal's method	02
12	IV	Prepare potassium sulphate	02
13	IV	Prepare potasium chloride	02
14	V	Estimate ratio from Ammonia to Phosphoric acid in DAP	02
15	V	Prepare potassium nitrate	02

S. No.	Unit No.	Practical/Exercise (Outcomes in Psychomotor Domain)	Approx. Hours Required
16	VI	Prepare bio-fertilizer	02
	Total		**32**

8. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual or group-based.

i. Prepare course/topic based presentations using internet
ii. Make a report on fertiliser plants in India/Gujarat with their capacity of production and technology being used.
iii. Participate in MCQ/Quiz.

9. SPECIAL INSTRUCTIONAL STRATEGY (IF ANY)

i. Show video/animation films about fertilizer production plants.
ii. Arrange Visit to nearby fertilizer production plant
iii. Arrange expert lectures
iv. Arrange MCQ/Quiz arrange in normal term period.

10. SUGGESTED LEARNING RESOURCES

A) Books

S. No.	Title of Book	Author	Publication
1	Dryden's Outlines of Chemical Technology,	M. Gopala Rao Sitting Marshall	Affiliated East West Press (Pvt) Ltd, 3rd Ed., New Delhi
2	Shreve's Chemical Process Industries, 5th edition	Austin G.T.	McGraw Hill publication, New Delhi
3	Chemical Technology -Vol. I and II, 2nd edition	Pandey G.N. and Shukla	Vani Books Company - Hyderabad
4	Biofertilizers in Agriculture, 2nd edition	N. S. Subba Rao	Oxford & IBH Publishing Company, New Delhi 1988

B) Major Equipment / Instrument with Broad Specifications

i. Glassware: Conical flask, burette, pipette, RBF, measuring cylinder, beaker
ii. Glass Assembly: RBF, reaction vessel, condenser, separating vessel
iii. Burner
iv. Weight balance (minimum 0.1gm)
v. Heating and cooling bath
vi. Kjeldhal Assembly

C) Software/Learning Websites

i. http://nptel.ac.in/courses/103107086/4
ii. http://ijset.com/ijset/publication/v1s6/285-291%20IJSET_PK%20JAGA.pdf
iii. www.gses.com/images/pressreleases/Manufacturing-Process-Fertilizer.pdf
iv. http://nzic.org.nz/ChemProcesses/production/1A.pdf
v. http://tnau.ac.in/eagri/eagri50/SSAC222/lec12.pdf
vi. www.fnca.mext.go.jp/bf/bfm/pdf/Biofertilizer_Manual.pdf

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. N. N. Hansalia**, Lecturer in Chemical Engineering, Government Polytechnic, Rajkot
- **Prof. R. P. Hadiya,** Lecturer in Chemical Engineering, Government Polytechnic, Rajkot
- **Prof.Rakesh R Vasava,** Lecturer in Chemical Engineering, Shri K. J. Polytechnic, Bharuch
- **Prof. M. R. Aacharya**, Lecturer in Chemical Engineering, Government Polytechnic, Gandhinagar

Coordinator andFaculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur**. Associate Professor, Department of Applied Sciences
- **Dr. Joshua Earnest**, Professor, Department of Electrical & Electronics Engineering.

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: CHEMICAL ENGINEERING PLANT ECONOMICS
(COURSE CODE: 3360502)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	Sixth

1. RATIONALE

A plant-design project moves to completion through a series of stages starting from preliminary evaluation of economics and market to commercial production. Chemical engineering design of a new chemical plant and the expansion or revision of existing one require the use of engineering principles and theories combined with consideration of practical limits imposed by industrial conditions. In this course special emphasis is given on the applied economics and engineering principles involved in the design of chemical plants. Use of these principles is highly required for any successful chemical engineer to work in the area of production, administration, sales, marketing, research, and development of a new chemical project.

2. COMPETENCY

The course content should be taught and curriculum should be implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Design chemical engineering plants considering principles of economics.**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes:

i. Explain basic concepts of process and plant design
ii. Select appropriate piping and equipment
iii. Select appropriate plant location
iv. Prepare general layout (outline diagram) of proposed plant
v. Evaluate economics of a chemical project
vi. Optimise conditions with one and two variables

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**ESE**	**PA**	**ESE**	**PA**	**100**
4	4	0	8	70	30	00	00	

