UNIVERSITY OF KERALA

B. TECH. DEGREE COURSE

(2013 SCHEME)

SYLLABUS FOR

III SEMESTER

CHEMICAL ENGINEERING

SCHEME -2013

III SEMESTER
CHEMICAL ENGINEERING (H)

Course No	Name of subject	Credits	Weekly load, hours			C A Marks	Exam Duration Hrs	U E Max Marks	Total Marks
			L	T	D/P				
13.301	Engineering Mathematics II (ABCEFHMNPRSTU)	4	3	1	-	50	3	100	150
13.302	Physical and Inorganic Chemistry (H)	4	3	1	-	50	3	100	150
13.303	Fluid Flow Operations I (H)	4	2	2	-	50	3	100	150
13.304	Machine Drawing (H)	3	-	-	3	50	3	100	150
13.305	Computer Programming in C++ (H)	4	2	2	-	50	3	100	150
13.306	Chemical Technology I (H)	4	3	1	-	50	3	100	150
13.307	Chemistry Lab I(H)	3	-	-	3	50	3	100	150
13.308	Chemical & Instrumental Lab (H)	3	-	-	3	50	3	100	150
	Total	**29**	**13**	**7**	**9**	**400**		**800**	**1200**

13.301 ENGINEERING MATHEMATICS - II (ABCEFHMNPRSTU)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objective:

This course provides students a basic understanding of vector calculus, Fourier series and Fourier transforms which are very useful in many engineering fields. Partial differential equations and its applications are also introduced as a part of this course.

Module – I

Vector differentiation and integration: Scalar and vector functions-differentiation of vector functions-velocity and acceleration - scalar and vector fields - vector differential operator-Gradient-Physical interpretation of gradient - directional derivative – divergence - curl - identities involving ∇ (no proof) - irrotational and solenoidal fields - scalar potential.

Vector integration: Line, surface and volume integrals. Green's theorem in plane. Stoke's theorem and Gauss divergence theorem (no proof).

Module – II

Fourier series: Fourier series of periodic functions. Dirichlet's condition for convergence. Odd and even functions. Half range expansions.

Fourier Transforms: Fourier integral theorem (no proof) –Complex form of Fourier integrals-Fourier integral representation of a function- Fourier transforms – Fourier sine and cosine transforms, inverse Fourier transforms, properties.

Module – III

Partial differential equations: Formation of PDE. Solution by direct integration. Solution of Langrage's Linear equation. Nonlinear equations - Charpit method. Homogeneous PDE with constant coefficients.

Module – IV

Applications of Partial differential equations: Solution by separation of variables. One dimensional Wave and Heat equations (Derivation and solutions by separation of variables). Steady state condition in one dimensional heat equation. Boundary Value problems in one dimensional Wave and Heat Equations.

References:

1. Kreyszig E., *Advanced Engineering Mathematics*, 9/e, Wiley India, 2013.
2. Grewal B. S., *Higher Engineering Mathematics*, 13/e, Khanna Publications, 2012.

3. Ramana B. V., *Higher Engineering Mathematics*, Tata McGraw Hill, 2007.
4. Greenberg M. D., *Advanced Engineering Mathematics*, 2/e, Pearson, 1998.
5. Bali N. P. and M. Goyal, *Engineering Mathematics*, 7/e, Laxmi Publications, India, 2012.
6. Koneru S. R., *Engineering Mathematics*, 2/e, Universities Press (India) Pvt. Ltd., 2012.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Five Short answer questions of 4 marks each. All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

At the end of the course, the students will have the basic concepts of vector analysis, Fourier series, Fourier transforms and Partial differential equations which they can use later to solve problems related to engineering fields.

13.302 PHYSICAL AND ANALYTICAL CHEMISTRY (H)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objective:

- *To impart sound knowledge in the different fields of physical and Analytical chemistry so as to apply it to the problems in Chemical engineering field.*
- *To develop analytical capabilities of students so that they can characterize, transform and use materials in engineering and apply knowledge gained in solving related engineering problems.*
- *To evoke interest in students to take up chemistry related topics for their project works during their course of study.*

Module – I

Gaseous state: Kinetic theory of gases-Vander Waals equation-Critical constants-Liquifaction of gases.

