

**3CR1A: Ceramic Raw Materials & Characterization**

**B.Tech. (Ceramic) 3<sup>rd</sup> Semester**  
3L

**Max. Marks: 80**  
**Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	<b>Rocks Types:</b> Various types of rocks; igneous, sedimentary and metamorphic.	3
	<b>Structures rocks:</b> Textures, Structures and classification of above rocks. Origin of igneous, sedimentary and metamorphic rocks.	4
	<b>Geology</b> and its utility in ceramic industry.	1
II	<b>Ceramic Minerals:</b> Description and classification of various minerals based on their chemical compositions, Physical properties and occurrence.	3
	<b>Brief idea on processing of synthetic raw materials:</b> Bayer process, Calcined Alumina, Tabular Alumina, Fused Alumina, Sea-water Magnesia, Zircon and Zirconia, Titania, Magnesio-Aluminate Spinel, Fumed Silica etc.	4
	<b>Application &amp; limitations:</b> The application areas and limitations of synthetic raw materials.	1
III	<b>Ceramic Raw materials:</b> Importance, use and limitations of natural raw materials in refractories, whitewares, cement, potteries, and glass ceramic Industries; Bauxite, Limestone, Chromite, Magnesite, Dolomite, Fluorite, Graphite, Gypsum, Haematite, Kaolinite, Fireclay, Ball clay, Montmorillonite, Magnetite, Nepheline Syenite, Microcline, Feldspars (soda, potash, lime), Pyrophyllite, Quartz, Quartzite, Sillimanite, Kyanite, Andalusite, Talc, Wollastonite, Zircon, Beryl, Mica, Vermiculite, Silica sand etc ;	9
IV	<b>Optical Properties:</b> Optical activity, Polarizing microscope, Isotropic and anisotropic minerals, Bi-refringence, Pleochroism, Propagation of light through uni-axial and bi-axial minerals, Extinction, Cleavage and interference figures, Beck's effect.	5
	<b>Optical microscope:</b> Systematic description of minerals under polarizing microscope.	2
V	<b>Chromatography:</b> Introduction, Paper and thin layer chromatography, Liquid chromatography, Types of liquid chromatography, Column and detection systems.	4
	<b>Effect of heat on different raw materials:</b> Differential thermal analysis (DTA), thermo gravimetric analysis (TGA), thermal analysis, Differential Scanning Calorimetry (DSC), Factors affecting the phase transformations with suitable examples, Dilatometry–basic principles, instrumentations and case study in ceramic applications.	4
	<b>TOTAL</b>	<b>40</b>

### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	Dr. Praveen Singh/Engineering Geology	2012
2	W. E. Worrall /Ceramic Raw Material /Pergamon Press	1982
3	S. Kumar/Hand Book of Ceramic/Kumar and Associates	1995

### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	Chatwal Anand/Instrumental Methods of Chemical Analysis / Himalaya Pub.	2009
2	R. F. Speyer/Thermal Analysis of Materials/CRC Press	1994
3	Berry/ Mineralogy/ W H Freeman & Co (Sd); 2 Sub edition	1983
4	Braithwaete/Chromatographic Methods /Chapman and Hall	1996
5	Sinton/Raw Materials for Glass and Ceramics /Wiley	2006
6	Paul Bormans/ Ceramics are More Than Clay Alone/Cambridge International Science Publishing	2004

