Course Structure for UG Engineering Degree in Ceramic Technology under Autonomy
Semester III

3rd semester CT								
Sl. No.	Type of course	Course Code	Course Title	Hours per week				Credits
				Lecture	Tutorial	Practical	Total	

Theory

1.	Basic Science Course	BS (CT) 307	Engineering Mathematics	3	1	0	4	4
2.	Engineering Science Course	ES (CT) 307	Basic Mechanical Engineering	3	0	0	3	3
3.	Professional Core Course	PC (CT) 301	Ceramic Raw Materials	3	1	0	4	4
4.	Professional Core Course	PC (CT) 302	Unit Operation I	3	1	0	4	4
5.	Professional Core Course	PC (CT) 303	Energy Resources & Furnaces	4	0	0	4	4
6.	Engineering Science Course	ES (CT) 308	Chemical & Engineering Thermodynamics	3	1	0	4	4

Sessional

1.	Professional Core Course	PCL (CT) 304	Powder Preparation & Chemical Analysis of Ceramic Raw Materials and Products Lab	0	0	3	3	1.5
2.	Professional Core Course	PCL (CT) 305	Fuels Testing Lab	0	0	3	3	1.5
3.	Basic Science Course	BSL (CT) 308	Numerical Methods Lab	0	0	2	2	1

Practical

1.	Comprehensive Laboratory Assessment	CLA (CT) 3	All Labs	0	0	0	0	1
			TOTAL	*19*	*04*	*08*	*31*	*28*
1.	MANDATORY COURSE	MC (CT) 301	Environmental Sciences	2	0	0	2	0

Detailed Syllabus for UG Engineering Degree in Ceramic Technology under Autonomy
Semester III

THEORY PAPERS

Engineering Mathematics

Paper Code: BS (CT) 307 Credits: 4

Pre-Requisite:

1. Knowledge of Differential and Integral Calculus
2. Knowledge of Differential equations

Course objective:

The objective of this course is to provide a good foundation to the concept and techniques of integral transforms for spectral analysis and solutions of ODE and PDE relevant to the field of Ceramic science. This course provides an understanding PDE for formulation and modeling of diffusion and heat conduction problems. This course also provides the basic understanding of different tools of interpolation to estimate and predict for unknown functional value. This course provides an understanding of the kinds of techniques of numerical solutions of nonlinear equations and system of equations that arises from different real-life engineering problems and where existing analytical methods are not sufficient for solutions and how to determine proper numerical methods to deal with specific problems of definite integrals and ODE.

Module 1: Integral Transform

Laplace Transforms: Laplace transform, properties of Laplace Transform, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Solution of ODE using L.T. [8L]

Fourier Transforms: Fourier transforms properties, Sine & Co-sine Fourier transforms, convolution, inverses and Parseval's Identity. [6L]

Module 2: Partial Differential Equation

Partial Differential Equation: Introduction to PDE, Formation of PDE.

First Order Partial differential equations, solutions of first order linear PDEs.

Partial Differential Equation of second Order: Solution of Wave Equation, Heat Conduction equation and Laplace's equation by a) Laplace transform b) Fourier transforms and c) Method of separation of variables.
[8L]

Module 3: Numerical Analysis

Approximation in numerical computation: Absolute error, Relative error, Percentage error,Truncation and rounding errors, Fixed and floating-point arithmetic, Propagation of errors. [2L]

Interpolation: Newton forward & backward interpolation, Lagrange's and Newton's divided difference Interpolation. [4L]

Numerical integration: Trapezoidal rule, Simpon's 1/3 rule, Weddle's rule, expression for corresponding error terms. [2L]

Numerical Solution of a system of linear equation: Gauss elimination method, Matrix inversion, Gauss Jordan, Gauss-seidel iterative method. [4L]

Numerical Solution of Algebraic equation: Bisection method, Regula-Falsi method, Newton Raphson method. [4L]

Numerical Solution of Ordinary Differential Equation: Euler's method, Modified Euler's &Runge-Kutta (4^{th} Order) method. [4L]

Course Outcomes:

After completing the course the student will be able to
CO 1: apply the concept and techniques of integral transforms for spectral analysis and solutions of ODE and PDE relevant to the field of Ceramic science.

CO 2: apply the techniques of PDE for formulation and modeling of diffusion and heat conduction problems and its understanding.

CO 3: learn the tools of interpolation to estimate and predict for unknown functional value.