Solutions: Raoults law- Ideal solutions-Partially miscible liquids- Phenol water system.

Dilute solutions: Introduction- Colligative properties- Lowering of vapour pressure-Elevation of boiling point- Depression of freezing point- Osmotic pressure.

Module – II

Kohlrauches law- Transport number and its determination- Degree of dissociation- Ionic equilibria-Ostwald's dilution formula-Anomaly of strong electrolytes-Theory of strong electrolytes-Solubility products and its applications- Henderson equation.

Surface chemistry: Types of adsorption. Heat of adsorption- The Langmuir theory derivation- Langmuir and classical isotherms. Chemisorption- Differences with physical adsorption. Applications of adsorption.

Module – III

The colloidal state: Multimolecular, macromolecular and associated colloids. Stability of colloids. The zeta potential. Kinetic, optical and electrical properties of colloids. Electrokinetic phenomena: Electrophoresis, electro osmosis.

Catalysis: Mechanism and theories of homogeneous and heterogeneous catalysis. Acid-base and enzyme catalysis. Bimolecular surface reactions. Langmuir-Hinshelwood mechanism.

Separation Methods: Classical separation methods: Theories of distillation, fractional distillation, steam distillation, sublimation and zone refining- Solvent extraction- Distribution law- Separation of mixtures, Craig method.

Module – IV

Phase rule: Introduction- One component system (water)- Two component system-Eutectic system, Pb- Ag system, Compound formation, Zn-Mg system- Applications of phase rule.

Spectroscopy: Introduction- Brief study of Raman, Mass and ESR spectroscopy.

Analysis of Selected Materials: Analysis of milk products: Theory of the analysis of milk, butter and other diary items. Analysis of fats and oils. Characterization of fats and oils. Iodine value, iodine-bromine value and saponification value, and their significances. Analysis of drugs and pharmaceuticals: Classical and modern methods of drug analysis.

References:

1. Puri B. R. and L. R. Sharma, *Physical Chemistry*, Vishal Publishing Co., 2008.
2. Skoog D. A., D. M. West and F. J. Holler, *Fundamentals of Analytical Chemistry*, Saunders, 1996.
3. Gurtu J. N. and H. Snehi, *Advanced Physical Chemistry*, Pragati Prakashan, 2000.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

- *The confidence level of students will be improved to tackle problems in engineering field related to chemical aspects.*
- *The students gain capability in developing innovative materials possessing special properties that find applications in process engineering industries.*
- *The students will be equipped to take up chemistry related topics as part of their project works during higher semesters of the course.*

13.303 FLUID FLOW OPERATIONS I (H)

Teaching Scheme: 2(L) - 2(T) - 0(P) **Credits**: 4

Course Objectives:

- *To impart fundamental knowledge in fluid flow phenomena.*
- *To impart knowledge about flow of compressible and incompressible fluids, Equations of motion, equation of continuity, Transportation of fluids, fluid flow measurements so as to enable them to be able to solve fluid flow problems encountered in industries*

Module – I

Introduction, concept of Continuum, ideal and real fluids, properties of fluids, measurement of viscosity, compressibility, surface tension, capillarity - absolute and gauge pressures.

Fluid statics: Pascal's Law, hydrostatic law, hydrostatic equilibrium, barometric equation, Continuous gravity decanter - Centrifugal decanter - measurement of pressure using barometer, manometers, differential manometers, pressure gauges. Pressure at a point in a compressible fluid, temperature at any point in a compressible fluid, temperature lapse rate. Buoyancy and floatation- centre of buoyancy, metacentre, metacentric height, stability of floating and submerged bodies.