**3CR2A: CERAMIC PROCESSING**

**B.Tech. (Ceramic) 3<sup>rd</sup> Semester**  
**3L**

**Max. Marks: 80**  
**Exam Hours: 3**

<b>UNIT</b>	<b>CONTENTS</b>	<b>CONTACT HOURS</b>
I	<b>Ceramic Fabrication Processes:</b> Introduction, Ceramic fabrication processes & their classification viz. Gas phase reactions, Liquid precursor methods etc.	5
	<b>Production of polycrystalline ceramics from powders:</b> An overview, A case study in processing	3
II	<b>Science of colloidal processing of ceramics:</b> Introduction, Types of colloids, Attractive surface forces, Electrostatic, Steric and electrostatic stabilizations, Structure of consolidated colloids	5
	<b>Rheology:</b> Detailed study of rheology of ceramic systems. Particle sol-gel processing	3
III	<b>Forming of ceramics and powder consolidation method:</b> Introduction, Characteristics of solid particles, Particle shapes, Size, Equivalent particle diameter, Surface area, Average particle size & size distribution.	6
IV	<b>Binders &amp; Additives:</b> Packing of particles, Additives in forming processes, Selection of additives; Solvent, Binder, Plasticizers, deflocculants and lubricant,	3
	<b>Dry and semidry pressing methods:</b> Dry and semidry pressing methods, Die compaction and isostatic compaction,	3
	<b>Casting methods:</b> slip casting, pressure casting and tape casting,	3
	<b>Plastic forming method:</b> extrusion and injection molding.	2
V	<b>Drying &amp; Calcination:</b> Drying of cast or extruded articles, Binder removal, Calcinations & affecting factors	4
	<b>Sintering:</b> Introduction to sintering of ceramics, Hot and iso-static processing of ceramics.	3
	<b>TOTAL</b>	<b>40</b>

**TEXT BOOK**

<b>SN</b>	<b>Name of Authors/Books/Publishers</b>	<b>Year of Publication</b>
1	M. N. Rahaman/ Ceramic Processing and Sintering/ 2nd Ed/ CRC Press,	2003.
2	J.S. Reed/ Introduction to the Principles of Ceramic Processing/ 2nd Ed./ John Wiley & Sons.	1995.

## REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	D. W. Richerson/ Modern Ceramic Engineering: Properties, Processing, and Use in Design/ 3 <sup>rd</sup> ed/ CRC Press	2005.
2	D. A. Brosan and G. C. Robinson/ Introduction to Drying of Ceramics: with laboratory exercises/Net Library/ Incorporated,	2003.
3	H. Mehrer/ Diffusion in Solids: Fundamentals, Methods, Materials, Diffusion-Controlled Processes/ Springer,	2007
4	David Segal/ Chemical Synthesis of Advanced Ceramic Materials/ Cambridge University Press	1989.
5	A. J. Moulson and J. M. Herbert./Electroceramics: Materials, Properties and Applications/ John Wiley & Sons	2003
6		

**3CR3A: MATERIALS SCIENCE**

**B.Tech. (Ceramic) 3<sup>rd</sup> Semester**  
**3L+1T**

**Max. Marks: 80**  
**Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	<b>Crystallography:</b> Introduction, Space lattice, Bravais lattice, Basis, Unit Cell, Lattice parameters, Crystal structure, Factor affecting ceramic crystal structures, Miller indices, crystal symmetry.	5
	<b>Different crystal structures:</b> BCC, FCC and HCP. Study of AX, $A_mX_p$ , and $A_mB_nX_p$ type ceramic crystal structures.	3
II	<b>Type of standard crystal structures:</b> Introduction, Structure of silicates (Orthosilicates, Pyrosilicates, Single chain, Double chain, Sheet and Network silicates), Structure of kaolinite clay $Al_2(OH)_4(Si_2O_5)$ , Talc $Mg_3(OH)_2(Si_2O_5)_2$ , and Mica $KAl_2(OH)_2(AlSi_3O_{10})$ , Zeolite.	5
	<b>Polymers and Liquid crystals.</b> Polymer and liquid crystals	3
III	<b>Crystal imperfection: Classification of defects in natural crystals:</b> Point, Line, Plane, Electronic imperfections, Transient imperfection. Points defects: thermodynamics of point defects, Lattice vacancies, Schottky defects, Frenkel defects, Extrinsic vacancies and colour centers.	4
	<b>Dislocations:</b> Introduction, edge and screw dislocations, Burger vector, Slip systems, Energy of dislocations, Theory of dislocation, Interaction between dislocations.	4
IV	<b>Mechanical Properties:</b> Mechanism of plastic deformation, Strengthening mechanism, Recovery recrystallization and grain growth, Dislocations in crystal growth.	3
	<b>Imperfection Techniques, Effect:</b> Effects of crystal imperfection on electronics, optical and mechanical properties and technique for imperfect determination and controlling the crystal imperfection in crystal growth	3
	<b>Diffusion:</b> Diffusion, Diffusion mechanisms, Steady-State Diffusion, Nonsteady-State Diffusion, Factors that influence Diffusion	2
V	<b>Optical properties:</b> Interaction of electromagnetic waves with matter. Absorption, reflection, transmittance and colour of materials.	2
	<b>Photoconductivity:</b> Introduction. Photo conducting materials. Electronic transition in photoconductors. Absorption and Excitation. Trapping and capture. Simple model of a photoconductor.	3
	<b>Luminescence:</b> Introduction. Model for luminescence in sulphide phosphors. Thallium activated alkali halides. Electroluminescence.	3
	TOTAL	40