CO 4: understand and apply the techniques of numerical solutions of nonlinear equations and system of equations that arises from different real-life engineering problems and where existing analytical methods are not sufficient for solutions.

CO 5: learn to choose proper numerical methods to deal with specific problems of definite integrals and ODE.

Learning resources

1. LokenathDebnath, DambaruBhatta, Integral Transform and their applications, CRC Press

2. Larry C. Andrews, Bhimsen K. Shivamoggi, Integral Transforms for Engineers, Macmillan.

3.Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons.

4. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers.

5. S. S. Sastry, Introductory Methods of Numerical Analysis, PHI

6. S. A. Mollah, Numerical Analysis and Computational Procedure, Books and Allied (P) Ltd.

Basic Mechanical Engineering

Paper Code: ES (CT) 307 Credits: 3

Pre-Requisite:

3. Class 12th standard physics knowledge
4. Class 12th standard knowledge in differential and integral calculus

Course objective:

The objective of this course is to provide a good foundation for taking up advanced courses of the subsequent semesters. A working knowledge of statics with emphasis on force equilibrium and free body diagrams is provided. This course provides an understanding of the kinds of stress and deformation and how to determine them in a wide range of simple, practical structural problems, and an understanding of the mechanical behavior of materials under various load conditions. This course also provides the basic understanding of different machine elements and joints like cam-follower, power screw, belt drives, gear drives, riveted and welded joints.

Detailed syllabus:

Module 1: Introduction to statics (9L)

Two dimensional force systems: Principle of transmissibility, Resolution of force into rectangular components, Moment, Varignon's theorem, Couple, Equivalent couples, Force couple systems. (5L)

Equilibrium of forces in two dimensions: Concept of free body diagram, Equilibrium conditions. (4L)

Module 2: Strength of materials (12L)

Concept of stress: Normal stress and shearing stress,

Tension and compression within the elastic limit: Definition of elasticity, plasticity, ductility, malleability, hardness, fatigue, creep, brittleness; Hooke's law, Stress-strain diagram for ductile and brittle material, working stress, factor of safety, stress and strain in composite bar, Thermal stress. (5L)

Torsion of circular shafts, angle of twist, torque and power developed in hollow and circular shafts. (2L)

Shear Force and Bending Moment: Relation between shear force and bending moment, Sign convention, Shear force and bending moment diagrams for simply supported beam, overhanging beam and cantilever subjected to point loads & uniformly distributed load, location of point of contraflexure. (5L)

Module-3: Theory of machine elements (18L)

Cams and followers: Classification of cams and followers, Different follower motions and their displacement diagrams like uniform velocity, SHM. Drawing of profile of radial cam with knife-edge follower without offset with reciprocating motion (graphical method only). (4L)

Power screws: Forms of threads, Terminology of power screw, Torque requirement while lifting and lowering load, self locking screw, efficiency of square threaded screw. (3L)

Belt drives: Types of belt and belt drives, action of belts on pulleys, velocity ratio. (2L)

Gear drives: Friction wheels, Advantages and disadvantages of gear drive, classification of gears, terminology used in gears, simple and compound gear train. (3L)

Riveted Joints: Types of riveted joints, Failure, strength and efficiency of a riveted joint. (3L)

Welded joints: Welding processes, butt joints, lap joints, strength of butt welds, stress relieving of welding joints. (3L)

Course outcome:

The students will be able to:

CO1: Use analytical techniques for analyzing two dimensional force systems
CO2: Confidently tackle equilibrium equations, moments and couple problems of engineering mechanics
CO3: Determine normal stress, shear stress, thermal stress of deformable body.
CO4: Define mechanical properties of materials and understand and analyze stress-strain diagram of engineering materials and realize the effect of deformable body under various loading conditions
CO5: Attain an introduction to basic machine elements and joints such as power screw, belt drives, riveted and welded joints, gear drives, cam-follower system.

Books recommended:

Engineering mechanics- Timoshenko and Young

Engineering mechanics- Mariam and Kraige

Strength of materials- Timoshenko and Young

Theory of machines- S S Rattan

Design of machine elements- V B Bhandari

Ceramic Raw Materials

Paper Code: PC (CT) 301 Credits: 4

Pre-Requisite:

1.Class 12th standard knowledge of chemistry

2. Class 12th standard knowledge in basic chemical calculation and Stoichiometric relations

Course Objective : The objective of the course is to acquire

(a) knowledge on the structure, classification, properties and application of different natural ceramic raw materials.

(b) knowledge on different processing technique of ultrapure synthetic ceramic materials and their properties / characterisation.