Legends: L - Lecture; **T -** Tutorial/Teacher Guided Student Activity; **P -** Practical; **C -** Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
Unit – I Basics of Process and Plant Design	1a. Describe role of Chemical Engineer 1b. Justify the need of plant design 1c. Explain components of chemical Engineering Design 1d. Describe criteria for good designs 1e. Explain Process design and its components 1f. Describe plant design factors	1.1 Plant designs: Chemical Engineering Designs,Process Design, Equipment Design, Building Design 1.2 Criteria for good design: Process design Technical factors, Economic factors Legal phases, Selection of a process 1.3 Continuous v/s Batch processing Shift and Operating schedules Types of flow diagrams
	1g. Describe process evolution stages	1.4 Process evolution stages and their importance, Logical evolution stages 1.5 Checklist for pilot plant investigation.
Unit – II Selection of Process Equipment and Piping	2a. Plan for selection of equipment 2b. Differentiate Standard and special equipment 2c. Prepare specification sheet for equipments 2d. Select appropriate equipments	2.1 Selection of process equipment 2.2 Standard v/s Special equipment 2.3 Specification sheet for equipment 2.4 Selection of equipments: Size reduction equipment, Heat transfer equipment, 2.5 Mass transfer equipment, Material handling equipment, Pumps
	2e. Explain piping, layout and insulation 2f. Classify different insulation.	2.6 Piping, Pipe strength and wall thickness 2.7 Piping design problems, Piping layout rules, Ferrous and non-ferrous pipe, Non-metallic Piping and tubing, 2.8 Types of insulation, Factors governing selection of insulation.
Unit – III Plant Layout and Location	3a. Describe principles of plant layout 3b. Compare methods of plant layout 3c. Explain factors affecting plant location	3.1 Principles of plant layout 3.2 Methods of plant layout: Unit area Concept, Two-dimensional layout 3.3 Scale models 3.4 Factors for selection of plant location: Primary factors and specific factors
Unit – IV Economic Evaluation of Projects	4a. Evaluate total capital investment 4b. Estimate equipment cost solve the numerical based on cost indices 4c. Explain depreciation 4d. Calculate depreciation using different methods 4e. Identify components of total product cost	4.1 Total Capital Investment, 4.2 Fixed capital investment, Working capital investment 4.3 Equipment cost estimation, Cost-Size 4.4 relation, Cost-Time relation, 4.5 Numerical based on Cost Indices 4.6 Depreciation and it's types 4.7 Methods for determining depreciations 4.8 Arbitrary methods, Methods with interest on investment, Numerical for depreciation 4.9 Total product cost (TPC)
	4f. Estimate profitability	4.10 Profitability analysis: Net and gross earnings, Methods of profitability, Percent return on investment, Pay-out time period,Present worth, Turn-over ratio

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
	4g. Calculate break-even capacity	4.11 Break-even analysis (Analytical method), 4.12 Break-even chart (Graphical method), 4.13 Numerical of Break-even analysis
Unit – V Optimum Design	5a. Explain procedure to find out optimum condition 5b. Estimate the optimum insulation thickness and pipe diameter 5c. Solve numerical to find optimum design	5.1 General procedure for determining optimum condition: Procedure with one variable (Analytical and graphical), Procedure with two variables (Analytical and graphical) 5.2 Optimum economic design for Insulation Thickness and Pipe diameter 5.3 Numerical for optimum design

6. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (Theory)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Process and Plant Design	12	5	5	5	15
II	Selection of Process Equipment and Piping	12	5	5	5	15
III	Plant Layout and Location	07	2	5	2	09
IV	Economic Evaluation of a Project	17	7	7	7	21
V	Optimum Design	08	2	3	5	10
Total		**56**	**21**	**25**	**24**	**70**

Legends: R = Remember**, U** = Understand**, A=** Apply and above Level (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED TUTORIALS

In tutorials numerical or conceptual problems may be given to individual or group of students. Students should be first allowed to struggle on their own to find the solution, and should try their creativity. However, faculty should remain around the students and help them if they are not able to proceed.

It is better if real life problems are case studies are given where different groups of students may come out with different solutions, which can be discussed in a larger group of student to generate more discussions. Following is the suggestive list of exercises; concerned faculty may change/add exercises to this list.