**TEXT BOOK**

<b>SN</b>	<b>Name of Authors/Books/Publishers</b>	<b>Year of Publication</b>
1	W. F. Smith/ Foundations of Materials Science and Engineering/ McGraw-Hill Professional.	2003.
2	V. Raghavan/ Materials Science and Engineering 4th Ed/ Prentice- Hall of India Pvt. Ltd, New Delhi.	2004
3	J. F. Shackelford and M. Meier/ Introduction to Materials Science for Engineers/ Prentice Hall PTR.	2005
4	W. D. Calister/ Material Science and Engineering By/Willy India	2006
5	Shackelford /Introduction to Materials Science for Engineers/ Prentice Hall	2008
6	Chung/ Introduction to Materials Science and Engineering /CRC Press	2006

**REFERENCE BOOKS**

<b>SN</b>	<b>Name of Authors/Books/Publishers</b>	<b>Year of Publication</b>
1	W. D. Kingery, H. K. Bowen and D. R. Uhlmann/ Introduction to Ceramics, 2nd Ed./ John Wiley & Sons, Singapore.	1991
2	L.V. Azaroff/ Introduction to Solids/ Tata McGraw Hill Publishing Co. Ltd.	1977
3	L. H. V. Vlack/ Elements of Materials Science and Engineering, 6th Edition/ Prentice Hall,	1989

**3CR4A: ELECTRONIC MEASUREMENT & INSTRUMENTATION****B.Tech. (Ceramic) 3<sup>rd</sup> Semester**  
**3L****Max. Marks: 80**  
**Exam Hours: 3**

<b>UNIT</b>	<b>CONTENTS</b>	<b>CONTACT HOURS</b>
I	<b>Theory of errors:</b> Accuracy & precision, Repeatability, Limits of errors, Systematic & random errors Modeling of errors, Probable error & standard deviation, Gaussian error analysis, Combination of errors.	8
II	<b>Electronic Instruments for measuring basic parameters:</b> Electronic Voltmeter, Electronic Multimeters, Digital Voltmeter, Component Measuring Instruments, Q meter, Vector Impedance meter, RF Power & Voltage Measurements. Measurement of frequency. Introduction to shielding & grounding.	7
III	<b>Oscilloscopes:</b> CRT Construction, Basic CRO circuits, CRO Probes, Oscilloscope Techniques of Measurement of frequency, Phase Angle and Time Delay	5
	<b>Types of Oscilloscopes:</b> Multibeam, multi trace, storage & sampling, Oscilloscopes. Curve tracers.	4
IV	<b>Signal generation:</b> Sine wave generators, Frequency synthesized signal generators, Sweep frequency generators.	4
	<b>Signal Analysis</b> - Measurement Technique, Wave Analyzers, Frequency – selective wave analyser, Heterodyne wave analyser, Harmonic distortion analyser, Spectrum analyser.	4
V	<b>Transducers:</b> Introduction, Classification, Selection Criteria, Characteristics, Construction, Working Principles	3
	<b>Application of Transducers-</b> RTD, Thermocouples, Thermistors, LVDT, RVDT, Strain Gauges, Bourdon Tubes, Bellows. Diaphragms, Seismic Accelerometers, Tachogenerators, Load Cell, Piezoelectric Transducers, Ultrasonic Flow Meters.	5
	<b>TOTAL</b>	<b>40</b>