(c knowledge on the different properties, structure in relation with application field of ceramic raw materials.

(d) knowledge on the different characteristics of different natural materials applicable in relation with application oriented ceramic product manufacturing.

Part-I: Natural Raw Materials

(a) Structure and properties of ceramic minerals 2L

(i) Structure of ionic compound
(ii) Structure of covalent ceramic minerals

(b) Identification of minerals 3L

(i) Physico-chemical properties
(ii) Optical mineralogical properties

(c) Silica and silicate minerals: 4L

Polymorphic forms of silica, their transformation, different applications in ceramic industries; different natural forms of silica of industrial importance, their properties, uses: e.g. quartzite, ganister, flint, silica sand. Other forms of silica and their applications: silica gel, vitreous silica.

(d) Plastic ceramic raw materials: clay minerals, classification of clays, structure, properties and application.

(i) Important properties of clay: plasticity, CEC, drying strength, shrinkage, vitrification, effect of heat on clay. 4L

(ii) Important clay minerals: china clay, ball clay, fireclay, bentonite, mica etc. 1L

(e) Fluxing agent: feldspar, nephelene syenite, bone ash, lepidolite and wollastonite- their composition, properties, availability and uses in relevant ceramic industries. 4L

(f) Refractory raw materials: bauxite, magnesite, dolomite, chromite, graphite, sillimanite group of minerals, limestone---their composition, properties, effect of heat, occurrence and applications. 4L

(g) Other important raw materials: Laterite, rutile, gypsum, garnet, fluorspar, borax. 2L

Part-II: Synthetic Ceramic raw Materials:

1. Scope, Application & Basic background of Synthetic Ceramic Powder: 3L

Purpose /Advantage of synthetic Ceramic Raw Materials, Ultra pure Synthetic ceramic raw materials, Industrially used synthetic ceramic raw materials, Idea about crystal, crystallite, grain, particle, Particle size and shape, Agglomerated & Mono dispersed particle, Application areas of synthetic ceramic powder in different Engineering field.

2. Methods of Ceramic Powder preparation: 6L

Sol-Gel process (SGP), Sol-Gel-Auto combustion & Low temperature Solution Combustion process (LCS), Precipitation and co-precipitation technique, Hydrothermal synthesis, Solvent vaporization technique

2. Characterization of Synthetic Ceramic powder: 3L

Particle size distribution of nano and micron range particles, Decomposition and crystallization study by DTA, TGA and DTGA, Phase analysis by XRD, Debye Scherer equation for crystallite size determination. SEM and TEM.

3. Alumina: 4L

Phases of Alumina and its structure, Bayer alumina and its purification, Calcined Alumina, Tabular alumina, Fused alumina, Synthesis of oxide and hydroxide Powder from solution/combustion routes & powder Characterization

4. Zirconia: 4L

Polymorphic transformation of ZrO_2 , Partially stabilized and fully stabilized zirconia (PSZ & FSZ), Synthesis of stabilized ZrO2 powder (with Y_2O_3 , CeO_2 etc.) from solution routes & powder Characterization , Monodisperse spherical ZrO2 powder spinel

5. Mullite, Silica Gel and Precipitated Silica: 4L

Synthesis from different precursors in solution routes & their Characterization

6. Barium Titanate and Ferrite: 4L

Temperature dependent structural stability of $BaTiO_3$, Synthesis of $BaTiO_3$ by Pechini and modified Pechini process, Normal and inverse spinel ferrites, Synthesis of Ni, Zn and Mn ferrite powder by sol-gel-auto combustion , co-precipitation techniques & powder Characterization.

Course Outcome:

After successful completion of the course the student should be able to understand

CO1: The importance of natural as well as synthetic ceramic raw materials for practical application in different field of application in ceramic industries.

CO2: Different methods of synthesis of synthetic ceramic materials & their characterization.

CO3: The structure-properties relationship of different ceramic raw materials.

