PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To prepare students to excel in research or to succeed in Ceramic Technology profession through global, rigorous post graduate education.

II. To provide students with a solid foundation in scientific and Technology fundamentals required to enrich Ceramic Technology.

III. To train students with good scientific and engineering knowledge so as to comprehend, analyze, design, and create novel products and solutions for the real life problems.

IV. To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to relate Ceramic Technology issues to broader social context.

V. To provide student with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career.

PROGRAMME OUTCOMES (POs):

On successful completion of the programme,

1. Graduates will demonstrate knowledge of science and Technology.
2. Graduates will demonstrate an ability to identify, formulate and solve engineering problems.
3. Graduate will demonstrate an ability to design and conduct experiments, analyze and interpret data.
4. Graduates will demonstrate an ability to design a system, component or process as per needs and specifications.
5. Graduates will demonstrate an ability to visualize and work on laboratory and multidisciplinary tasks.
6. Graduate will demonstrate skills to use modern engineering tools, software and equipment to analyze problems.
7. Graduates will demonstrate knowledge of professional and ethical responsibilities.
8. Graduate will be able to communicate effectively in both verbal and written form.
9. Graduate will show the understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
10. Graduate will develop confidence for self education and ability for life-long learning.
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# M. Tech. CERAMIC TECHNOLOGY

## SEMESTER I

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| 7.   | CR7111      | Material Characterization Lab        | PC       | 2              | 0 | 0 | 2 | 1  |
| 8.   | CR7112      | Processing and testing of Ceramics   | PC       | 2              | 0 | 0 | 2 | 1  |

**TOTAL** 22 | 18 | 0 | 4 | 20

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| 8.   | CR7212      | Refractories Lab                     | PC       | 2              | 0 | 0 | 2 | 1  |

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**Employability Enhancement Courses (EEC)**

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OBJECTIVE
The course is aimed to impart basic knowledge about various characterization techniques employed to characterize a ceramic material.

UNIT I CHEMICAL AND THERMAL METHODS
Elemental analysis by wet chemical methods – Volumetric, Gravimetric and Colorimetric analysis. Thermal Methods – TGA, DTA and DSC.

UNIT II SPECTROSCOPIC METHODS
U-V, Visible, FTIR, Raman and NMR spectroscopy – fluorescence and phosphorescence methods – flame photometry – atomic absorption – ICP.

UNIT III X-RAY METHODS

UNIT IV SURFACE AND PARTICLE ANALYSIS
Optical Microscope, SEM, TEM – particle size and surface study – electron microprobe analysis – ion scattering spectrometry (ISS), secondary ion mass spectrometry (SIMS), auger emission spectrometry (AES), electron spectroscopy for chemical analysis (ESCA), AFM, Surface area, pore volume measurements by B.E.T. method, Mercury porosimetry - Particle size measurement – laser diffraction, x-ray diffraction, dynamic light scattering.

UNIT V NON-DESTRUCTIVE METHODS
Analysis of finished goods – ultrasonic techniques – reflection techniques – back reflection and pulse-echo – thickness measurement by resonance; Acoustic emission techniques- Radiographic testing - thermographic testing.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
- Have a basic understanding about chemical methods, spectroscopic techniques, surface analysis.
- Have learnt about various non-destructive methods.
- Have basic knowledge about X-Ray diffraction spectroscopy.

REFERENCES
OBJECTIVE
The course is aimed to impart basic knowledge about crystal structures, phase diagrams and properties of materials.

UNIT I CRYSTAL STRUCTURE

UNIT II PHASE DIAGRAMS
Gibb’s Phase rule – Phase, component, variable, phase diagrams - single, binary and ternary phase diagrams – lever rule – applications of phase diagrams

UNIT III MECHANICAL PROPERTIES

UNIT IV ELECTRICAL AND ELECTRONIC PROPERTIES

UNIT V MAGNETIC , THERMAL AND OPTICAL PROPERTIES

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
- Have a basic understanding about crystal structures and various laws related to structures.
- Have learnt about various properties.
- Have basic knowledge about phase diagrams.

REFERENCES

CR7103 MECHANICAL BEHAVIOR OF CERAMICS

OBJECTIVE
The course is aimed to impart basic knowledge about elasticity, fracture methods, strength, creep behaviour and thermal shock behaviour of ceramic materials.

UNIT I FRACTURE MECHANICS 10

UNIT II STRENGTH 9
Tensile strength – measurement techniques; Factors affecting strength – processing defects & surface defects; Statistical treatment of strength – significance, methods – Gaussian distribution, Weibull distribution. Strength reducing mechanisms – subcritical crack propagation, time dependent strength behaviour, cyclic fatigue, SPT diagram.

UNIT III TOUGHENING 8
Toughening mechanisms – crack deflection, crack bowing, crack branching, crack tip shielding by process zone & bridging effect; Stable crack propagation and R-curve behaviour,

UNIT IV CREEP AND THERMAL SHOCK BEHAVIOUR 9
Introduction to creep, Dislocation creep, diffusion creep, microstructure dependence, multicomponent system techniques, creep deformation maps, creep rupture at high temperatures and safe life design. Thermal stress, thermal shock resistance parameters, thermal stresses and cracking, thermal shock testing techniques, application.

UNIT V FATIGUE AND WEAR 9
Fatigue of ceramics – types, mechanism, measurement, life time prediction. Wear of ceramics – types, mechanism, measurement, factors affecting.
OUTCOME

On completion of the course the students are expected to
Have a basic understanding about elasticity, deformation point of isotropic and
crystalline materials.
Have learnt about various fractures, fracture testing techniques,
strength behaviour and creep on application of loads.
Have basic knowledge about thermal shock resistance parameters

REFERENCES
   Inc., NY.
2. Davidge, R.W., Mechanical Behaviour of Ceramics, Ceramic Book Literature
3. Hasselman, D.P.H and R.A.Heller(Ed), Thermal Stresses in Service Environments,
4. A.C.F Cocks and A.R.C Ponter, 1989, Mechanics of creep brittle material -1 & 2,
   Elsevier Applied Science.
   Dekker Inc.
7. V.Z.Parton and V.G.Borishkovsky, Dynamic Fracture Mechanics (VOl-2) , 1990,
   Hemisphere Publishing.
8. K.Kussmaul, Fracture Mechanics Verification by Large-Scale Testing, 1991,
   Mechanical Engg. Publication.
    & Sons.

CR7104 INTRODUCTION TO CERAMICS

OBJECTIVE
The courses is aimed to impart basic knowledge about traditional ceramics its raw
materials, body preparation, glazing and firing behavior.

UNIT I RAW MATERIALS
Ceramics raw materials – Plastic & non plastic; Clay formation – classification –
ocurrence and mineralogy – Properties of clay-water mixtures and influencing factors
– absorption, cation exchange capacity, plasticity, rheology, electrical double layer
theory, zeta potential & its measurement; Non – plastic raw materials – feldspar and
quartz – properties and characteristics; additives.