**TEXT BOOK**

<b>SN</b>	<b>Name of Authors/Books/Publishers</b>	<b>Year of Publication</b>
1	A.K. Sawhney/ Electronic Measurement & Instrumentation/ Dhanpat Rai & Sons.	2002
2	H.S. Kalsi/ Electronic Measurement & Instrumentation /Tata Mc Graw Hill.	2004

**REFERENCE BOOKS**

<b>SN</b>	<b>Name of Authors/Books/Publishers</b>	<b>Year of Publication</b>
1	Electronic Measurements & Instrumentation/ Bernard Oliver/ TMH	2008
2	Introduction To Measurements And Instrumentation/ Arun K. Ghosh/ PHI	2012
3	Electronic Instrumentation And Measurements/ David A. Bell, PHI	2012
4	Theory And Design For Mechanical Measurements/ Figliola/ Wiley	2011
5	Electronic Instrument And Measurement/ Bell/ Oxford	2007
6	Electronic Measurements And Instrumentation/, Dally/ Wiley	1993
7	Instrumentation Measurement & Analysis, B.C.Nakra/ K.K. Chaudhry/ TMH	2004



**3CR5A: THEORY OF SOLID MECHANICS**

**B.Tech. (Ceramic) 3<sup>rd</sup> Semester**  
**3L+1T**

**Max. Marks: 80**  
**Exam Hours: 3**

<b>UNIT</b>	<b>CONTENTS</b>	<b>CONTACT HOURS</b>
I	<b>Stress-strain:</b> Tensile, Compressive, Shear stress and strain. Stress-strain diagram	3
	<b>Stress-strain Relationships:</b> Hooke's law, Poisson's ratio, elastic constants and their relationships for a isotropic homogeneous material, thermal stresses.	5
II	Composites bars, simple elastic, plastic and visco-elastic behavior of common materials in tension and compression test, concept of factor of safety and permissible stress.	3
	Mohr's circle of stress and strain, a brief theory of elastic failures	5
III	Types of load, types of beams, Introduction to bending moment and shear force diagrams	3
	bending stress and shear stress distributions in various sections viz. circular, hollow, T etc	3
	Torsional shear stress in solid, hollow and stepped circular shafts; Concept of equivalent bending and equivalent twisting moment,	3
IV	<b>Kinematics:</b> Elements, pairs, mechanism, four bar chain and its inversions.	3
	Velocity and acceleration, Klein construction, Instantaneous center method, synthesis of mechanism, pantograph, Scott-Russel mechanism	3
	Trifler suspension and Hooke's joint	2
V	<b>Friction:</b> Laws of static, dynamic and rolling friction, dry & viscous friction, inclined plane and screw jack, friction axis, bearing and theory of film lubrication	4
	<b>Clutches.</b> Introduction to thin and thick walled cylinders.	3
	<b>TOTAL</b>	<b>40</b>

**TEXT BOOK.**

<b>SN</b>	<b>Name of Authors/Books/Publishers</b>	<b>Year of Publication</b>
1	B.C. Punnia/ Theory of Solid Mechanics	2002
2	Sadhu Singh /Strength of Materials/ Khanna Publishers.	1980
3	Timmosoko/Theory of Solid Mechanics/CBS	2002

**REFERENCE BOOKS**

<b>SN</b>	<b>Name of Authors/Books/Publishers</b>	<b>Year of Publication</b>
1	Crandall, Dahl and Lardner/An Introduction to the Mechanics of Solids/ Tata McGraw Hill.	2008

2	Beer, Johnston, Dewolf and Mazurek/Mechanics of Materials/Tata McGraw Hill.	2006
3	Ryder G.H./Strength of Materials/Macmillan India.	2002
4	Punmia, Jain and Jain/Mechanics of Material/Laxmi Publications.	2001