S. No.	Unit No.	Tutorial Exercises	Approx. Hours Required
1	I	Prepare block type and equipment flow diagram for production of desired (quantity and quality) chemical	4
2	I	Prepare block type material balance flow diagram for production of desired (quantity and quality) chemical	8
3	I	Prepare block type energy balance flow diagram for production of desired (quantity and quality) chemical	4

S. No.	Unit No.	Tutorial Exercises	Approx. Hours Required
4	II	Prepare detailed process and instrumentation flow diagram for production of desired (quantity and quality) chemical	4
5	II	Prepare specification sheet for 1-2 shell and tube heat exchanger	4
6	II	Prepare specification sheet for packed type distillation column	4
7	III	Solve given simple problems using cost–size relationship and cost- time relationship (Cost indices)	4
8	III	Calculate depreciation using Straight line method for given plant	2
9	III	Calculate depreciation using Declining balance method for given plant	2
10	III	Calculate depreciation using Sum of the years digits method for given plant	2
11	III	Calculate depreciation using Sinking fund method for given plant	2
12	III	Find-out break-even point Using Analytical and Graphical methods for given plant	8
13	IV	Solve given simple problems to determine optimum value using one variable and two variable methods. (Graphical and Analytical methods)	8
Total Hours			**56**

8. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

i. Explore internet, visit websites of reputed chemical production companies and prepare ppt presentations on different topics (in group of four-five) and present in class
ii. Study (in group of four-five) the design of some real chemical plant and identify good features of design and also weaknesses in it, present in class to have a group discussion.

9. SPECIAL INSTRUCTIONAL STRATEGY (IF ANY)

i. Use online course material from reputed universities
ii. Show videos related to good economical designs of plants for production of different chemical products.
iii. Show excel spreadsheets from internet about economic evaluation of chemical plants
iv. Show charts and models of different plants and handouts about their design features and specification of equipment
v. Arrange expert lectures
vi. Discuss real life case studies of good and bad design of chemical plants.

10 SUGGESTED LEARNING RESOURCES

A) Books

S. No.	Title of Books	Author	Publication
1	Plant Design and Economics for Chemical Engineers,	Peters, Max and Klaus Timmerhaus	McGraw Hill, New Delhi, 4th edition
2	Chemical Engineering Plant Design.	Vilbrandt, Frank Carl and Dryden,Charles E.	McGraw Hill, New Delhi, 4th edition
3	Chemical Engineering Design	Towler, Gavin and Sinnott, R. K.	Butterworth-Heinemann (2008)
4	Process Engineering Economics	Couper, James R.	Marcel and Dekker

B) Major Equipment/Materials with Broad Specifications

i. Charts and Models
ii. Specification sheets of equipment from fabricator
iii. Commercial project report

C) Software/Learning Websites

i. www.cheresources.com
ii. http://people.clarkson.edu/~wwilcox/Design/refcosts.htm
iii. http://app.knovel.com/web/toc.v/cid:kpCEDPPEP4
iv. https://www.lib.utexas.edu/chem/info/chemengecon.html
v. http://www.mhhe.com/engcs/chemical/peters/data/ce.html

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. Kartik R. Desai**, Head, Chemical Engg. Dept., N. G. Patel Polytechnic, Isroli-Afwa
- **Prof. D. H. Joshi**, Lecturer, Chemical Engg. Dept., G. P. Valsad
- **Prof. P. D. Chaudhari**, Lecturer, Chemical Engg. Dept., G. P. Valsad
- **Prof. J. R. Vadher**, Lecturer, Chemical Engg. Dept., Shri BPTI, Bhavnagar

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- **Dr. Joshua Earnest**, Professor of Electrical & Electronics Engineering.

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: CHEMICAL REACTION ENGINEERING
(COURSE CODE: 3360503)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	Sixth

1. RATIONALE

Chemical reactor design uses information, knowledge, and experience from a variety of areas like thermodynamics, chemical kinetics, fluid mechanics, heat transfer, mass transfer, and economics. Chemical reaction engineering is the synthesis of all these factors with the aim of properly designing a chemical reactor. The basic concepts of chemical reaction engineering are applied to the design and operation of various commercial reactors performing non catalytic and catalytic reactions. This course enables the diploma engineer to some extent in accomplish the task of selecting, sizing and determining the optimal operating conditions for the reactor.

2. COMPETENCY

The course content should be taught and curriculum should be implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Operate and maintain various chemical reactors to produce products of desired quality with minimum cost.**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning outcomes in cognitive, psychomotor and affective domain to demonstrate following outcomes:

i. Explain basic concepts to distinguish chemical reactions.
ii. Calculate rate, rate constant, activation energy and order of reaction.
iii. Interpret kinetic data to find order of reactions.
iv. Operate different reactors efficiently using basic knowledge about their functioning
v. Calculate volume, space time and space velocity for Ideal reactors.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	100
3	2	0	5	70	30	00	00	