UNIT II THEORY OF PACKING
Body composition – packing of two components system – porosity – effect of grain size
– unfired porosity – experimental verification – wet to dry contraction - unfired strength
– permeability and casting rate – dry to fired contraction – fired strength.

UNIT III FABRICATION PROCESS
Triaxial bodies – batch formulations – body formulations – porcelains, stoneware,
earthenware, terracotta; pressing – types, process, defects; Plastic forming – types –
extrusion, jiggering and jollying, injection molding, defects; casting Plaster mould
preparation – slip formation – suspensions/ceramic slurries – stability of slurries, types
of stabilization – fluidity and thixotrophy – various casting techniques – defects.

UNIT IV  GLAZING

UNIT V  DRYING & FIRING

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to have a basic understanding about traditional ceramics.

REFERENCES

CR7111  MATERIAL CHARACTERIZATION LAB  L T P C
0  0  2  1

OBJECTIVE
The course is aimed to impart knowledge about characterization of ceramic Sample.

1. Particle Size Analysis – LASER Diffraction.
2. Determination of Viscosity by Brookfield Viscometer.
3. Thermal Analysis – TGA, DTA.
4. Optical Microscopy
5. Vickers Hardness.
7. Compressive Strength.
8. Wear and Abrasion Resistance.
Equipments:
1. Vickers Hardness tester
2. MOR tester
3. Pin on Disc apparatus
4. Particle size analyser
5. Optical microscope
6. Brookfield Viscometer
7. TGA / DTA
8. CCS machine.

TOTAL: 30 PERIODS

OUTCOME
On completion of the course the students are expected to have basic understanding about different methods of characterizing a ceramic sample.

CR7212 PROCESSING AND TESTING OF CERAMICS LAB

OBJECTIVE
The course is aimed to impart basic practical knowledge about processing and testing of ceramic materials.

2. Analysis of ceramic materials: (i) Silica Content and (ii) Alumina Content
3. Particle Size Distribution – Hydrometer, Andreason Pipette
5. Fabrication Techniques: (i) Uniaxial Pressing & Hot pressing and (ii) Cold Extrusion, (iii) Slip Casting
7. Analysis of strength of ceramic material: Flexural Strength – 3 point & 4 point, Compressive Strength, Tensile Strength, Rheology study, Hot MOR

EQUIPMENTS:
1. Universal testing machine
2. MOR test equipment
3. Hydrometer
4. Hot press

TOTAL: 30 PERIODS

OUTCOME
On completion of the course the students are expected to have a basic understanding about different tests done on ceramic materials in the laboratory.
OBJECTIVE
The course is aimed to impart basic knowledge about various advanced ceramic materials and its structure, properties and applications.

UNIT I  STRUCTURAL CERAMICS
Carbides – nitrides – oxides – SiAlON – borides – silicides – composites

UNIT II  ELECTRONIC CERAMICS

UNIT III  MAGNETIC CERAMICS
Spinel Ferrites – Hexogonal Ferrites – Garnet – Processing and Applications

UNIT IV  SPECIAL GLASSES AND GLASS CERAMICS

UNIT V  BIOMATERIALS
Introduction – biomaterials, bioceramics – composition, interaction with biological systems, properties, applications, shape memory alloys.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have a basic understanding about ceramics in turbine blades, piezoelectrics. Have learnt about various advanced and structural ceramics.
Have basic knowledge about special glasses and glass ceramics.

REFERENCES
OBJECTIVE
The course is aimed to impart basic knowledge about powder preparation techniques and modern ceramic processing.

UNIT I
POWDER PREPARATION
9

UNIT II
PROCESSING ADDITIVES
7
Types, Properties and Effect of addition of liquids and wetting agents, deflocculants, coagulants, binders, plasticizers, foaming and antifoaming agents, lubricants, preservatives.

UNIT III
FORMING
10
Forming of ceramics – dry and semidry pressing - die compaction and isostatic compaction; casting methods - slip casting, pressure casting, gel casting, electrophoretic deposition; plastic forming methods - extrusion, co-extrusion, injection molding, solid freeform fabrication - particle filled polymer methods, powder methods, suspension methods- Porous ceramic forming- foaming, intrusion, organic additives – advanced composite manufacture – CVI, polymer impregnation followed by pyrolysis(PIP).

UNIT IV
SINTERING
11

UNIT V
POST FORMING PROCESSES
8
Mechanism of material removal and its effect on strength; Surface grinding and mechanical polishing - non abrasive finishing - ceramic surface coating; Cutting techniques – water jet cutting, laser ablation; Etching; Joining of ceramics – metal ceramic joints.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have a basic understanding about powder preparation, characterization and compaction.
Have learnt about various techniques for modern processing.
Have basic knowledge about sintering and fired product characterization

REFERENCES
7. K.K.Chawla, Ceramic Matrix Composites

CR7203 PHASE EQUILIBRIA IN CERAMIC SYSTEMS L T P C

3 0 0 3

OBJECTIVE
The course is aimed to enable the students to have a thorough knowledge about the importance of phase equilibrium and analyzing different systems.

UNIT I INTRODUCTION
Introduction, criteria of phase equilibrium, criterion of stability, phase equilibria in single component system and multi component system; Gibb’s phase rule – phase, component, variable; Single component system – H_2O, SiO_2, iron; Binary phase diagrams – Hume Rothery’s rule, congruent and incongruent, solid solutions; Ternary phase diagrams.

UNIT II PHASE DIAGRAMS
Binary Systems – Phase diagram, microstructural constituents, significance of Al_2O_3 – SiO_2, MgO – Al_2O_3, MgO – SiO_2, Al_2O_3 – ZrO_2; Ternary Systems – Phase diagram, microstructural constituents, determination of crystallization path during heating and cooling of K_2O – Al_2O_3 – SiO_2, MgO – Al_2O_3 – SiO_2, Na_2O – Al_2O_3 – SiO_2, CaO – Al_2O_3 – SiO_2.

UNIT III PHASE TRANSFORMATIONS
Introduction, Time Scale for phase transformations; Types of transformations – spinoidal, nucleation & growth, theory of transformation kinetics; Nucleation and growth – nucleation kinetics, homogeneous nucleation, heterogeneous nucleation, growth and overall transformation kinetics; Sintering & crystallization in ceramics and glass forming systems.

UNIT IV EXPERIMENTAL METHODS
Techniques for determining phase diagrams – dynamic, static, microscopic methods – optical, electron microscopy, X-ray methods, thermal analysis.

UNIT V APPLICATIONS
Prediction of alkali corrosion of alumino silicate refractories using phase diagrams – Use of phase diagrams in the study of Silicon nitride ceramics – Application of phase diagrams to the production of advanced composites.

TOTAL : 45 PERIODS
OUTCOME
On completion of the course the students are expected to
Have learnt the basics of phase equilibrium and phase diagrams.
Have studied the thermodynamics behind phase equilibria.
Have a better understanding on the different two component and three component
phase diagrams.
Have studied the types and theory behind phase transformations and also about
nucleation and growth.
Have gained knowledge on the different experimental methods to determine phase
diagrams.