Recommended Books

1. Clays and Ceramic Raw materials: W.E. Worrall Applied Sc publishers
2. Properties of Ceramic Raw materials: W. Ryan, Pergamon Press
3. The Chemistry and Physics of Clays and other Ceramic Materials: R. W. Grimshaw, Ernest Benn Ltd
4. Ceramic Raw Materials (2nd Revised Edition) – W. E. Worrall (1982). Pergamon Press, Oxford. 111p.
5. Ceramic Raw Materials of India: A Directory – S.K Guha (Editor) (1982). Indian Institute of Ceramics, Kolkata. 202p.
6. Ceramic Powder preparation : A Hand Book, Dibyendu Gangully & Minati Chatterjee, Kluwer Academic Publishers
7. Sol-Gel Processing of Advanced Ceramics, Editor by F. D. Gnanam, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi

Unit Operation I

Paper Code: PC (CT) 302 Credits: 4

Pre-Requisite:

1.Class 12th standard knowledge of physics

2. Class 12th standard knowledge in differential & integral calculus

Course Objective:

The objective of the course is to provide an exposure to the engineering application of the physical principles involved in various unit operations related to processing of ceramic materials. Familiarising the students with the major physical features and the working principles of the equipment for handling various kinds of fluid and transport of heat through conduction, convection and radiation is also a part of the objective. This course also provides an understanding of practical problem solving techniques for the processes as described in section 1, 2, 3 & 4.

Section 1: Fluid Mechanics

Introduction to unit operations for ceramic processes, Units and dimensions, dimensional analysis, Hydrostatic Equilibrium, Manometer, Newtonian & non-Newtonian fluid, Laminar & turbulent flow, Reynold's stress, Boundary layers, Momentum balance and Bernoulli equation, Friction factor and friction factor charts, Pipe, Fittings and Valves, Pumps, Fans and Compressors, Flowmeters, Drag and Friction in flow.

Section 2: Heat Transfer by Conduction

Steady State Heat Transfer by conduction, Fourier's law, Compound resistance in series, Heat transfer through hollow cylinder and spheres, Unsteady state heat conduction, Semi infinite solid, Penetration distance

Section 3: Heat Transfer by convection

Principles of heat flow in fluids, Countercurrent and parallel flows and related temperature profiles, Overall heat transfer co-efficient, Logarithmic mean temperature difference, Individual heat transfer coefficients, Calculation of overall co-efficients, Heat transfer by forced convection, Application of Empirical Equations, Heat exchanger equipments

Section 4: Heat Transfer by Radiation

Fundamental concepts of radiation, Emissivity, Blackbody radiation, Planck's law, Wein's displacement law, Stefan-Boltzman Law, Kirchoff's law, Gray body, Angle of vision, Radiation intensity of blackbody, View factor, Radiation between two black surfaces, Heat exchange between parallel gray surfaces

Course outcome:

After successful completion of the course the student should be able to

CO1: Distinguish the basic features of moving fluids at low and high velocities through pipes in order to determine the frictional losses and propose suitable materials of construction for a pipeline.

CO2: Propose machineries for transportation of fluids with special emphasis on ceramic processes.

CO3: Propose a pipeline layout complete with fittings, valves and flow meters for a flow of fluid with certain flow rate.

CO4: Apply the laws of heat conduction for calculation of heat flow through successive layers of furnace wall.

CO5: Apply the principles of heat flow in fluids to calculate the heat transfer area for a heat exchanger and eventually propose a suitable heat exchanger.

CO6: Apply rudimentary concepts of radiation to determine the amount of heat transfer by radiation in furnaces.

Books recommended:

1. Unit Operations of Chemical Engineering – W. M. McCabe., J. C. Smith., P. Harriot., McGraw Hill

2. Chemical Engineering – Coulson, Richardson, Backhurst and Harker, Pergamon Press

3. Heat Transfer – B. K. Datta., Prentice Hall of India, New Delhi

Energy Resource & Furnaces

Paper Code: PC (CT) 303 Credits: 4

Pre-Requisite:

1. Class 12th standard knowledge of physics and chemistry

2. Class 10th standard knowledge of basic mathematics

Course Objective:

The objective of the course is to provide the knowledge on basic characteristics and the sources of the energy resources being used for processing ceramic materials at high temperature furnaces. Familiarising the students with the major physical features and the working principles of those furnaces as well as the accessories forms a major part of the objective. This course also provides some important clues for solving practical numerical problems related to fuel combustion and furnace efficiency.

A) Energy Resources

Section 1: Basic Definitions

Calorific value, Primary and Secondary Air, Inflammability limits, Flame temperature etc.