**3CR6A: ADVANCE ENGG. MATHEMATICS-1**

**B.Tech. (Ceramic) 3<sup>rd</sup> Semester**  
**3L +1T**

**Max. Marks: 80**  
**Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	<b>Laplace Transform</b> - Laplace transform with its simple properties, applications to the solution of ordinary and partial differential equations having constant co-efficients with special reference to the wave and diffusion equations	8
II	<b>Fourier series:</b> Expansion of simple functions in Fourier series. Half range series, Change of intervals, Harmonic analysis.	4
	<b>Z Transform:</b> Z Transform - Introduction, Properties, Inverse Z Transform	4
III	<b>Fourier Transform</b> - Complex form of Fourier Transform and its inverse, Fourier sine and cosine transform and their inversion.	4
	<b>Applications of Fourier Transform:</b> Applications of Fourier Transform to solution of partial differential equations having constant co-efficient with special reference to heat equation and wave equation.	4
IV	<b>Complex variables</b> - Analytic functions, Cauchy-Riemann equations, Elementary conformal mapping with simple applications, Line integral in complex domain,	4
	<b>Cauchy's theorem:</b> Cauchy's theorem. Cauchy's integral formula.	4
V	<b>Complex variables:</b> Taylor's series Laurent's series poles, Residues,	4
	<b>Evaluation of simple definite real integrals</b> using the theorem of residues. Simple contour integration.	4
	TOTAL	40

**TEXT BOOK**

SN	Name of Authors/Books/Publishers	Year of Publication
1	Dr. D. N. Vyas/Engineering Mathematics-3	2008
2	Dr. Kantesh Gupta/Engineering Mathematics-3/Ashirwad	-
3	T Veerarajan/Engineering Mathematics/ TMH	2005
4	Jordan/ Mathematical Techniques/ Oxford	2008

## REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	Potter/ Advance Engineering Mathematics/Oxford	2005
2	Dutta/Text BOOK Of Engineering Mathematics/New Age	2006
3	Dutta, D./Mathematical Methods/New Age	2002
4	Irvin Kreyszig/ Advanced Engineering Mathematics/Wiley	2011

### 3CR7: CERAMIC RAW MATERIAL & CHARACTERIZATION LAB

1. Determination of sulphate and chlorides in a given sample.
2. Determination of bicarbonates in a given sample.
3. Estimation of  $\text{Na}_2\text{O}$ ,  $\text{K}_2\text{O}$  and  $\text{B}_2\text{O}_3$  present in a sample.
4. Chemical analysis of limestone for insoluble content  $\text{R}_2\text{O}_3$  (R = Fe, Al etc.), CaO, MgO.
5. Chemical analysis of gypsum and dolomite for insoluble content.
6. Chemical analysis of a given sample of sand.
7. Thermo gravimetric analysis of a given sample.
8. Differential thermal analysis of given sample.
9. Determination of moisture content in a given sample using Infrared Moisture Balance.
10. Determination of thermal behavior of ceramic specimen by dilatometric method.

### 3CR8: MINERALOGY AND MICROSCOPY LAB

#### Section A: Mineralogy

1. Determination of specific gravity of mineral by Pycnometer.
2. Megascopic identification in hand specimen of important rock forming minerals.
3. Sieve Analysis of Ceramic Raw Material through dry process using sieve shaker.
4. Sieve Analysis of Ceramic Raw Material through wet process using sieve shaker.

#### Section B: Microscopy Laboratory

5. Study of a polarizing microscope and its different parts, setting of a polarizing microscope and centering of the object.
6. Study of Becke's effect and refractive index of given materials.
7. To prepare and identify the following minerals in thin section used in ceramic industries : Quartz, orthoclase, albite, silimanite, kyanite, andalusite, gypsum, calcite, hornblende, tourmaline, muscovite, biotite, quartzite, limestone, labradorite and other ceramic minerals..
8. Preparation and identification of rocks in thin section under microscope such as: quartzite, gypsum, dolomite, limestone, granite, gabbro, basalt, schist, gneiss.

### 3CR9: ELECTRONICS MEASUREMENT & INSTRUMENTATION LAB

1. Measure earth resistance using fall of potential method.
2. Plot V-I characteristics & measure open circuit voltage & short circuit current of a solar panel.
3. Measure unknown inductance capacitance resistance using following bridges  
(a) Anderson Bridge (b) Maxwell Bridge.
4. To measure unknown frequency & capacitance using Wein's bridge.
5. Measurement of the distance with the help of ultrasonic transmitter & receiver.
6. Measurement of displacement with the help of LVDT.
7. Draw the characteristics of the following temperature transducers:  
(a) RTD (Pt-100) (b) Thermistors (c) Thermocouple
8. Draw the characteristics between temperature & voltage of a K type thermocouple.
9. Measure the speed of a Table Fan using stroboscope.