REFERENCES
1. Kingery W.D, Yet Ming Chiang and Dunbar P.Birnie III, Physical Ceramics –
3. Kingery W.D, Bowen H.K and Uhlmann D.Rm Introduction to Ceramics, 2nd Edn.,

CR7204 REFRACTORIES L T P C
3 0 0 3

OBJECTIVE
The course is aimed to impart basic knowledge about refractories, fabrication
methods, testing and monolithics.

UNIT I INTRODUCTION
Definition; Classification of Refractories based on raw materials, temperature, shapes;
Fundamental Properties of Refractories – Physical, Thermal, Mechanical, Chemical and
Electrical; Process industry standards – Indian and International test methods (ISI) –
QC procedures – Statistical QC, ISO 9000 Etc.

UNIT II SILICA & ALUMINO SILICATE REFRACTORIES
Silica – raw materials, manufacturing steps, properties, applications; Alumina – raw
materials, manufacturing steps, properties, applications; Al₂O₃–SiO₂ phase diagram;
Alumino-Silicate – raw materials, types of refractories, manufacturing steps, properties,
applications.

UNIT III BASIC REFRACTORIES
Types - Forsterite, Dolomite, Magnesite, Magnesia Carbon, and Chrome based
refractories; Raw materials, Manufacturing Steps, Properties and Applications.

UNIT IV SPECIAL REFRACTORIES
Raw materials, manufacturing steps, properties and applications of Oxide based –
Cordierite, Zirconia, Thoria, Beryllia; Carbide based – Silicon carbide, boron carbide;
Nitride based – silicon nitride; Fused cast refractories – raw materials, manufacturing
step, properties, applications; Ceramic Fibers – types, properties, applications;
Insulating refractories – preparation, properties, applications.
UNIT V MONOLITHICS

Castables – types, composition, properties, applications; Plastics – types, composition, properties, applications. Dry mixes – types, composition, properties, applications.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have a basic understanding about refractory raw materials, classification and properties.
Have learnt about various fabrication techniques and testing.
Have basic knowledge about monolithics and its applications.

REFERENCES

CR7211 CAD FOR CERAMICS

OBJECTIVE
To impart CAD modeling and design of ceramic components using FEA software.

1. Stress analysis of beams (Cantilever, Simply supported & Fixed ends)
2. Stress analysis of a plate with a circular hole.
4. Thermal stress analysis of 1D component.
5. Thermal stress analysis of 2D component.
7. Stiffness measurement by three point bending.
8. Fatigue studies on 2D component.

TOTAL : 30 PERIODS

OUTCOME
The students are trained to create modeling of basic ceramic components and analyze the same using finite element analysis software.
CR7212

REFRACTORIES LAB

L T P C

0 0 2 1

OBJECTIVE:
To study and compare the physical properties of various refractories.

OUTCOME:
The students may achieve knowledge in the field refractory Ceramics by experimenting the evaluation of physical properties.

1. Preparation and property evaluation of silica refractory of various compositions.
2. Preparation and property evaluation of fire clay refractory with different percentage of grog.
3. Preparation and property evaluation of high alumina refractories of various compositions.
4. Influence of shaping methods on physical properties of refractories.
5. Influence of firing temperature on physical properties of refractories.
6. Preparation of insulating refractory with different pore formers.
7. Determination and comparison of properties of different insulating refractories.
8. Comparing the characteristics of a dense and porous refractory.

TOTAL : 30 PERIODS

EQUIPMENTS:

1. Universal Testing Machine
2. Hot Plate
3. Extruder

CR7301

NANO SCIENCE AND TECHNOLOGY OF CERAMICS

L T P C

3 0 0 3

OBJECTIVE
The course is aimed to enable the students to have a basic knowledge about the developing field on nanotechnology, nanoceramics and composites.

UNIT I
INTRODUCTION
General definition and size effects—important nano structured materials and nano particles—importance of nano materials—applications.

UNIT II
SYNTHESIS & CONSOLIDATION
Bottom up and Top down approach for obtaining nano materials—Precipitation methods—sol gel technique—high energy ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods—laser ablation, sputtering.

UNIT III
NANOCERAMICS
Introduction to nano ceramics—properties of nano ceramics—advanced nano ceramics—carbon nano tubes, fibres, nanosilica-nano alumina—nano titania and zinc oxide—applications.
UNIT IV  PATTERNING

UNIT V  NANO COMPOSITES
Definition - importance of nanocomposites - nano composite materials - classification of composites - metal/ceramics, metal-polymer - thermoplastic based, thermoset based and elastomer based - influence of size, shape and role of interface in composites - applications.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to have a complete knowledge about the preparation, characterization and applications of nano ceramics and composites.

REFERENCES

CR7001  ABRASIVES

OBJECTIVE
The course is aimed to impart basic knowledge about classification of abrasives and importance of grinding and polishing.

UNIT I  RAW MATERIALS

UNIT II  COATED ABRASIVES
UNIT III  COATED ABRASIVE BACKUPS  9
Contact wheels - cloth contact wheels, rubber contact wheels, hardness, face serrations, shape, wheel diameter, speed, belt tension, dressing and protection of contact wheels, their characteristics; Other backups – drums, rolls, pads, and platens – types, characteristics, choice and uses.

UNIT IV  BONDED ABRASIVES  9
Bonded wheel manufacture with different bonds and their characteristics. Shapes and sizes of wheels. Factors determining grinding action – characteristics of abrasive grain, bond type, structure. Other types of wheels – Diamond wheels, reinforced wheels, mounted wheels.

UNIT V  GRINDING AND POLISHING  9

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have a basic understanding about contact wheels, belt tension etc.
Have learnt in detail about coated abrasives.
Have basic knowledge about grinding and polishing Have learnt in detail about bonded abrasives

REFERENCES
2. Coated Abrasives – Modern Tool of Industry, Coated Abrasive Manufacturer’s Institute, Cleaveland, Ohio, 1982.

CR7002  ADVANCED PROCESSING TECHNIQUES FOR CERAMICS  L T P C
3 0 0 3

OBJECTIVE
The course is aimed to impart basic knowledge about non-conventional powder preparation techniques and advanced ceramic processing.
UNIT I  SOL-GEL PROCESS  9

UNIT II  AGGLOMERATION PROCESS  9

UNIT III  BIOMORPHIC CERAMICS  9
Preparation and Characteristics of Biomorphous carbide ceramics: SiC, TiC, SiSiC – Biomorphous oxide ceramics: Al₂O₃, ZrO₂, TiO₂, ZnO – Biomorphous ceramic composites

UNIT IV  MICROWAVE PROCESSING OF CERAMICS  9

UNIT V  ADVANCED CONSOLIDATION TECHNIQUES  9
Hot Isostatic Pressing – Spark Plasma Sintering – Explosive Shock Consolidation

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have a better understanding on powder preparation by sol-gel process and agglomeration process.
Have learnt about biomorphic ceramics and microwave processing of ceramics. Have basic knowledge about advanced consolidation techniques.