Section 2: Solid Fuel

Origin of Coal, Proximate & Ultimate Analysis, Stages of Coal, Coal Petrography, Storage of Coal & Spontaneous combustion; Carbonisation of coal, Low Temperature & High Temperature Carbonization, Coke Making & By-product Recovery, Salient features of LTC & HTC

Section 3: Liquid Fuel

Origin of Petroleum, Classification of Petroleum, Products from Petroleum Distillation, General Scheme of Petroleum Distillation, Cracking, Visbreaking, reforming, sweetening, viscosity index, flash point & fire point, Cloud Point & Pour point, Carbon Residue, Aniline Point & Diesel Index, Octane & Cetane no., Coal-Tar Fuel

Section 4: Gaseous Fuel

Natural gas, Liquefied Petroleum Gas, Producer Gas & water gas

B) Furnaces

Section 1: General Features of Industrial Furnaces

Introduction, Classification of Industrial Furnaces, Components of total Furnace System, Furnaces/Kiln Construction materials.

Section 2: Efficient Utilization of Energy

Heat/Fuel Economy, Energy Audit and its Necessity, Sources of Heat Losses, Factors affecting Fuel Economy, Thermal Efficiency in operation of Furnace, Techniques of waste heat recovery, Recuperators & Regenerators, Operation of different type of Recuperators & Regenerators

Section 3: Dynamics of Flue Gas Movement in a furnace

Definition of Draught; its necessity, Classification of Draught, Deduction of Equations for Calculation of Natural Draught & Chimney Height

Section 4: Study of Typical Furnaces/Kilns and useful Heating Elements

Down Draft Kiln, Tunnel Kiln, Shuttle kiln, Bell type kiln, Glass Tank Furnace, Blast Furnace, BOF, EAF, Roller Hearth Kiln, Rotary Kiln, Induction Furnaces, Electrical Furnaces, SiC, $MoSi_2$ & Lanthanum Chromate heating Element

Course outcome:

After successful completion of the course the student should be able to

CO1: Apply the knowledge of basic definitions and properties of solid, liquid and gaseous fuels to specify right kind and quantity of fuel for use in industrial and other furnaces.

CO2: Apply the knowledge of carbonization of coal for using it for metallurgical and domestic purpose.

CO3: Assess the properties of various petroleum fractions and coal tar fuels for their suitable use as automobile fuel/furnace fuel or as lubricants

CO4: Propose solutions for problems based on various parameters and basic features of common furnaces

CO5: Apply the concept of dynamics of gas movement, fuel economy, techniques of heat recovery, operations of heat exchangers used in ceramic industry.

CO6: Select suitable furnaces & kilns for different ceramic & glass making processes.

Books recommended:

1. Elements of Fuels, Furnaces & Refractories – O.P. Gupta.
2. Fuels & combustions – Samir Sarkar
3. Industrial Furnaces Vol. I & II – Trincs W.
4. The science of Flames and Furnaces – M.W. Thring.
5. Principles of Blast Furnaces for iron making- A.K. Biswas.

Chemical & Engineering Thermodynamics

Paper Code: ES (CT) 308 Credits: 4

Pre-Requisite:

1. Class 12th standard knowledge of physics, physical Chemistry & basic chemical thermodynamics

2. Class 12th standard knowledge in differential & integral calculus

3. Basic concepts of thermodynamics as contained in the syllabus of 1st year of 4-year degree course

Course objective:

A) Chemical Thermodynamics

The objective of the course is to provide the knowledge on thermodynamic and kinetic parameters of solid state reactions including third Law of thermodynamics and its application in crystalline solids. Imparting knowledge on stability of domain in different oxides, configurational entropy of crystalline solid oxides, phase equilibria and phase diagram of binary oxide system, congruent and incongruent melting of oxide ceramics also constitute a major part of the objective.

B) Engineering Thermodynamics

The objective of the course is to provide an exposure to the engineering application of the basic concepts of thermodynamics. Providing major clues as to how the energy balance equation, concept of second law, entropy change and availability can be applied for solving practical problems is also a part of the objective. This course also provides an understanding of practical problem solving techniques for Carnot vapour cycle, Rankine cycle, Diesel cycle and auto cycle by applying the knowledge on properties of pure substance in all three phases and their behaviour in power cycles

Course content

A) Chemical Thermodynamics

Section-1: Thermodynamics of Solid metallic oxide:

Thermodynamically controlled and Kinetically controlled product, Free energy diagram of polymorphic transformation of solid metallic oxide, Chemical potential and Electrode potential of solid oxides, Gibbs-Duhem relation and its application, Gibbs Helmoltz equation and its applicability in ceramic system.