### 3CR10: SOLID MECHANICS AND MACHINE LAB

1. To determine the co-efficient of friction for the given surface and samples.
2. To determine moment of inertia of the given object using of Trifler suspension.

3. Direct tensile test of the given samples Using UTM.
4. Torsion test on torsion testing machine of a given sample.
5. Shear/bending test of a given sample using UTM.
6. Determination of spring constant K of the given sample using spring testing machine.
7. Fatigue testing of a given sample.
8. Impact test of given sample.

**3CRDC: DISCIPLINE & EXTRA CURRICULAR ACTIVITY**

**4CR1A: CERAMIC ANALYSIS AND INSTRUMENTATION**

**B.Tech. (Ceramic) 4<sup>th</sup> Semester**

**Max. Marks: 80**

**3L**

**Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	<b>Crystallography:</b> Continuous and characteristic emission of X-rays. Absorption filters. Diffraction. Bragg's Law powder and single Crystal X-ray diffractometer. Atomic scattering factor. Geometrical structure factor. Indexing of diffraction patterns, determination of structure and lattice parameters.	5
	<b>Applications of XRD &amp; XRF:</b> Applications of X-ray diffraction in ceramic systems, X-ray fluorescence (XRF).	4
II	<b>Spectroscopic Analysis:</b> Introduction, Absorption and reflection techniques	2
	<b>Atomic techniques:</b> emission, absorption and fluorescence, Photo acoustic spectroscopy, Microwave spectroscopy and mass spectrometers. Atomic Absorption spectrometer. IR, FTIR and Raman– Basic principle, instrumentation and analysis of data.	5
III	<b>Gas and Liquid Analysis 1:</b> Infrared and ultraviolet absorption analyzers, Paramagnetic oxygen analyzers, Thermal conductivity analyzers,	4
	<b>Gas and Liquid Analysis 2:</b> Chemical luminescence analyzers and flame photometer and its uses in analysis. PH meters, conductivity meter, analyzers for measurement of ammonia, silica, sodium and dissolved oxygen.	4
IV	<b>Electron Microscopy 1:</b> Principle construction and operation of Scanning Electron Microscope, principle construction and working of	4
	<b>Electron Microscopy 2:</b> Transmission Electron Microscope (TEM), Electron Diffraction, Bright field and dark field images, SAD. Sample preparation of ceramic materials for SEM, TEM and EPMA.	4
V	<b>Particle Size,:</b> Light scattering, Coulter counter, Sieving, X-ray line broadening and sedimentation method for particle size measurements	4
	<b>Surface Area and Porosity Measurements,</b> BET surface area measurements, Gas Adsorption, Mercury porosimetry and Pycnometry for porosity of powders.	4
	TOTAL	40

**TEXT BOOK**

SN	Name of Authors/Books/Publishers	Year of Publication
1	B. D. Cullity/ Elements of X-ray Diffraction/ Addison Wesley Publishing Company; 2nd edition	1978
2	R. F. Speyer/ Thermal Analysis of Materials/ CRC Press,	1994
3	M. N. Rahaman/ Ceramic Processing and Sintering, 2nd Ed/ CRC Press	2003
4	Willard ,Dean, Merit/ Instrumental Methods of Analysis/ CBS	1988

**REFERENCE BOOKS**

SN	Name of Authors/Books/Publishers	Year of Publication
1	P.J. Goodhew, J. Humphreys and R. Beanland/ Electron Microscopy and Analysis/, Third Edition, Taylor & Francis,	2001
2	H. P. Klug and L. E. Alexander/ X-ray Diffraction procedures for Polycrystalline and Amorphous Materials/ 2nd Edition, John Wiley,	1974.
3	Dally/ Instrumentation for Engineering Measurement/ Willey	1984
4	D. A. Skoog, F. J. Holler and T. A. Nieman/ Principles of Instrumental Analysis, 5th Ed./ Hartcourt College Publishers.	1998