REFERENCES

CR7003  BIO CERAMICS  L T P C
3 0 0 3

OBJECTIVE
The course is aimed to enable the students to have a sound knowledge about the applications of ceramic materials in biological field.
UNIT I MATERIALS IN MEDICINE

UNIT II CALCIUM PHOSPHATE CERAMICS

UNIT III BIOACTIVE GLASSES AND GLASS CERAMICS
Surface active glasses, bioactive glass – preparation, mechanical properties, bonding mechanism to living tissue – interfacial bonding. Doped bioactive glasses. High strength bioactive glass ceramics – mechanical and biological properties, bone bonding mechanism, mechanism of surface apatite formation, compositional dependence.

UNIT IV BIOACTIVE COMPOSITES
Hydroxyapatite composites with zirconia, alumina and titania – preparation and properties. SiC whisker reinforced hydroxyapatite and bioactive glass ceramics, zirconia toughened and bioactive glass ceramics, bioglass-hydroxyapatite composites, carbon composites.

UNIT V BIOACTIVE COATINGS
Importance of bioactive coatings. Hydroxyapatite coated metal implants – coating methods, characterization and properties. Bioglass and bioactive glass ceramics coating over metals and alloys.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have learnt the various applications of ceramic materials in the medical field.
Have a complete knowledge about the various calcium phosphate based ceramic materials along with the preparation, properties and applications.
Have studied about the different bioactive glasses and glass ceramic materials. Have studied about the different bioactive composites.
Have studied about the different bioactive coatings.

REFERENCES
OBJECTIVE

The course is aimed to enable the students to have a complete knowledge on the manufacture, quality control and types of cement, and preparation, properties and different types of concrete.

UNIT I  CEMENT


UNIT II  TESTING AND QUALITY CONTROL


UNIT III  TYPES OF CEMENT

Types of Portland cement, blast furnace slag cement, trifer cement, high alulina cement, white and coloured cement, oil well cement, hydrophobic cement, water proof cement, super sulphate cement, sulphate resisting cement.

UNIT IV  CONCRETES


UNIT V  PROPERTIES OF CONCRETE

Strength, permeability, creep, thermal expansion, shrinkage, moisture movement, penetration of X-ray, abrasion resistance, fire resistance, freeze-thaw resistance, electrical properties.

TOTAL : 45 PERIODS

OUTCOME

On completion of the course the students are expected to

- Have studied the raw materials, manufacturing process and mechanism of hydration of cement.
- Have learnt the tests done on cement and the quality control procedures. Have studied the different types of cements and their characteristics.
- Have learnt the types of aggregates and admixtures used for concrete making and the preparation, properties and testing methods of concrete.

REFERENCES

CR7005 CERAMIC CALCULATIONS L T P C
3 0 0 3

OBJECTIVE
The course is aimed to enable the students to have a basic knowledge about the methods of calculating the various ceramic properties.

UNIT I ULTIMATE & RATIONAL ANALYSIS 9
Ultimate analysis, proximate analysis, rational analysis of clay, silica and feldspar - mica convention – substitution of clays in body recipes – triangular plot.

UNIT II DETERMINATION OF PHYSICAL PROPERTIES 9

UNIT III SLIP CALCULATIONS 9

UNIT IV GLAZE CALCULATIONS 9
Molecular weights – formula and use of chemical equations – oxides – percentage composition and formula – calculation of a recipe from a simple glaze formula – given the recipe of a glaze calculate the formula – synthesis of a fritted glaze – given the recipe calculate the formula for a fritted glaze – calculation of the percentage composition of the mill batch

UNIT V GLASS CALCULATIONS 9
Determination of molecular formula of glass from chemical composition of the glass and from glass batch – determination of batch from molecular formula of glass – determination of batch from the given chemical composition – glass yield calculation.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have learnt the basic methods of calculating the properties of ceramic raw materials.
Have learnt to calculate the properties of ceramic bodies. Have learnt to calculate the properties of suspensions.
Have learnt to formulate glaze batches by varying the parameters. Have learnt to formulate glass batches.

REFERENCES
3. R.Charan, Handbook of Glass Technology

CR7006 CERAMIC COATING TECHNOLOGY L T P C 3 0 0 3

OBJECTIVE
The course is aimed to impart basic knowledge about glaze and advanced coating techniques.

UNIT I INTRODUCTION

UNIT II GLAZE
Definitions, classification, raw materials, frit preparation, compounding, frit characteristics and quality testing - glaze body reactions, glaze formulation, additives, thermal characterization, chemical resistance, evaluation methods.
For glasses and coating, unit operations and processes, glaze application methods, selection of glaze to suit end product characteristics, glaze stains, ceramic colors, lusters.

UNIT III CONTROL METHODS

UNIT IV ADVANCED COATING TECHNIQUES
Slurry coating – dip coating, spray coating, plasma spray – EVD, CVD, PVD, thermal spray, magnetic sputtering, laser ablation, nanocoatings - lithography techniques.

UNIT V ENAMELS

TOTAL : 45 PERIODS
OUTCOME

On completion of the course the students are expected to
Have a basic understanding about glazes, manufacturing processes.
Have learnt about various selection and control methods.
Have basic knowledge about advanced coating techniques.

REFERENCES

CR7007 CERAMIC FIBRES AND COMPOSITES L T P C
3 0 0 3

OBJECTIVE

The course is aimed to impart basic knowledge about composites, whiskers and fibres with their properties, manufacturing routes and applications.

UNIT I CERAMIC FIBRES

UNIT II REFRACTORY FIBRES
Alumina silicate, mullite, alumina, silica, zirconia aramid and boron fibres - structure, fibre manufacturing process, properties and applications; silicon carbide fibre – manufacturing process – CVD, polymer pyrolysis , properties and applications.

UNIT III WHISKERS
Whisker forming mechanism, VLS, CVD, silicon carbide, boron carbide and strontium hexa-aluminate whiskers and platelets microstructure, properties and application.

UNIT IV COMPOSITES
Introduction to composite materials – definition, characteristics, classification; Matrix Materials – polymers, metals and ceramics; Fabrication of thermosetting resin matrix composites, thermoplastic resin matrix composites, metal matrix composites, ceramic matrix composites, carbon – carbon composites.

UNIT V CHARACTERIZATION
Physical – density, constituent weight and volume fractions, void volume fraction, thermal expansion co-efficient, moisture absorption and diffusivity, moisture expansion...
co-efficients; Mechanical properties – properties in tension, compression, in place shear properties, flexural properties, impact properties; damage identification using non destructive evaluation techniques – ultrasonics, acoustic emission, x-ray, thermography, laser shearography.