Section-1I: Thermodynamics of Solid State reactions:

Free energy diagram for solid state reactions like calcination, dehydroxylation etc. Stability of domain in different oxides phases, Ellingham Diagram, Chemical equilibrium and equilibrium constant, Reaction isotherm, Temperature dependence of equilibrium constant, Van’t Hoff equation and its application

Section-1II: Statistical Thermodynamics: Thermodynamics probability and Configurational entropy of crystalline solid, Third Law of thermodynamics and its application in ceramic compounds, Specific entropy of solid metallic oxides, Boltzman distribution Law, Partition function and its application

Section-1V: Phase Equilibrium: Phase, Component, Degree's of Freedom, Gibb's phase rule, Phase diagram of one and two component oxide system, Construction of different types of phase diagram, Eutectic and Peritectic reactions with examples. Congruent melting and incongruent melting of solid metallic oxides

B) Engineering Thermodynamics

Section 1:

Concept of energy and various forms of energy, first law applied to elementary processes, Control volume, steady flow process, mass and energy balance in simple steady flow process, application of steady flow process to nozzle, throttling device and turbine/compressor, variable flow processes.

Section 2:

Carnot cycle, efficiency of reversible heat engine, inequality of Clausius, entropy change in irreversible process, principle of increase of entropy, applications of entropy principle, available and unavailable energy, decrease in unavailable energy when heat is transferred through finite temperature difference, available energy from finite energy source, quality of energy, law of degradation of energy, maximum work in a reversible process

Section 3:

Thermodynamic properties of pure substance, P-V-T behaviour of simple compressible substance, ideal and real gas,

Section 4:

Carnot vapour cycle, Ideal Rankine cycle, Reheat Rankine cycle, Air-standard Otto and Diesel cycle.

<u>Course outcome</u>:

After successful completion of the course the student should be able to

CO1: Apply thermodynamic concepts to predict the stability of metal and metallic oxides and the possibility of solid state reactions

CO2: Apply the concept of configurational entropy and third Law of thermodynamics to detect imperfections in crystalline solids

CO3: Utilize the features of phase diagram in eutectic and peritectic system

CO4: Apply mass and energy balances to closed and open systems including various thermal devices such as nozzles, diffusers, turbines and compressors, for solving representative numerical problems.

CO5: Evaluate the performance of energy conversion devices using the concept of second law, entropy change and availability.

CO6: Solve problems involving different practical power cycles using the knowledge on the properties of pure substances like water and changes in properties of substances in various processes.

Books recommended:

1. Introduction to Ceramics— W. D. Kingery, H. K. Bowen & D. R. Uhlmann

2. Solid State Phase Transformation— V. Raghavan

3. Fundamentals of Ceramics—M. W. Barsoum

4. Physical Chemistry—P. C. Rakshit

5.Engineering Thermodynamics – P.K.Nag

6.Thermodynamics: An engineering approach- Yunus A Cengel; Michael A Boles

ENVIRONMENTAL SCIENCES

Paper Code: MC (CT) 301 Mandatory Course

PRE-REQUISITE:

Class 12 standard knowledge of physics, chemistry, biology, mathematics

COURSE OBJECTIVE:

The objective of the course is to provide the students the knowledge as to why the study of environment is of great importance.

They will learn about problems of various types of pollution (anthropogenic and natural), loss of forest, degradation of land, waste disposal, global warming, depletion of ozone layer and loss of biodiversity i.e. degradation of Mother Earth made by the humans.

They will get to know about "Sustainable development", i.e. meeting human goals along with sustaining the ability of natural systems to provide resources and services for mankind to survive.

Disaster management will help them to learn how to manage environmental hazards in the events of natural and anthropogenic calamities.

Knowledge of Environmental Impact Assessment (EIA), which is mandatory for setting up new industries, and various Acts related to environmental protection will help the students in their professional life.

MODULE 1: The Multidisciplinary nature of environmental studies **2 LECTURES**

Definition, scope and importance, Need for public awareness.

MODULE 2: The Natural Resources **5 LECTURES**

Renewable and non-renewable resources:

a) Natural resources and associated problems

Forest resources: Use and over-exploitation, deforestation, mining, dams and their effects on forests and tribal people.

Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dam's benefits and problems.

Mineral Resources: Use and exploitation, environmental effects of extracting and using mineral resources.

Food Resources: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizers- pesticides problems, water logging, salinity.

Energy Resources: Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources.

Land Resources: Land as a resource, land degradation, man induced landslides, soil erosion, and desertification.

b) Role of individual in conservation of natural resources.

c) Equitable use of resources for sustainable life styles.