Module – II

Introduction to fluid flow – Flow field, classification of flow- steady and unsteady flow, uniform and non uniform flow, one two and three dimensional flow, rotational and irrotational flow, adiabatic flow, streamline, streak line, path line, stream tube, stream function velocity potential

Potential flow, rheology of fluids, shear rate and shear stresses, Newtonian and non-Newtonian fluids, viscosity, momentum flux, Reynolds's experiment, turbulent flow, turbulence, nature of turbulence, Equations of change for isothermal systems, equation of continuity, equation of motion, Navier-Stoke's equation, Euler equation - Bernoulli equation, kinetic energy correction factors, correction in Bernoulli equation for fluid friction, Friction head loss for changes in velocity, direction and due to pipe fittings. Shear stress and velocity distribution in circular channel. The friction factor - Hagen-Poiseuille equation, Frictional loss in non circular conduits- Hydraulic radius and equivalent diameter.

Module – III

Shell momentum balance for falling film, laminar flow of non-Newtonian fluids – Velocity distribution for turbulent flow. The friction factor chart, Flow in boundary layers, wake

formation, boundary layer thickness and boundary layer conditions in laminar flow - Blasius solution, boundary layer thickness and boundary layer conditions in transition and turbulent flow. Dimensional analysis- Raleigh's method and Buckingham pi method.

Module – IV

Transportation and metering of fluids, pipes and pipe standards, tubings, pipe joints, flange - expansion joints, valves, pressure relieving devices, safety and relief valves, accessories for safety relieving valves, materials of construction.

Pumps, reciprocating pumps, centrifugal pumps, centrifugal pump theory - selection of centrifugal pumps - various types, head Vs. flow rate - characteristics of centrifugal pumps, priming - cavitation, NPSH - Water hammer -calculations involving pump characteristics – loss of head and power in centrifugal pumps – Pumps in series and parallel, material of construction of pumps, design of pipeline systems.

The displacement and current meters, variable area meter, orifice meter, venturimeter, flow nozzles, rotameter, weirs and notches - Pitot tubes – velocity meters - anemometers, turbine flow meter, current meters, hot wire anemometer, laser doppler anemometry, flow visualization.

References:

1. McCabe W. J. Smith and P. Harriott, *Unit Operations in Chemical Engineering*, McGraw Hill, 2004.
2. Streeter V. L., *Fluid Mechanics*, 9/e, McGraw Hill, 2010.
3. Kunii D. and O. Levenspiel, *Fluidization Engineering*, Butterworth-Heinemann, 1991.
4. Geankoplis C. J., *Transport Processes and Unit Operations*, Prentice Hall of India, 2003.
5. Kumar K. L., *Engineering Fluid Mechanics*, Eurasia Publishing House, New Delhi, 1995.
6. De Nevers N., *Fluid Mechanics for Chemical Engineers*, 2/e., McGraw Hill, 1991.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

Students will be able to design piping and pumps, select suitable metering devices and valves, solve problems related to flow of process fluids.

13.304 MACHINE DRAWING (H)

Teaching Scheme: 0(L) - 0(T) - 3(P) **Credits**: 3

Course Objective:

- *To impart basic knowledge and training scaled, dimensioned engineering drawing and free hand sketching of various machineries, parts and engineering components.*
- *Give training in making a drawing of engineering components or machinery or its parts which can be used for fabricating and assembling the required equipment/ machinery/ components.*

Module – I

Conversion of pictorial views into orthographic views- Sectional views-types of sectional views, conventions- Dimensioning techniques.

Module – II

Freehand sketching: Different forms of screw thread, conventional representations, different types of lock nuts, foundation bolts, forms of rivet heads, Riveted joints- Lap (chain, zigzag, multiple rows), butt joints (chain, zigzag, multiple rows, single cover and double cover plate). Different types of keys.

Module – III

Dimensioned Drawing: Hexagonal and square headed bolt with nut, Sectional drawings of Socket and spigot joint, Knuckle joint, Flange coupling, Bushed pin flexible coupling and Plummer block. Pipe joints: Sectional drawings of Cast Iron Flanged joint, Hydraulic joint and Union joint.

Module – IV

Assembly and working drawing *(Part drawing)*: Pedestal bearings, Foot step bearing. Valves: Stop valve for boilers, Rams bottom safety valve and lever safety valve.