**4CR2A: HEAT AND MASS TRANSFER**

B.Tech. (Ceramic) 4<sup>th</sup> Semester  
3L+1T

Max. Marks: 80  
Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Conduction:</b> Heat transfer by conduction. Fourier's law, thermal resistances in series, conduction through infinite slab, thick walled cylinder and thick sphere, variation of conductivity with temperature	3
	<b>Convection:</b> Heat transfer through liquid. Newton's law, film coefficient, natural and forced, overall heat transfer coefficient, heat transfer coefficient based on inside and outside areas, dirt and foul factors, elementary concepts of dimensionless numbers, their use in predicting film coefficient, heat transfer to liquid under laminar and turbulent flows, forced convection outside tubes.	5
II	<b>Radiation and furnace:</b> Stefan-Boltzmann law, emissivity and absorptivity, black and grey bodies, view factors, gas radiation, radiant heat transfer in glass melting.	3
	<b>Furnaces:</b> solid, liquid and gaseous fuels, their feeding devices, primary and secondary air for combustion, complete and partial combustion, calculation of radiant heat transfer in furnaces.	4
	<b>Fuel gas:</b> analysis and its utility, purpose of furnace linings and higher chimneys, application to steam boilers	2

III	<b>Heat Exchanger:</b> Shell and tube heat exchangers, baffles, design of heat exchanger and their relative advantages, multi pass heat exchangers	4
	<b>LMTD:</b> Mean temperature difference in co-current and counter current flows, LMTD correction factor for multi pass heat exchanger, plate heat exchanger, Current, counter current and cross-flow heat exchangers.	4
IV	<b>Diffusion and Diffusivity:</b> Fick's law, mass and molar rates of flow, different velocities and fluxes under static and moving co-ordinate system, concentration gradients in dimensional concurrent and counter current flows, two film theory, analogy between mass momentum and heat transfer	5
	<b>Mass transfer co-efficients:</b> Mass transfer co-efficients, their experimental determination, use of dimensionless numbers, Sherwood, Lewis, Schmidt numbers.	3
V	<b>Absorption:</b> absorption and desorption in packed beds and in plate columns, relative advantages.	2
	<b>Drying:</b> Internal flow of moisture within the solids surface evaporation drying shrinkage estimation of drying rates and achievement of maximum drying rate	2
	<b>Dryers:</b> Detail study of the various driers used in ceramic industries; tray driers, tunnel driers drum driers vacuum driers and spray driers.	3
	TOTAL	40

#### TEXT BOOK.

SN	Name of Authors/Books/Publishers	Year of Publication
1	P.K. Nag/Heat & Mass Transfer.	2011
2	W. L. McCabe, J. C. Smith and P. Harriot/Unit Operations of Chemical Engineering, McGraw Hill professional,	2005

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	D. Q. Kern/Process Heat Transfer/McGraw Hill International Auckland Bogota	1986.
2	Dutta, Heat Transfer/ Prentice-Hall of India Pvt.Ltd	2004
3	Anantharaman/.Element of Mass Transfer/ PHI Learning Pvt. Ltd.	2005
4	Sharma.Principles/ of Mass Transfer/ PHI Learning Pvt. Ltd.	2007