TOTAL : 45 PERIODS

OUTCOME

On completion of the course the students are expected to
Have a basic understanding about whiskers and their forming mechanism. Have learnt about various fibres, their properties and applications.
Have basic knowledge about manufacturing of composites.

REFERENCES

CR7008 CERAMIC MACHINING AND JOINING LT P C 3 0 0 3

OBJECTIVE:
The course is aimed to impart basic knowledge about various machining and joining techniques of ceramics.

UNIT I BASIC MACHINING METHODS
9
Basic machining requirement of ceramics- Ductile grinding –material removal mechanisms. Diamond wheels, Electrolytic In-Process Dressing Grinding of Ceramic materials – Mechanism, Ultrasonic machining,Abrasive water jet machining

UNIT II ADVANCED MACHINING
9

UNIT III SURFACE FINISHING
9
Super polishing of Magnetic heads, Magneto rheological abrasive finishing, Polycrystalline Diamond lapping of ceramics, Flame polishing–Annealing–Healing of surface cracks–Gaseous etching, Ionic polishing of optical surfaces–Ceramic surface texture by reflective replica technique.
UNIT IV JOINING METHODS 9

UNIT V ADVANCED JOINING METHODS 9

TOTAL: 45 PERIODS

OUTCOME:
On completion of the course, the students are expected to
- Have a basic understanding about various joining and machining techniques.
- Have learnt about the surface finishing methods.
- Have basic knowledge about fundamentals in machining and Joining.

REFERENCES:

CR7009 CERAMIC MATRIX COMPOSITES L T P C
3 0 0 3

OBJECTIVE:
The course is aimed to impart basic knowledge about Ceramic Fibres, processing methods, testing and applications of ceramic matrix composites.

UNIT I REINFORCEMENTS AND COMPOSITES 9

UNIT II PROCESSING OF CMC 9
UNIT III THERMAL TREATMENT AND COATING

UNIT IV TOUGHENING AND INTERFACE PROPERTIES
Interphase Properties–Interfacial tensile and shear strength–Strengthening of interphase–coating–Formation of interphase

UNIT V TESTING AND APPLICATIONS

TOTAL: 45 PERIODS

OUTCOME:
On completion of the course the students are expected to
- Have a basic understanding about fibres and reinforcements.
- Have learnt about various processing of ceramic matrix composites.
- Have basic knowledge about ceramic testing and applications.

TEXT BOOK:

REFERENCES:
2. M. Rosso, Ceramic and metal matrix composites: route and properties, Mechanical and Mechanical Engineering, 2003, Italy.

CR7010 ELECTRONIC CERAMIC MATERIALS AND THEIR APPLICATIONS L T P C
3 0 0 3

OBJECTIVE
The course is aimed to impart basic knowledge about ceramic materials used for electronic applications.

UNIT I CERAMIC INSULATORS
Porcelain insulators, low tension and high tension, steatite, forsterite, cordierite and...
high alumina insulators, glass insulators, thermal and mechanical properties, dielectric properties, insulation resistance, electrical conduction, defects, diffusion, oxide conduction.

UNIT II CERAMIC CAPACITORS 9
Properties of barium titanate, effect of various additives and composition on dielectric properties, manufacturing techniques – film capacitors, single layer discrete capacitors, multilayer capacitors, barrier layer, multilayer GBBL capacitors.

UNIT III THERMISTORS AND VARISTORS 9
NTC materials: solid solutions of oxides with the spinel structure, Fe$_3$O$_4$, ZnCr$_2$O$_4$, Fe$_2$O$_4$, MgCr$_2$O$_4$, PTC materials - BaTiO$_3$, SrTiO$_3$ and BLT materials, principles of operation, properties and applications, ZnO varistors, properties and applications.

UNIT IV PIEZO–ELECTRIC CERAMICS 9
Preparation of various types of PZT ceramics, effect of additives, various types of PZT and PLZT devices, PMN, PMMN their properties and applications, actuators.

UNIT V GAS SENSORS AND FUEL CELLS 9
Sensors – principle, types - Zirconia and titania based gas sensors, properties and applications, humidity sensors, fuel cells – principle of operation, fuel cell reaction, types, hydrogen oxygen fuel cell, carbon-oxygen, hydrazine and ammonia fuel cells, high temperature fuel cell, applications.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
- Have a basic understanding about gas sensors and fuel cells, Piezo-electric Ceramics.
- Have learnt about various thermistors and varistors.
- Have basic knowledge about insulators and capacitors.

REFERENCES
2. Levinson, M.L., Electronic Ceramics, 1988, Marcel Dekker, NY.

CR7011 ENVIRONMENTAL ENGINEERING L T P C 3 0 0 3

OBJECTIVE
The course is aimed to impart basic knowledge about pollution and it’s control techniques.

UNIT I POLLUTION DYNAMICS 9
UNIT II EQUIPMENT SELECTION
Choice of techniques - selection of equipment for the treatment of gaseous particulate and liquid effluents of chemical, petrochemical and ceramic industries.

UNIT III TREATMENT AND DESIGN
Waste disposal and treatment for the recovery of valuable chemicals, design of pollution control devices, design of chimneys, stacks for pollution control.

UNIT IV CONTROL TECHNIQUES AND EQUIPMENTS
Counter current wet scrubber, venturi scrubber, absorption system design, adsorption and combustion devices, bag filters, electrostatic precipitation, reverse osmosis, recycle systems and sustainable development.

UNIT V CONTROL PROCEDURES
Sampling procedures, analytical methods, odours and their control, noise pollution and abatement, high voltage transmission and safety, legislative aspects of management. Pollution Act.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
- Have a basic understanding about atmospheric dispersion of pollutants.
- Have learnt about various choice of equipments selection.
- Have basic knowledge about control procedures and various filtration techniques.

REFERENCES

CR7012 FUEL CELLS

OBJECTIVE:
The course is aimed to impart basic knowledge about fuel cells, their types, characterization and application.

UNIT I HYDROGEN STORAGE AND APPLICATIONS

UNIT II PRINCIPLE AND PERFORMANCE

UNIT III TYPES
AFC- PAFC- SOFC- MCFC- DMFC- PEMFC – relative merits and demerits.
UNIT IV  CHARACTERISATION  9
Fuel cell characterization– in-Situ and ex-situ characterization techniques, i-V curve, BET Surface area determination, Structure determinations-chemical determinations.

UNIT V  FUEL CELLS  9
Fuel cell usage for domestic power systems - large scale power generation - Automobile space. Economic and environmental analysis on usage of Hydrogen and fuel cell - Future trends in fuel cells.

TOTAL: 45 PERIODS

OUTCOME:
On completion of the course, the students are expected to
- Have a basic understanding about hydrogen storage.
- Have learnt about fuel cell and their characterization techniques.
- Have basic knowledge about applications of fuel cells.

REFERENCES

CR7013  FUELS, FURNACES AND PYROMETRY  L T P C
3 0 0 3

OBJECTIVE
The course is aimed to enable the students to have a thorough knowledge on the fuels used and equipments involved in firing of a ceramic article, and the temperature measurement methods.