References:

1. Bhatt N. D. and V. M. Panchal, *Machine Drawing*, Charotar Publisher, 2002.
2. Varghese P. I., *Machine Drawing*, VIP Publishers, Thrissur, 2012.
3. Gill P. S., *Machine Drawing*, S.K. Kataria & Sons, New Delhi, 2010.
4. Parkinson A. C., *Engineering Drawing*, Pitman & Sons, 1966.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Three questions of 10 marks each, covering Modules I and II. There should be at least one question from each module. Candidates have to answer two full questions out of the three.

Part B (80 Marks) – Two questions each from Modules III and IV. Candidates have to answer one full question out of the two from each module. Each question carries 40 marks.

Course Outcome:

Students will be able to make engineering drawings of the designed machinery/ parts or components of which can be used for fabricating and assembling the required equipment/ components/ machinery.

13.305 COMPUTER PROGRAMMING IN C++ (H)

Teaching Scheme: 2(L) - 2(T) - 0(P) **Credits:** 4

Course Objectives:

- *To introduce the students to computer programming*
- *To impart to the students the basics of OOP concepts and the C++ language*

Module – I

Organization of digital computers. Components of digital computers and their functions. Basic concepts of computer programming languages. Object Oriented Programming (OOP). Benefits of OOP. OOP languages. Introduction to C++, Structure of C++ programs. Creating source files, compiling and linking.

Tokens, keywords, basic data types, user-defined data types, storage class, life time and visibility of variables. Derived data types, symbolic constants, declaration and initialization of variables. Reference variables, Operators in C++, Scope resolution operator, member dereferencing operators, memory management operators, manipulators, type casting, operator overloading, control structures.

Module – II

Functions: The main(), built in functions, prototyping, call by reference, return by reference, inline functions, default arguments, const arguments, recursion, function overloading, friend functions, virtual functions, math library functions.

Classes and objects: Introduction to classes, member functions, nesting of member functions, private member functions, arrays in classes, memory allocation for objects, static data and member functions, arrays of objects, objects as function arguments, pointers to classes.

Module – III

Constructors, parameterized constructors, multiple constructors, dynamic initialization, dynamic constructors, copy constructors, destructors.

Operator overloading: rules for operator overloading, overloading of unary and binary operators, using Friends, manipulation of strings,

Inheritance: Derived classes, single inheritance, multilevel, hierarchical and hybrid inheritance, virtual base classes, abstract classes.

Module – IV

Pointers: Pointers to objects, this pointer, pointers to derived classes, virtual functions, pure virtual functions. Virtual constructors and destructors.

Streams: Stream classes, I/O operations, manipulators.

Files: Classes for file stream operators, open and close files, end-of-file, file pointers, sequential input output operations, updating of files

References:

1. Balaguruswamy E., *Object Oriented Programming with C++,* Tata McGraw Hill, 1992.
2. Lafore R., *Object Oriented Programming in Turbo C++* , GALGOTIA, 2001.
3. Stroustrup B., *The C++ Programming Language*, Pearson Education, 2007.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

- *Students will be able to analyze engineering problems and identify the potential to solve them using computers.*
- *Students will be able to write C++ programs to solve engineering problems.*

13.306 CHEMICAL TECHNOLOGY I (H)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objective:

To impart knowledge of various process engineering technologies and process flow sheeting methods used in process industries.

Module – I

Introduction to Chemical Technology, Sectors of Chemical Industry, Overview of Indian Chemical Industry.

Industrial gases: Manufacture, properties and uses of hydrogen, oxygen, nitrogen, carbon dioxide, carbon monoxide, acetylene, hydrogen and rare gases.

Industrial acids: Hydrochloric acid manufacture by synthesis process, manufacture of sulphur from fuel gases, sulphuric acid manufacture by DCDA and single absorption processes, lead chamber process, sulphuric acid concentration, nitric acid manufacture from ammonia, phosphate ore beneficiation, phosphoric acid manufacture by wet process and electric furnace process.