MODULE 3: Eco Systems **5 LECTURES**

a) Concept of an eco-system: Understanding ecosystems, Ecosystem degradation, Resource utilization

b) Structure and function of an eco-system.

c) Producers, consumers, decomposers.

d) Energy flow in the eco systems: Water cycle, Carbon cycle, Oxygen cycle, Nitrogen cycle, Energy cycle, Integration of cycles in nature

e) Ecological succession.

f) Food chains, food webs and ecological pyramids.

g) Introduction, types, characteristic features, structure and function of (1) Forest ecosystem (ii) Grass land ecosystem (iii) Desert ecosystem (iv) Aquatic eco systems (ponds, streams, lakes, rivers, oceans, estuaries)

MODULE 4: Biodiversity and its Conservation **5 LECTURES**

(a) Introduction, Definition: genetic diversity, species diversity and ecosystem diversity.

(b) Biogeographically classification of India.

(c) Value of biodiversity: consumptive, productive, social, ethical

(d) Biodiversity at global, national and local level.

(e) India as a mega diversity nation.

(f) Hot-spots of biodiversity.

(g) Threats to biodiversity: habitats loss, poaching of wild life, man wildlife conflicts.

(h) Endangered and endemic species of India.

(i) Conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

MODULE 5: Environmental Pollution **6 LECTURES**

(a) Definition,

(b) Causes, effects and control measures of: (1) Air pollution, (2) Water pollution, (3) Soil pollution, (4) Marine pollution, (5) Noise pollution, (6) Thermal pollution, (7) Nuclear hazards

(c) Solid waste Management: Causes, effects and control measures of urban and industrial wastes.

(d) Role of an individual in prevention of pollution.

(e) Disaster management: Floods, earth quake, cyclone and landslides, industrial safety.

MODULE 6: Social issues and the Environment **4 LECTURES**

(a) Urban problems related to energy

(b) Water conservation, rain water harvesting, water shed management

(c) Resettlement and rehabilitation of people; its problems and concerns,

(d) Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust

(e) Wasteland reclamation

(f) Consumerism and waste products

(g) Environment protection Act

(h) Air (prevention and control of pollution) Act

(i) Water (prevention and control of pollution) Act

(j) Wildlife protection act

(k) Forest conservation act

(l) Issues involved in enforcement of environmental legislations

(m) Public awareness

Course outcome:

After completion of the course the students:

CO1: will be able to apply the knowledge regarding how human beings should make a sustainable living using the Earth's finite resources.

CO2: will use scientific methods judiciously in preventing causes which damage natural ecosystems.

CO3: will be able to use the knowledge in protecting endangered and endemic species and conserving biodiversity.

CO4: will use the knowledge in preventing/minimising various types of pollution, their causes and effects.

CO5: will be able to apply their knowledge of disaster management in case of natural and anthropogenic calamities.

CO6: will be able to apply their knowledge of various environment protection acts, “Environment Impact Assessment” (EIA) as and when required in setting up of new industries as well as expansion of industries in which they will be employed.

Recommended Books:

1. Textbook of Environmental studies, Erach Bharucha, UGC

2. Fundamental concepts in Environmental Studies, D D Mishra, S Chand & Co Ltd

3. Environmental chemistry, A. K. Dey

SESSIONALS

Powder Preparation & Chemical Analysis of Ceramic Raw Materials and Products Lab.:

Paper Code: PCL (CT) 304 **Credits: 1.5**

Pre-Requisite:

1. Class 12th standard knowledge of Inorganic Chemistry

2. Class 12th standard knowledge in basic Analytical Chemistry

Course Objective: The objective of the course is to acquire

(a) Knowledge on synthesis of ultrapure ceramic powder by Sol-Gel process & process variable for gelation.

(b) Knowledge on synthesis of ultrapure ceramic powder by Precipitation and co-precipitation techniques in relation with particle size.

(c) Knowledge on synthesis of nano-crystalline ceramic powder by solution combustion techniques.

(d) Knowledge of the different constituents present in different ceramic raw materials by analysing in complex metric method.

(e) Knowledge of the different constituents present in fired ceramic products through different analysing methods.

List of Experiments of Powder Preparation Lab.

1 Synthesis of ultrapure Silica powder by Sol-Gel Method and effect of Catalyst on Gelation.

2 Synthesis of Alumino hydrogel by precipitation techniques and effect of precursor concentration on particle size.

3 Synthesis and characterisation of Alumina from Alumino hydrogel.

4 Synthesis of MAH gel & $MgAl_2O_4$ spinel by co-precipitation techniques

5 Synthesis of Nano crystalline $ZnFe_2O_4$ & Zn/Mg (Fe_2O_4) by solution combustion techniques.

List of Experiments of Chemical analysis Lab.