UNIT I  FUELS  9

UNIT II  BURNERS AND COMBUSTION  9

UNIT III  FURNACES  9
Introduction, definition, various parts of furnaces classification and description of different types of furnaces— metal heating furnaces, reheating furnace, continuous furnace, sintering furnace, crucible furnaces, electric furnace, unit melters and smelters, muffle furnace, glass tank furnace, chamber furnace, blast furnace, coke oven batteries. Prevention of energy losses in furnace.
UNIT IV  KILNS  9
Introduction, definition, classification – draught kiln, chamber kiln, tunnel kiln, roller kiln, rotary kiln, continuous kiln, shuttle kiln, top hat kiln, muffle kiln, Hoffman’s kiln – principle, materials used in foundation and construction, working.

UNIT V  PYROMETRY  9
Introduction and thermometry, thermocouples, radiation pyrometers, low temperature measurement, temperature control, heat work recorders – Segar cone, Holdcroft’s bar, Buller rings, Watkin recorders.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
- Have a thorough knowledge on the different types of fuels and burners used based on the fuel type and the types of flame produced from burners.
- Have studied the different types of furnaces and their operation.
- Have a better knowledge on different types of kilns, their construction and working.
- Have a clear understanding on the temperature and heat measurement techniques in kilns and furnaces.

REFERENCES

CR7014  GLASS ENGINEERING  L T P C
3 0 0 3

OBJECTIVE
The course is aimed to impart basic knowledge on manufacture, properties and applications of glass.

UNIT I  GLASS FORMATION  10
Definition. Glass Formation – atomistic hypothesis of glass formation, kinetic approach to glass formation. Structures of glasses – fundamental laws, elements of structural models for glasses, structural models for silicate glasses. Phase diagrams of glass forming oxide systems – CaO-Al₂O₃-SiO₂, Na₂O-CaO-SiO₂ etc.

UNIT II  RAW MATERIALS AND BATCH PREPARATION  9
UNIT III  GLASS MELTING FURNACES
Construction and operation of pot furnace and day tank furnace. Tank furnace – types, design & construction, refractories used. Electric tank furnace – design & operation, electrodes used, electric boosting in tank furnace. Major reactions and physiochemical changes during glass melting.

UNIT IV  FORMING PROCESS

UNIT V  SPECIAL TREATMENTS
Mirror, chemical vapour deposition, physical vapour deposition process, laminated glass, tempered glass, decorated glasses, vycor & micro porous glass, sealing glass, neutral glass, photosensitive glass, glass ceramic, glass fibers.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have a basic understanding about raw materials and batch charging. Have learnt about various fuels and glass melting furnaces.
Have basic knowledge about forming and annealing processes
Have learnt about the properties and applications of special glasses.

REFERENCES
12. Glass & Ceramic Technology, NIIR Board of Consultants & Engineers, Asia Pacific Business Press Inc.
OBJECTIVE
The course is aimed to enable the students to have a sound knowledge about the methods to recover the waste heat from furnaces and also methods to minimize wastage of heat.

UNIT I ENERGY BALANCE IN FURNACE 9
Temperature and thermal conditions in furnace, calculation of thermal operation of furnaces – heat balance & heat capacity of furnace, furnace efficiency, furnace productivity and durability.

UNIT II HEAT EXCHANGERS 9

UNIT III REGENERATORS 11
Principle of operation, types of regenerators, design and construction, materials of construction and applications, performance estimation.

UNIT IV RECUPERATORS 8
Principle of operation, types of recuperators, design, applications, comparison over regenerator.

UNIT V ENERGY CONSERVATION DESIGNS 8
Prevention of energy loss in furnace – insulation, coatings, low thermal mass materials – importance, design and applications.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have a thorough knowledge on thermal operation of furnaces.
Have studied the various heat exchange equipments like heat exchangers, boilers, calandrias and extended surface equipments.
Have learnt the types, design and construction of regenerators. Have learnt the types, design and construction of recuperators.
Have understood the methods of minimizing heat loss and heat consumption in furnace by proper design.

REFERENCES
OBJECTIVE
The course is aimed to enable the students to have a sound knowledge about the types, properties and applications of monolithics and castables.

UNIT I  CASTABLES

UNIT II  PLASTIC REFRACTORIES, RAMMING AND GUNNING MIXES

UNIT III  MORTARS, COATINGS AND DRY VIBRATABLES

UNIT IV  MONOLITHIC INSTALLATION
Methods of installations of castables, plastic refractories, ramming mix and gunning mix. Drying and heating up of installed monolithic lining. Application designs – blast furnace trough design, trough lining, and form design, tundish, steel ladle, electric arc furnace. Linings in installation – anchors, steel fibre reinforcements.

UNIT V  PROPERTIES AND TESTING METHODS
Tests done on monolithics – chemical analysis, density, porosity, strength, high temperature properties, wear - corrosion, erosion, penetration, spalling.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have learnt the types of castables, its composition and characteristics. Have studied about the composition and characteristics of plastic refractories, ramming and gunning mixes, mortars, coatings and dry vibratables.
Have a clear idea on the methods of installing different monolithic materials, the application design and have studied the wear mechanisms and methods to test a monolithic

REFERENCES
OBJECTIVE
The course is aimed to enable the students to have a basic knowledge about the various non-destructive methods of testing.

UNIT I  SURFACE NDT METHODS  7
Introduction- Definition of terms, discontinuities and defects/flaws- fracture mechanics concept of design and the role of NDT- NDE - life extension and life prediction- penetrant testing and magnetic particle testing - basic principle, limitations & advantages – development and detection of large flux – longitudinal and circular magnetization – demagnetization.

UNIT II  RADIOGRAPHIC TESTING  12

UNIT III  ULTRASONIC TESTING  10
Ultrasonic waves- velocity, period, frequency and wavelength- reflection and transmission- near and far field effects and attenuation- generation- piezoelectric and magnetostriction methods- normal and angle probes- methods of Ultrasonic testing-
Principle of pulse echo method- Equipment – examples- rail road inspection, wall thickness measurement- range and choice of frequency.

UNIT IV  EDDY CURRENT TESTING  8
Introduction- principles of eddy current inspection- conductivity of a material- magnetic properties- coil impedance- lift off factor and edge effects- skin effect- inspection frequency- coil arrangements - inspection probes- types of circuit- Reference pieces- phase analysis-display methods-typical application of eddy current techniques.

UNIT V  OTHER METHODS  7

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have studied the basic concepts of non-destructive testing and surface NDT methods
Have learnt about small business and preparation of feasibility chart.
Have a basic knowledge about establishment of a business.
Have learnt about how to manage a business unit.
Have some basic concepts about promotion of entrepreneurship and practical knowledge about some case studies.

REFERENCES

CR7018    NUCLEAR AND SPACE CERAMICS    L T P C
                      3 0 0 3

OBJECTIVE
The course is aimed to enable the students to the basic concepts of ceramic materials used for nuclear and space applications.