Module – II

Fertilizers: Ammonia manufacture, manufacture of urea by once through process and total recycle process, ammonium sulphate manufacture from coke-oven gas and by direct neutralisation. Manufacture of nitrogenous fertilizers - ammonium chloride, ammonium sulphate, ammonium nitrate, ammonium phosphate, calcium ammonium nitrate, barium nitrate, nitro chalk and urea. Phosphatic fertilizers - super phosphates. Potassium fertilizers:-, basic slag, potassium chloride, potassium sulphate. Compound and complex fertilizers:- MAP and DAP, urea ammonium phosphate, ammonium phosphate sulphate, nitro phosphates, NPK fertilizers. Other fertilizers: Mixtures and granulated products, fluid fertilizers, controlled release fertilizers. Secondary nutrients and micro-nutrients.

Module – III

Marine chemicals: Manufacture of sodium chloride, sodium sulphate, sodium silicate, byproducts of salt industry, recovery from bitterns, bromine manufacture. Soda ash: Manufacture by Solvay process and modified Solvay process. Chlorine and caustic soda: Manufacture by electrolytic process - Diaphragm cells, membrane cells, mercury cells. Purification of caustic soda and chlorine.

Module – IV

Electrothermal products: Manufacture, properties and uses of graphite, fused alumina, silicon carbide, carbon disulphide. Cements: Raw materials, proportioning and manufacture

of ordinary portland cement, dry, semi-dry and wet processes, Puzzolana Portland cement and other types of cements. Testing of cement. Glasses: Types, raw materials and methods of manufacture. Ceramics: Types, raw materials, processing methods - drying and firing of ceramic wares. Refractories: classification, manufacture and testing of refractories.

Oils, fats and waxes: Manufacture of Vanaspati, Edible and essential oils: raw materials, manufacture, expelling methods, solvent extraction and refining.

Soaps and detergents: Soap manufacture by fat splitting – by-product glycerine and its purification - detergents - anionic and non-ionic - manufacture of alkyl-benzene sulphonates.

References:

1. Austin G. T., *Shreve's Chemical Process Industries* 3/e, McGraw Hill, 1984.
2. Dryden C. E., Outline of Chemical Technology, 2/e, East West Publishers, 1997.
3. *Chemtech Vol. I – IV*, Chemical Engineering Education Development Centre, Indian Institute of Technology, Madras, 1979.
4. Shukla S. D. and G. N. Pandey, "A Text Book of Chemical Technology. Vikas Publishing House, 1986.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

On completion of this course, students will know the process technologies of production of industrial gases, acids, marine chemicals, fertilizers and such products. They will be capable of drawing a flow sheet of the technology of each and use it for project design and implementation.

13. 307 CHEMISTRY LAB-I (H)

Teaching Scheme: 0(L) - 0(T) - 3(P) **Credits**: 3

Course Objective:

- *To impart sound knowledge in the different fields of analytical chemistry and make familiar with the use of modern analytical instruments in lab and industry.*
- *To develop analytical capabilities of students so that they can characterize, transform and use materials in engineering and apply knowledge gained in solving related engineering problems.*
- *To evoke interest in students to take up chemistry related topics in Industrial analysis.*
- *This lab makes them to understand the difference between conventional analysis and modern analysis in different engineering fields.*

List of Experiments:

A. **Volumetric analysis**

1. Preparation of standard solution of sodium carbonate, standardisation of strong acids (Eg. HCl) and estimation of unknown concentration of NaOH.
2. Estimation of carbonate- bicarbonate mixture.
3. Preparation of standard oxalic acid, standardisation of potassium permanganate and estimation of unknown solutions of hydrated ferrous sulphate.
4. Preparation of standard ferrous sulphate solution and standardisation of potassium permanganate and estimation of Mohs salt.
5. Preparation of standard solution of potassium dichromate and estimation of iron.
6. Standardisation of sodium thiosulphate against dichromate and estimation of copper sulphate.
7. Preparation of standard sodium chloride and standardisation of silver nitrate.
8. Estimation of total and permanent hardness by EDTA method.

B. Analysis of ores and alloys

9. Estimation of iron in heamatite.
10. Estimation of copper in brass.
11. Estimation of calcium in lime stone or dolamite.

C. Potentiometric measurements

12. Estimation of strength of given HCl solution by titrating against sodium hydroxide solution.
13. Determination of electrode potential and emf of an electrochemical cell.