1. Estimation of SiO_2, Fe_2O_3, Al_2O_3, CaO and MgO in Lime stone/ Marble Dust

2. Estimation of SiO_2, Fe_2O_3, Al_2O_3, CaO and MgO in Dolomite.

3. Complete Analysis of Water Glass.

4. Quantitative analysis of Bauxite.

5. Determination of insoluble portion in Portland cement.

6. Determination of Free Lime content in Portland cement.

7. Complete analysis of Portland cement.

8. Quantitative analysis of Bauxite.

9. Complete Analysis of Soda-lime – silica glass.

10. Quantitative analysis of Blast Furnace Slag.

11. Quantitative analysis of Fly Ash.

12. Rapid estimation of silica in glass sand and glass.

Course Outcome:

After successful completion of the course the student should be able to understand

CO1: The importance of different techniques to synthesis of ultrapure ceramic powder

CO2: The importance of different processing parameter in relation with particle size.

CO3: The importance of synthesis of nano-crystalline ceramic powder

CO4: The chemical composition of various ceramic raw materials & products used in refractory and glass industry.

CO5: The complete analysis of Portland cement, free lime in Cement and insoluble materials content in OPC and Slag cement.

CO6: The composition of water glass and soda-lime-silica glass, blast furnace slag.

CO7: The percentage of silica in silica glass and glass sand.

Fuel Testing Lab:

Paper Code: PCL (CT) 305 Credits: 1.5

Pre-Requisite:

1.Class 12th standard knowledge of physics and chemistry

2. Class 10th standard knowledge of basic mathematics

Course Objective:

The objective of the course is to provide the scope of doing experiments to determine some important basic characteristics of common fuels and lubricants being used for processing ceramic materials at high temperature furnaces. Familiarising the students through printed manual (for each experiment) with the techniques and the major physical features along with the working principles of the instruments with which the said properties are determined is also a part of the objective.

List of Experiments:

1. Proximate Analysis of coal: Determination of Moisture, Volatile Matter, Ash and Fixed Carbon content of coal
2. Determination of Calorific Value of Coal/Oil
3. Studying the nature of change in Viscosity of lube oil at different temperatures
4. Determination of Flash Point and Fire Point of Fuel oils
5. Determination of Carbon Residue of Fuel Oil/Lube Oil
6. Performing Distillation Test for Petroleum Products

Course Outcome:

After successful completion of the course the student should be able to

CO1: Determine basic industrially important properties like calorific value and proximate analysis of solid fuel.

CO2: Determine basic industrially important properties of liquid fuel like Calorific value, flash point & fire point, boiling range etc.

CO3: Determine basic industrially important properties of lubricants like Carbon Residue, Viscosity and Temperature Relationship etc.

Books Recommended:

Respective IS manuals and the manuals provided in the fuel testing laboratory

Numerical Methods Lab:

Paper Code: BS (CT) 308 Credit: 1

Pre-Requisite:

1. Basic knowledge of algorithms

2. Basic knowledge of C programming

Course Objective:

This basic objective of the course is to provide scope for writing program for numerical techniques such as interpolation to estimate and predict for unknown functional values within a huge dataset using C language. This course also provides a scope of writing algorithm and program using high level languages on numeric solutions of nonlinear equations, integrations, ODE and system of equations that arises from different real-life engineering problems. The course also expose students to different software packages where such numerical solutions and their solutions curve are easily visible for complicated numerical problems.

List of Problems:

1. Assignments on Newton forward, backward and Lagrange's interpolation.

2. Assignments on numerical integration using Trapezoidal rule, simpson's 1/3 rule, weddle's rule.

3. Assignments on numerical solution of a system of linear equations using Gauss elimination and Gauss – seidel iterations.

4. Assignments on numerical solution of Algebraic Equation by Regular-Falsi and Newton Raphson methods.

5. Assignment on ordinary differential equation: Euler's and Runge- Kutta methods.

6. Introduction to software packages: C/Matlab/Labview/Mathematica.

Course Outcome:

After successful completion of the course the student should be able to

CO1: write C program program for numerical interpolations to estimate and predict for unknown functional values within a huge dataset

CO2: write algorithm and program using high level languages on numeric solutions of nonlinear equations, integrations, ODE and system of equations that arises from different real-life engineering problems

CO3: deal with software packages like Mathlab/Mathematica/Labview to find numerical solutions of different analytical problems.