UNIT I    NUCLEAR REACTORS
Types of reactors- ordinary water moderated reactors- heavy water cooled and moderated reactors- design, construction and control of nuclear reactors- moderators- coolant- reflectors and structural materials.

UNIT II    CERAMICS IN NUCLEAR REACTORS
Structure, preparation and properties of oxides, carbides, nitrides and composites used in Fission and Fusion nuclear reactors.

UNIT III    NUCLEAR FUEL
Different physical forms of nuclear fuels, nuclear fuel cycle, spent fuel characteristics, post irradiation examination, reprocessing techniques.

UNIT IV    RADIATION PROTECTION
Types of nuclear waste - disposal- ICRP recommendations- radiation hazards and prevention- radiation dose units.

UNIT V    SPACE CERAMICS
Materials aspects of missile and satellite re-entry- aerospace nuclear propulsion technology, auxiliary space powder devices- rocket nozzle technology- the space environment and its effects.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have studied the basic concepts of nuclear physics. Have learnt about the nuclear reactors.
Have studied in detail about the production and properties of various fuels. Have studied about the radiation protection.
Have studied the basics about space ceramics.
REFERENCES

CR7019 NUMERICAL TECHNIQUES L T P C 3 0 0 3

OBJECTIVE
The course is aimed to impart basic knowledge about numerical solutions of partial differential equations.

UNIT I INTERPOLATION AND APPROXIMATION 9
Piecewise spline approximation, uniform approximation, rational approximation

UNIT II NUMERICAL SOLUTIONS OF ORDINARY DIFFERENTIAL EQUATION 9

UNIT III NUMERICAL SOLUTIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9
Second order equations, elliptic, parabolic, hyperbolic types using finite difference methods.

UNIT IV FINITE ELEMENT METHODS 9
One dimensional stress deformation, global and local co-ordinates, one dimensional problems, interpolation functions, relations between global local coordinates, requirements for approximation functions, stress and strain relations, principle of minimum potential energy, potential energy approach for assembly, boundary conditions.

UNIT V PERTURBATION METHOD 9
Perturbation theory, Regular and singular Perturbation Theory. Perturbation methods for linear Eigen Value problems, asymptotic matching

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
• Have a basic understanding about interpolation and approximation..
• Have learnt about various numerical solutions for ordinary and partial differential equations.
• Have basic knowledge about pertubation theories

REFERENCES
2. Desai C.S. Elementary Finite Methods, Prentice Hall 1922 Ch.2&3

CR7020 OPERATION RESEARCH LT P C
3 0 0 3

OBJECTIVE
The course is aimed to impart basic knowledge about linear programming and the various control methods.

UNIT I MATHEMATICAL PROGRAMMING 12
Introduction, linear programming, solution by simplex methods, duality, sensitivity analysis, dual simplex method, integer programming, branch and bound method.

UNIT II DYNAMIC PROGRAMMING 9
Elements of DP models, Bellman’s optimality criteria, Recursion formulae, solution of multistage decision problem by DP method.

UNIT III PERT, CPM 9
Network representation of projects, critical path calculation, construction of the time chart and resource leveling, probability and cost consideration in project scheduling, project control.

UNIT IV ELEMENTS OF QUEURING THEORY 8
Basic elements of the Queuing model, M/M/I and M/M/C Queues.

UNIT V ELEMENTS OF RELIABILITY THEORY 7
General failure distribution of components, Exponential failure distributions, General model, maintained and non-maintained systems.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
• Have a basic understanding about linear programming and its branches.
• Have learnt about various control methods and path calculations of a process in inline. Be capable of understanding failure distributions.

REFERENCES
OBJECTIVE
The course is aimed to impart basic knowledge about Modelling, Optimization and modelling of heat, mass and momentum transfer operations.

UNIT I  BASIC MODELLING

UNIT II  MODELLING OF HEAT, MASS AND MOMENTUM TRANSFER OPERATIONS
Review of heat, mass and momentum transfer operations, Modelling of heat Exchangers, Evaporators, Absorption Columns, Extractors, Distillation columns, Membrane processes.

UNIT III  MODEL DISCRIMINATION AND PARAMETER ESTIMATION
Rate equations, Linear and Non-Linear Regression Analysis, Design of Experiments, Factorial, Central, Fractional Design, Evolutionary Operation Techniques, Case studies.

UNIT IV  OPTIMIZATION TECHNIQUES
Functions, Analytical and numerical methods for single variable and multivariable system, Constrained optimization techniques.

UNIT V  APPLICATION OF OPTIMIZATION

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have basic understanding about formulation, analytical and numerical techniques.
Have learnt about various optimization techniques.
Have basic knowledge about model discrimination, parameter estimation and transfer operations.

REFERENCES
OBJECTIVE
The course is aimed to impart basic knowledge about structural ceramics, its properties, and applications.

UNIT I  MICROSTRUCTURE  9
Quantitative analysis of texture, nature of grain boundaries, development of microstructure, grain growth, microstructure in glass ceramics, effect of particle size, pressure and sintering, dependence of mechanical and thermal properties on microstructure.

UNIT II  MECHANICAL PROPERTIES AT ROOM TEMPERATURE  9
Elastic modulus, tensile and flexural strength, hardness, fatigue, fracture, wear, mechanical shock.

UNIT III  MECHANICAL PROPERTIES AT ELEVATED TEMPERATURES  9
Thermal expansion, thermal conductivity, thermal shock resistance, creep, oxidation, long term stability under severe environmental conditions, toughening of ceramics, tensile & flexural strength (ASTM Standard).

UNIT IV  MECHANICAL APPLICATIONS  9
Wear resistance, rolling element bearings, cutting tool, IC engine, gas turbine, design considerations and failure analysis, material selection.

UNIT V  SPECIAL APPLICATIONS  9
Infra red window materials, lamp envelops, chemical degradation, nuclear waste storage materials, nuclear fuels and fuel cell, ceramic membranes, ceramic armours, ceramic radomes.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have a basic understanding about microstructure, nature of grain boundaries. Have learnt about elastic modulus, thermal shock resistance, etc.
Have basic knowledge about mechanical, optical and chemical applications of structural ceramics.

REFERENCES
2. Howlett, S.P. and D.Taylor (Ed), Special Ceramics, Vol.8 1986, The Institute of Ceramics Shelton, Stock On- Trent, Staff, U.K.
OBJECTIVE
The course is aimed to impart basic knowledge about standardization, quality and preparation of quality manual to keep up with the best end use property.

UNIT I CONCEPTS OF STANDARDISATION 9
Historical development of standards, aims, techniques, management, formulation, implementation of company standards, economic benefits of standardization.

UNIT II CONCEPTS OF QUALITY 9
Definition of quality, quality related terminology, key terms of quality systems, quality management, assurance and audit as per ISO 9000 guidelines.