D. Conductometric measurements

14. Coductometric titrations
    (a) Strong acid with strong base
    (b) Strong acid with Weak base
    (c) Mixture of acid with base

E. pHmetric measurements

15. (i) Preparation of buffer and standardisation of pH meter.
    (ii) Determination of molarity of HCl with M/10 NaOH.

F. Water Analysis

16. Analysis of Industrial and Domestic water
    (i) Determination of TDS present in a sample of water.
    (ii) Determination of Ca and Mg in a sample of water using flame photometer and UV- Visible spectro photometer.
    (iii) Determination of Sodium and Potassium Using Flame photometer.
    (iv) Determination of Acidity or Alkalinity present in water using P^H meter.
    (v) Analysis of unknown sample of Industrial and domestic water.

References:

1. Thomas A.O., *Practical Chemistry,* Scientific Book Centre, 2003.
2. Vogel A. I., *A Text Book of Quantitative Inorganic Analysis*, Longmans, 2003.
3. Sudha Rani and S. K. Bashin, *Laborarory Manual on Engineering Chemistry*, Dhanpat Rai, 1998.

Internal Continuous Assessment *(Maximum Marks-50)*

40% - Test

40% - Class work and Record

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

Candidates have to do two experiments based on the above list of experiments.

80% - Principle &Procedure (10%), conducting experiment (60%), results, tabulation and inference (10%)

20% - Viva voce

Candidate shall submit the certified fair record for endorsement by the external examiner.

Course Outcome:

- *The confidence level of students will be improved to tackle problems in engineering field related to chemical analysis.*
- *The students gain capability in conducting different modern analysis which has various engineering applications*
- *The students will be equipped to take up chemistry related experiments and analysis, as part of their project works during higher semesters of the course.*

13. 308 CHEMICAL AND INSTRUMENTAL ANALYSIS LABORATORY (H)

Teaching Scheme: 0(L) - 0(T) - 3(P) **Credits**: 3

Course Objective :

To impart practical knowledge and training to students in chemical analysis and analysis using instruments by doing experiments.

List of Experiments:

Chemical Analysis:

1. Analysis of oils and fats: Acid value, saponification value and iodine value. Analysis of soap, washing soda and bleaching powder.
2. Water analysis: Total alkalinity, acidity, hardness, chlorided sulphates, dissolved oxygen, residual and free chlorine.
3. Analysis of industrial effluents: COD and BOD determination. Analysis of Cement, Analysis of Soil,
4. Analysis of coal: Proximate analysis and coking characteristics. .
5. Sugar analysis: Determination of sucrose content.
6. Technical preparations : Soaps, detergents, paints and dye.

Instrumental Analysis:

1. Flue gas analysis.
2. pH analysis, flame photometry, spectro photometry.
3. Determination of flash point, fire point, refractive index and viscosity.
4. Calorific value of fuels

References:

1. Snell F. D. and F. M. Biffen, *Commercial Methods of Analyses*, Chemical Publishing Co., 1964.
2. Mendham J., R. C. Denney, J. D. Barnes and M. J. K. Thomas., *Vogel's Text Book of Quantitative inorganic Analyses*, 6/e, Pearson Education, 2008.
3. Ewing G.W., *Instrumental Methods of Chemical Analyses*, McGraw Hill, 1960.

Internal Continuous Assessment *(Maximum Marks-50)*

40% - Test
40% - Class work and Record
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

*There shall be two questions for the examination, one from **chemical analysis** part carrying 70 marks and the other from **instrumental analysis** part carrying 30 marks. The candidate shall write and submit a brief procedure of the experiment and the method of calculations if any to be followed to arrive at the results. This may carry 25% of the marks. During the course of the experiment the candidate shall appear for a viva voce examination where his/her knowledge level in the subject will be tested, which may carry 35% marks. 35% marks may be given for conducting the experiment as per the correct procedure ensuring precautions if any. 5% marks may be allocated for accuracy.*

Candidate shall submit the certified fair record for endorsement by the external examiner.

Course Outcome:

Students will be able to determine characteristic parameters, compositions etc of raw materials and or products by way of designing and conducting experiments and /or by using available instruments