Legends: L - Lecture; **T** - Tutorial/Teacher Guided Student Activity; **P** - Practical; **C** - Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
Unit – I Basics of Chemical Reactions	1a. Differentiate between various types of reactions such as chemical reactions Catalytic vs. Non-catalytic and the like 1b. Describe the factors affecting rate of reaction	1.1 Scope and importance of chemical reaction engineering 1.2 Classification of chemical reactions, a. Homogeneous vs. Heterogeneous, b. Catalytic vs. Non-catalytic c. Reversible vs. Irreversible d. By Molecularity e. Exothermic vs. Endothermic f. By order of reaction 1.3 Reaction rate on various basis and variables affecting the rate of reaction.
Unit – II Kinetics of Homogeneous Reactions	2a. Derive the rate law 2b. Calculate rate constant 2c. Estimate Molecularity and order of reaction	2.1 Rate equation/ Rate law 2.2 Concentration dependent term of rate Equation, Rate constant, Elementary and non-elementary reactions 2.3 Molecularity and order of reaction
	2d. Explain temperature dependency from Arrhenius law	2.4 Temperature dependent term of rate Equation, Temperature dependency from Arrhenius law
	2e. Describe the significance of activation energy 2f. Calculate activation energy	2.5 Activation energy
Unit – III Interpretation of batch reactor data	3a. Describe the methods for analysis of kinetic data 3b. Explain the relationships for constant volume batch reaction system	3.1 Methods for analysis of kinetic data Differential vs. Integral method Half life method
		3.2 Relationship for constant volume batch reaction system 3.3 Total pressure of the system and the partial pressure of reacting material Concentration and Conversion
	3c. Derive integrated rate equations	3.4 Integrated rate equation for different order of irreversible reactions: Uni-molecular first order, Bi-molecular, Second order, Tri-molecular third order, nth order, Zero order
Unit – IV Ideal reactors	4a. Describe an ideal reactors 4b. Describe the construction, benefits, limitations and applications of different types of reactors such as batch reactors and others.	4.1 Features of ideal reactors 4.2 Different types of reactors: Batch reactor, Semi batch reactor, Flow reactors, MFR/CSTR, PFR (Tubular), Fixed bed reactors, Fluidised bed reactors

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
	4c. Describe the construction, benefits, limitations and applications of different types of multiphase reactors such as slurry reactor and others	4.3 Multi phase reactors: G-L-S reactor, Slurry reactor, Bubble column reactor, Spray reactor, Trickle bed reactor
Unit – V Design of single Ideal reactor	5a. Explain the performance equation of different types of reactors such as Ideal batch reactor and others	5.1 Performance equation of : Single Ideal reactor for Single reaction Constant density system, Ideal batch reactor, Steady state mixed flow reactor, Steady state plug flow reactor
	5b. Explain space time and space velocity 5c. Differentiate holding time and Space time 5d. Calculate time/volume of reactor.	5.2 Flow reactors: Space time, Space velocity, Holding time Vs. Space time

6. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (Theory)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Chemical Reactions	6	3	4	3	10
II	Kinetics of Homogeneous reactions	8	4	6	4	14
III	Interpretation of batch reactor data	8	4	6	4	14
IV	Ideal reactors	10	6	6	4	16
V	Design of single Ideal rector	10	4	5	7	16
Total		**42**	**21**	**27**	**22**	**70**

Legends: R = Remember**, U =** Understand**, A=** Apply and above Level (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED TUTORIALS

In tutorials numerical or conceptual problems may be given to individual or group of students. Students should be first allowed to struggle on their own to find the solution, and should try their creativity. However, faculty should remain around the students and help them if they are not able to proceed.

It is better if real life problems are case studies are given where different groups of students may come with different solutions, which can be discussed in a larger group of student to

generate more discussions. Following is the suggestive list of exercises; concerned faculty may change/add exercises to this list.

S. No.	Unit No.	Tutorial Exercises	Approx. Hours Required
1	I	Classify chemical reactions and express rate on various basis	2
2	I	Solve the given problems based on rate equation	2
3	II	Solve given problems based on molecularity and order of reaction	2
4	II	Discuss temperature dependency of rate from Arrhenius' Law and solve given problems based on Arrhenius law	4
5	III	Explain various methods of kinetic data analysis	2
6	III	Derive integrated rate equation for different order of reaction	4
7	IV	Explain different Ideal reactors with sketch	2
8	IV	Explain different multiphase reactors with sketch	2
9	V	Derive performance equation of Ideal batch, mixed flow and plug flow reactor	2
10	V	Solve given problems based on performance equation of Ideal batch reactor	2
11	V	Solve given problems based on performance equation of Ideal mixed flow reactor	2
12	V	Solve given problems based on performance equation of Ideal Plug flow reactor	2
		Total	**28**

8. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

i. Explore internet, visit websites of reputed chemical production companies and prepare ppt presentations on different topics (in group of four-five) and present in class
ii. Refer books by different authors and solve as many numerical problems (related to above content) as possible. This will improve your understanding of effect of different parameters on functioning of reactors.