UNIT III TOOLS OF QUALITY CONTROL 9
Tools of quality management, concepts and management of quality assurance, quality system, quality loop, quality management and its relationship to overall management.

UNIT IV PREPARATION OF QUALITY MANUAL 9
Internal quality audit, audit management, external quality audit, quality certification, quality system maintenance.

UNIT V QUALITY COST 9
Quality improvement, concepts of TQC, TQM, KANBAN, JIT, continuous improvement, HRD in quality management, quality circles, Dr. Deming’s 14 point Management Concept.

OUTCOME
On completion of the course the students are expected to
Have a basic understanding about concepts of quality and standardization. Have learnt about various tools for quality control.
Have basic knowledge about quality cost and preparation of quality manual.

REFERENCES
5. Total Quality Control at Enterprise Level BY International Trade Centre (UNCTAD/GATT/GENEVA), 1986 (Division of United Nations) – Published in India by CMTI – Perfect Machine Tool Trust, Bangalore in Association With National Centre for Quality Management.
OBJECTIVE
The course is aimed to impart basic knowledge about refractory for various industries and conservation.

UNIT I SELECTION CRITERIA & INSTALLATION 9
Criteria for refractory selection – thermal criteria and calculations, structural criteria, chemical criteria. Installation – refractory bricks & shapes, castables, plastics, ceramic fibers.

UNIT II REFRACTORIES FOR FERROUS INDUSTRIES 9
Design, construction and refractories used in coke ovens, blast furnace, steel making furnaces, secondary steel making furnaces, continuous casting, heat treating & forging industries.

UNIT III REFRACTORIES FOR NON-FERROUS METALLIC INDUSTRIES 9
Design, construction and refractories used in copper, aluminum, lead, zinc extraction and processing industries.

UNIT IV REFRACTORIES FOR NON-METALLIC INDUSTRIES 9
Refractories used in refining & petrochemical, fertilizer, cement, glass, ceramic industries. Refractories used in combustors, boilers, incinerators, boilers etc.

UNIT V MAINTENANCE & SAFETY 9
Refractory maintenance & repair; Refractory Economics; Safety, health hazards, pollution control & ecology.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have a basic understanding about applications of refractories in steel, cement, glass industries.
Have learnt about various choice of refractory for kiln furniture.
Have basic knowledge about energy conservation using ceramic fibres.

REFERENCES
OBJECTIVE

The course is aimed to impart basic knowledge about refractory materials and their engineering aspects.

UNIT I MATERIALS
Shaped dense materials-Refractory brick based on $\text{SiO}_2$-$\text{Al}_2\text{O}_3$ system-Basic Refractory Bricks, Carbon containing basic bricks, Carbon containing bricks, Fused cast products-Shaped heat insulating bricks-Un shaped refractory materials-Ceramic fiber materials-metals-Other materials.

UNIT II DESIGN

UNIT III WORKING
Preparation for working guidelines, working and applications -Shaped dense and heat insulating materials-Unshaped refractory materials, Ceramic fiber materials-Welding of anchors.

UNIT IV THERMAL CALCULATION
Problem definition and explanation of terms-Heat conduction-Single Layer wall, multi-layer wall, Cylindrical Wall-Heat transmission-convection, radiation, heat flux, wall design-Heat insulation-Non stationary calculations

UNIT V APPLICATIONS
Application examples of Bottoms - Hearth furnaces, Glass furnaces, Rotary hearth furnaces walls - Arches and crowns - Suspended roofs-piping-pipe walls - Hexmesh linings.

TOTAL: 45 PERIODS

OUTCOME
On completion of the course, the students are expected to
- Have a basic understanding about different refractory materials.
- Have learnt about thermal calculations.
- Have knowledge about working and Industrial applications of Refractory materials

TEXT BOOK:

REFERENCES:
OBJECTIVE
The course is aimed to impart basic knowledge about hazards, its effects, safety and waste management together with risk analysis.

UNIT I  GENERAL  10
Safety - total definition - hazard identification, general hazards of plant operation, toxic hazards, fire & explosions – hazards transport of chemicals with safety unforeseen deviations emergency management, planning for safety, selecting basis of safety preventive and protective measures, safety based on emergency, relief systems, safety based on containment, operational safety procedural instructions Sla-routine checks, process and product charges, safety checks, checklist for safety, leaks and detection.

UNIT II  HAZARDS AND EFFECTS  10
Hazards of plant operation, toxic hazards, fire and explosion hazards, reaction hazards, literature calculations & explosions screening, normal reaction, gas evolution, characterizing runaways, control and mitigation of gas emanations, absorption with chemical reaction, health and environ effects.
special problem of developing countries, safety gadgets, dispersions, degree of hazard, disposals, hierarchy of options, I.C.A. application, nil hazards & alternate methods, threshold limits, laws of safety, accident reporting.

UNIT III  WASTE MANAGEMENT AND ECONOMICS  10
Storage, central handling safety, unintentional spills, run offs emits, containment economics, waste disposal and environmental projection, incineration, alternatives.

UNIT IV  RISK ANALYSIS  15
Risk analysis, evaluation, mitigation, hazop, hazard, definition, probability, quantification risk, engineering, clean technology, initiatives, standards, emergency handling, accident investigation, legislation, nil risk quantification methods, case histories of accidents, examples of hazards assessment, examples of use of hazard, explosion hazards in batch units, technical process, documentation for hazardous chemicals, format and methods.

TOTAL: 45 PERIODS

OUTCOME
On completion of the course the students are expected to
Have a basic understanding about hazard identification and checks for safety.
Have learnt about various waste management techniques.
Have basic knowledge about risk analysis, format and methods.

REFERENCES

CR7027 SPECIAL GLASSES L T P C 3 0 0 3

OBJECTIVE
The course is aimed to enable the students to have a thorough knowledge about the special applications of glasses in various fields.

UNIT I HEAT RESISTANT AND SAFETY GLASSES 9

UNIT II OPTICAL GLASSES 9

UNIT III GLASS FIBRES 9
Composition for fibre glass, glass wool, manufacturing process and applications. Optical fibres – optical properties of fibres, silica based glass fibres – applications in optical communication.

UNIT IV GLASS CERAMICS 9
Glass composition, heat treatment schedule, crystal nucleation in glass, nucleating agent, microstructure and properties, applications, machinable glass ceramics.

UNIT V COATED GLASS 9
Coating methods – physical vapour deposition, chemical vapour deposition. Types of coatings, characteristics of coated glass, applications of coated glasses, quality control of coated glass.

TOTAL : 45 PERIODS

OUTCOME
On completion of the course the students are expected to
- Have a clear understanding on the types and properties of heat resistant and safety glasses.
- Have studied the manufacture, types and applications of optical glasses.
- Have studied the composition of glass fibres and optical fibres, and their applications.
- Have learnt the composition, preparation and properties of glass ceramics.
- Have a knowledge on the methods and types of coatings on glass, their applications and quality control.
REFERENCES