9. SPECIAL INSTRUCTIONAL STRATEGY (If Any)

i. Use online course material from reputed universities
ii. Arrange expert lectures
iii. Give as many types of numerical problems to students as many possible and explain one example of each type of problem in detail.

10 SUGGESTED LEARNING RESOURCES

A) Books

S. No.	Title of Books	Author	Publication
1	Chemical Reaction Engineering	Octave Levenspiel	Third Edition, John Wiley and Sons
2	Essentials of Chemical Reaction Engineering	H. Scott Fogler	Fourth Edition, Prentice Hall International
3	The Engineering of Chemical Reactions	Lanny D. Schmidt	Second Edition, Oxford University Press

B) Major Equipment/Materials with Broad Specifications

--Nil--

C) Software/Learning Websites

i. http://nptel.ac.in/courses/103108097/
ii. http://www.umich.edu/~elements/toc/frames.htm
iii. http://ocw.mit.edu/courses/chemical-engineering/10-37-chemical-and-biological-reaction-engineering-spring-2007/lecture-notes/

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- **Prof. Shilpaben Patel**, Lecturer, Chemical Engg. Dept., Govt. Polytechnic, Gandhinagar

Coordinators andFaculty Members from NITTTR Bhopal

- **Dr. Bashirulla Shaik**, Assistant Professor, Department of Applied Sciences
- **Dr. Joshua Earnest**, Professor of Electrical & Electronics Engineering.

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: PULP & PAPER TECHNOLOGY
(COURSE CODE: 3360504)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	Sixth

1. RATIONALE

Out of total paper produced in the country, 35% paper is produced in Gujarat. Diploma engineers are responsible for ensuring paper quality, improving the efficiency of production and reducing the environmental impact of the industrial paper making process. Engineers apply their skill while working in laboratory, production, research, sales and marketing. Engineers use chemicals such as sodium hydroxide and sodium sulphide to chemically remove lignin from wood. They ensure that paper is produced uniformly in the same colour. This course is to enable the diploma engineer to some extent in accomplish the task of selecting chemicals, laboratory operations for the Pulp and Paper Technology.

2. COMPETENCY

The course content should be taught and curriculum should be implemented with the aim to develop required skills in the students so that they are able to acquire following competency:

- **Produce paper of required quality by controlling the process appropriately.**

3. COURSE OUTCOMES (COs)

The theory should be taught and practical should be carried out in such a manner that students are able to acquire required learning outcomes in cognitive, psychomotor and affective domain to demonstrate following course outcomes:

i. Apply basic concepts of pulp and paper technology to produce paper.
ii. Apply reactions and unit operations steps to manufacture pulp.
iii. Use reactions and unit operations steps appropriately in manufacturing of paper.
iv. Use reactions and unit operations appropriately in manufacturing cellulose and various lignin chemicals.
v. Apply waste disposal techniques.
vi. Perform various chemical tests to monitor quality of raw material, output quality and influent/effluent

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	**T**	**P**	**C**	**ESE**	**PA**	**ESE**	**PA**	**150**
3	0	2	5	70	30	20	30	

Legends: L - Lecture; **T -** Tutorial/Teacher Guided Student Activity; **P -** Practical; **C -** Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (In Cognitive Domain)	Topics and Sub-topics
Unit – I Basics of Pulp and Paper Technology	1a. Describe the consumption pattern of different types of paper	1.1 Pulp and paper industry 1.2 Consumption pattern of paper
	1b. Describe cellulose raw material 1c. Identify problems and scope in India	1.3 Cellulose raw material 1.4 Problems and scope of pulp and paper industries in India
Unit – II Pulp	2a. Explain various raw materials	2.1 Raw materials
	2b. Differentiate the various pulping processes	2.2 Pulping process: Sulphite pulping, Semi-chemical pulping, Mechanical and Thermo-mechanical pulping, Secondary fibber pulping, R.A.G. pulping, Dissolving pulp
	2c. Describe the Kraft pulping process with flow diagram	2.3 Kraft pulping process
	2d. Compare various types of pulps 2e. Explain chemical recovery process	2.4 Comparison of different types of pulps 2.5 Black liquor recovery process
Unit –III Paper	3a. Differentiate the features f various raw materials used in paper manufacture 3b. Describe the Wet process for paper Manufacture with flow diagram	3.1 Types of paper products, Various raw materials: Fibrous and Non-Fibrous 3.2 Wet process for paper Manufacture
	3c. Describe Fourdrinier machine 3d. Describe the economics in paper industry	3.3 Fourdrinier machine 3.4 Economics of paper industry
Unit – IV Cellulose and Lignin Chemicals	4a. Describe the properties of cellulose 4b. Prepare chemical cellulose	4.1 Properties of cellulose 4.2 Preparation of chemical cellulose
	4c. Describe the characteristics of Lignin chemicals 4d. Select cellulose and lignin chemicals	4.3 Lignin chemicals: Types, properties of Di-methyl sulphides and Di- methyl sulfoxide 4.4 Applications of cellulose and Lignin chemicals
Unit – V Waste Disposal Techniques	5a. Analyse pollution potentials of Indian pulp and paper industry	5.1 Pollution potentials of Indian pulp and paper industry
	5b. Interpret the characteristics of industrial Lignin water	5.2 Characteristics of Industrial Lignin water
	5c. Apply bio-technical approach for pollution 5d. Apply Lignin waste treatment.	5.3 Bio-technical approach for pollution 5.4 Enzymology for Lignin waste treatment

6. SUGGESTED SPECIFICATION TABLE WITH HOURS and MARKS (Theory)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basics of Pulp and Paper Technology	4	3	4	0	7
II	Pulp	12	4	12	4	20
III	Paper	10	4	10	3	17
IV	Cellulose and Lignin Chemicals	8	3	6	4	13
V	Waste Disposal Techniques	8	3	6	4	13
Total		**42**	**17**	**38**	**15**	**70**

Legends: R = Remember**, U** = Understand**, A=** Apply and above Level (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED PRACTICAL / EXERCISES

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills **(outcomes in psychomotor and affective domain)** so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note*: Here only outcomes mainly in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of* ***Course Outcomes*** *related to affective domain. Thus over all development of* ***Programme Outcomes (****as given in a common list at the beginning of curriculum document for this programme) would be assured.*

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical/Exercise	Approx. Hours Required
1	II	Undertake qualitative analysis of sodium sulphite	2
2	II	Estimate the amount of lignin by kappa number test	4
3	II	Calculate the moisture content present in wood	2
4	II	Perform pre-hydrolysis of the raw material for pulp	4
5	III	Measure gauge (thickness) of various types of papers	2
6	V	Determine the pH for influent/effluent using different techniques	2
7	V	Determine the COD and DO for influent/effluent	2
8	V	Determine the BOD for influent/effluent	4
9	V	Optimize pH for maximum COD removal for black liquor	4
10	V	Estimate the coagulant dose at optimum pH for maximum COD removal	4

11	V	Determine the total solids and dissolved solids present in influent	2
12	I to V	Prepare the report for pulp and paper production by visiting industry	6
13	I to V	Prepare the model/chart showing different operations and processes involve in pulp and paper industry	2
		Total	**40**
Note: Perform any of the practical exercises from above list for total of minimum 28 hours depending upon the availability of resources so that skills matching with the most of the outcomes of every unit are included.			

8. SUGGESTED STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

i. Explore internet, visit websites of reputed pulp/paper production companies and prepare ppt presentations on different topics (in group of four-five) and present in class
ii. Study (in group of four-five) the design of some real pulp/paper production plant and identify good features of design and also weaknesses in it, present in class to have a group discussion.
iii. Collect samples of different types of paper from market and identify their specifications, further explore their production processes.

9. SPECIAL INSTRCTIONAL STRATEGY (If Any)

i. Show animations/ videos and drawings/models of pulp and paper production processes
ii. Arrange visit to nearby paper/pulp production industry
iii. Arrange expert lectures.

10 SUGGESTED LEARNING RESOURCES

A) Books

Sr. No.	Title of Books	Author	Publication
1	Dryden's outlines of Chemical Technology	Rao, M.Gopal, Sitting, Marshall	Affilated East-West Press Pvt. Ltd. 3rd Edition
2	Shreves' Chemical Process Industries	Austin, George T.	McGraw-Hill Education India Pvt. Ltd - New Delhi, 5th Edition
3	Environmental Pollution and Control in Chemical Process Industries	Bhatia, S.C.	Second Edition 2011(ISBN**:** 8174091068)
4	Pollution Management in Industries	Trivedi, R.K.	Environmental Publication, Karad, India
5	Handbook of Pulping and Papermaking	Biermann, Christopher J.	ISBN-13: 978-0120973620

B) Major Equipment/Materials with Broad Specification

i. Simple micrometer,
ii. Digital micrometer
iii. Dilute HCl,
iv. Concentrated H_2SO_4, H_2S, Charcoal
v. Laboratory pulping unit/ digester, Digester Volume: 20 Liters, Max Pressure: 20Kg/cm^2, Max Temperature: 200^OC, Pump capacity 20 liters/min
vi. Centrifuge

C) Software/Learning Websites

i. http://www.youtube.com/watch?v=E4C3X26dxbM
ii. https://www.google.co.in/?gfe_rd=crandei=uwn7U4KME6XO8gfW5YGQCQandgws_rd=ssl#q=paper+making+process+pdfandsafe=off
iii. www.unitoperation.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. Harsh Shukla**, Lecturer in Diploma Chemical engineering, Shri K. J. Polytechnic, Bharuch
- **Prof. (Miss.) Upasana Singh**, Lecturer in Diploma Chemical engineering, Shri K. J. Polytechnic, Bharuch
- **Prof. (Ms.) Parul K. Patel**, Lecturer in Diploma Chemical engineering, G.P. Gandhinagar
- **Prof. (Ms.) Yaminiben Patel**, Lecturer in Diploma Chemical engineering, G.P. Gandhinagar

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr. Abhilash Thakur**. Associate Professor, Department of Applied Sciences
- **Dr. Joshua Earnest**, Professor of Electrical & Electronics Engineering.

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM
COURSE TITLE: PROJECT
(COURSE CODE: 3360508)

Diploma Programme in which this course is offered	Semester in which offered
Chemical Engineering	SIXTH

1. RATIONALE

Development of a plant for any chemical product is a big job. It requires preparing a comprehensive report of chemical process and unit operations specific to that product. It is necessary to study the properties of raw materials and product, economic factors, safety features and pollution issues. Calculation of material and energy consumption is very important for designing the plant. Specifications for major equipments, plant layout and location are to be dealt with great care. In view of all these a chemical engineering student must be able to prepare a project report for a particular chemical product including all above aspects to become an entrepreneur. A chemical product can be selected from various chemical sectors like Petrochemicals, Fertilizers, Pharmaceuticals, Pesticides, Natural products, Polymers, Acid and Alkalis, Speciality chemicals, Dyes and pigments etc.

2. COMPETENCY

The course content should be taught and implemented with the aim to develop different types of skills so that students are able to acquire following competency:

- To prepare a project report for a particular chemical product including important feature

3. COURSE OUTCOMES

1. Select a chemical product based on market survey
2. Carry out literature survey for selected product
3. Calculate material balance for major equipments
4. Select a suitable site and prepare plant layout
5. Estimate economic evaluation
6. Prepare MSDS and select waste treatment methods

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	200
0	0	8	8	00	00	80	120	

Legends: L - Lecture; **T -** Tutorial/Teacher Guided Student Activity; **P -** Practical; **C -** Credit; **ESE** - End Semester Examination; **PA** - Progressive Assessment

5. COURSE DETAILS

Unit	Major Learning Outcomes	Topics and Sub-topics
Project Report *of* a selected chemical product	1. Select a chemical product based on market survey	1. Selection of chemical product from various chemical sectors like Petrochemicals, Fertilizers, Pharmaceuticals, Pesticides, Natural products, Polymers, Acid and Alkalis, Speciality chemicals, Dyes and pigments etc.
	2. Describe introduction, history, present status and list of industries manufacturing the product	2. Introduction, history, present status and list of industries manufacturing the product
	3. Discuss Chemical, physical Properties and applications	3. Chemical and physical Properties of raw materials, product and applications of product
	4.1 Explain manufacturing processes with detailed flow diagram 4.2 Select most suitable process	4. Various manufacturing processes with flow diagram and selection of most suitable process
	5. List out and describe major equipments and Instruments	5. Major equipments and Instruments required for selected process
	6. Prepare material balance calculations	6. Material balance of selected process
	7. Describe various utilities	7. Utilities for selected process
	8.1 Explain Site selection parameters 8.2 Select suitable Plant location 8.3 Prepare plant layout	8. Site selection parameters, Plant location and layout
	9. Prepare Economic evaluation of plant	9. Economic evaluation of plant
	10.1 Prepare MSDS of raw materials and product 10.2 Discuss appropriate waste treatment method	10. Important aspects of Safety and Pollution control 10.1 MSDS of raw materials and product 10.2 Gaseous/Liquid/Solid waste treatments

Unit	Major Learning Outcomes	Topics and Sub-topics
Project Report *of* a selected chemical product	1. Select a chemical product based on market survey	1. Selection of chemical product from various chemical sectors like Petrochemicals, Fertilizers, Pharmaceuticals, Pesticides, Natural products, Polymers, Acid and Alkalis, Speciality chemicals, Dyes and pigments etc.
	11. Conclude and prepare list of references	11. Conclusion and references

6. SUGGESTED SPECIFICATION TABLE WITH HOURS & MARKS (THEORY)

Unit	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
Course contains Practical part only						

Legends: R = Remember; U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICAL

The practical/exercises should be properly designed and implemented with an attempt to develop different types of cognitive and practical skills **(Outcomes in cognitive, psychomotor and affective domain)** so that students are able to acquire the competencies. Following is the list of practical exercises for guidance.

***Note**: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of **Programme Outcomes/Course Outcomes in affective domain** as given in a common list at the beginning of curriculum document for this programme. Faculty should refer to that common list and should ensure that students also acquire those Programme Outcomes/Course Outcomes related to affective domain*

S. No.	Chapter No.	Practical/Exercise	Apprx. Hrs. Required
1	I	Selection of chemical product from various chemical sectors like Petrochemicals, Fertilizers, Pharmaceuticals, Pesticides, Natural products, Polymers, Acid and Alkalis, Speciality chemicals, Dyes and pigments	4
2	II	Introduction, history, present status and list of industries of product	8
3	III	Chemical and physical Properties of raw materials, product and applications of product	8
4	IV	Various manufacturing processes with flow diagram and	12

S. No.	Chapter No.	Practical/Exercise	Apprx. Hrs. Required
		selection of most suitable process	
5	V	Major equipments and Instruments required for selected process	8
6	VI	Material balance of selected process	20
7	VII	Utilities for selected process	6
8	VIII	Site selection parameters, Plant location and layout	12
9	IX	Economic evaluation	18
10	X	Important aspects of Safety and Pollution control (a) MSDS of raw materials and product (b) Gaseous/Liquid/Solid waste treatments	12
11	XI	Conclusion and references	4
		TOTAL	112

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities. These could be individual and group based.

1. Course/topic based presentation

9. SPECIAL INSTRUCTIONAL STRATEGY (IF ANY)

1. Industrial visit

10 SUGGESTED LEARNING RESOURCES

A. List of Books:

Sr. No.	Title of Books	Author	Publication
1	Encyclopedia of Chemical Processing and Design	Jhon J. McKetta, William A. Cunninghalm	Marcel Dekker Inc., New York and Basel
2	Encyclopedia of Chemical Technology	Kirk and Othmer	John Wiley and Sons, Wiley Interscience
3	Ullman's Encyclopedia of Industrial Chemistry	Ullman	VCH Publishers, Germany
4	Chemical Process Technology Encyclopedia	Coincidine	McGraw-Hill
5	Perry's Chemical Engineers' Handbook	Robbert H. Perry, Down W. Green	McGraw-Hill
6	Plant Design and Economics for Chemical Engineers	Max Peters, Klaus Timmerhaus	McGraw Hill
7	Chemical Engineering Plant Design	Frank C. Vilbrandt, Charles E. Dryden	McGraw Hill
8	Chemical Engineering Design: Principles, Practice and Economics of Plant and Process Design	Gavin Towler, R. K. Sinnott	Butterworth-Heinemann
9	Process Engineering	James R. Couper	Marcel & Dekker

	Economics		
10	Stoichiometry	B. I. Bhatt, S.M. Vora	Tata McGraw Hill
11	Safety and Accident Prevention in Chemical Operation	Faweett, Wood	Interscience Publishers
12	A course in Industrial Safety	K.U. Mistry	N.K.M. Publication
13	Pollution Control in Process Industries	S.P. Mahajan	Tata-McGrawHill
14	Safe Handling of Hazardous Chemicals	A.K. Rohatgi	J.K. Enterprise

B. List of Software/Learning Websites

1. http://www.sbioinformatics.com/design_thesis/design-2520thesis.htm
2. http://npcs.in/projects/
3. http://www.niir.org/books/book/detailed-project-profiles-on-9-selected-chemical-industries
4. http://avogadro.chem.iastate.edu/MSDS/

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

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- **Prof. N. N. Hansalia, Lecturer in Chemical engineering, Government Polytechnic, Rajkot**
- **Prof. R. R. Vasava, Lecturer in Chemical engineering, Shri K. J. Polytechnic, Bharuch**
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- **Dr. Bashirullah Shaikh, Assistant Professor, Department of Applied Sciences NITTTR Bhopal**