**4CR3A: PARTICLE AND FLUID MECHANICS**

**B.Tech. (Ceramic) 4<sup>th</sup> Semester**  
3L

**Max. Marks: 80**  
**Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	<b>Particle Mechanics:</b> Theory of crushing and grinding crushers grinders and ultra fine grinders. Close and open circuit grinding, selection of equipment and power requirement.	4
	<b>Screening &amp; Separation:</b> Sieve analysis, cumulative and differential plots. Industrial screening equipments, Separation based on size, shape, density and surface properties.	4
II	<b>Separators and Filters:</b> Law of motion of single particle sedimentation, free and hindered settling. Thickener and settling chambers. Flotation, rotary fluids, centrifuge, cyclone, electrostatic and magnetic separators. Pneumatic and hydraulic transportation of solids, Jansen's equation. Conveyors, bins, silos and hoppers. Different equipment for mixing of fluids and solids, mixing index.	5
	<b>Filtration:</b> Flow through filter cake and medium, plate and frame filters, centrifugal filters, filter media, filter aids, washing of filter cakes, selection of filtration equipments.	3
III	<b>Basic Definitions and Fluid Properties 1:</b> Definition of Fluid, Incompressible and compressible fluids, Fluid as a continuum, Mass, Density, specific weight, relative density, specific volume, Bulk modulus, velocity of sound ideal fluid viscosity, Newtonian and Non-Newtonian fluid, Kinematic viscosity,	4
	<b>Basic Definitions and Fluid Properties 2:</b> Effect of temperature and pressure on viscosity, surface tension capillarity, vapour pressure and cavitations. Fluid States: General differential equation, Hydrostatics manometry, Fluid forces on submerged surfaces. Curved surfaces, Aerostatics, Isothermal atmosphere, polytropic atmosphere.	4
IV	<b>Kinematics and Conservation of Mass:</b> Flow classifications, Fluid velocity and acceleration, streamlines and the stream function, Path lines and Rotational flow, Flownet, Laplace equation,	4
	<b>Kinematics and Conservation of Mass 2:</b> Conservation of mass and the continuity equation for three dimensions, Equation of motion, Euler's equation of motion, Bernoulli's equation, Applications of Bernoulli's Pitot tube,	4
V	<b>The Boundary Layer:</b> Description of the boundary layer. Boundary Layer thickness boundary layer separation and control, The Prandtl boundary layer equation, Flow round a body, Drag skin friction drag, pressure drag, combined skin friction & pressure drag (Profile drag) wave drag, lift induced drag, Variation of drag co-efficient with Reynolds's number.	8
	TOTAL	40

**TEXT BOOK**

SN	Name of Authors/Books/Publishers	Year of Publication
1	Modi & Seth /Hydraulic and Fluid mechanics/Standard Book House New Delhi	2004
2	Balachandran /Engineering Fluid Mechanics / Prentice-Hall of India Pvt.Ltd	2011
3	Munson/ Fundamentals of Fluid Mechanics /Wiley	2009

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	W. L. McCabe, J. C. Smith and P. Harriot/ Unit Operations of Chemical Engineering/ McGraw Hill professional	2005
2	R. H. Perry, D. W. Green and J. O. Maloney/ Chemical Engineers' Handbook/ McGraw-Hill	1999

#### 4CR4A: ELECTRIC PROPERTIES OF MATERIALS

B.Tech. (Ceramic) 4<sup>th</sup> Semester  
3L

Max. Marks: 80  
Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Band Theory &amp; Solids</b> - Conductivity of metals, Mattheisen's rule, Sommerfield model, Band theory of solids, Kronig-Penny model, Origin of energy gap, Brillouin zones, Distinction between metals, insulators and semiconductors, Direct experimental evidence for band structure.	6
	<b>Semiconductivity</b> , temperature dependence of carrier concentration, factor that affect carrier mobility.	2
II	<b>Magnetic Materials</b> - Classification of magnetic materials, Ferromagnetism, Diamagnetism and Paramagnetism, Origin of ferromagnetism and hysteresis loop, Domain and Magnetic anisotropy, Magnetostriction, Ferrimagnetic compounds, Spinel, Garnet	5
	<b>Properties:</b> High temperature susceptibilities, Specific heat and thermal conductivity. Soft and hard magnetic materials and their applications	3
III	<b>Polarization &amp; Dielectric Materials In Static Fields</b> - Introduction. Polar and non-polar dielectrics, Polarization of dielectric, Clausius-Mossoti equation.	6
	Measurement of dielectric constant.	2
IV	<b>Dielectric Material In Dynamic Fields</b> – Polarisability, Frequency and temperature dependence of polarisability, Dielectric relaxation.	4
	Dielectric losses and Breakdown of dielectrics, Electrets. Losses at microwave, IR & Optical frequencies	4



V	<b>Piezoelectric</b> : Piezoelectric effect: Introduction, theory and application of piezoelectric crystals.	3
	<b>Ferroelectric effect:</b> Introduction. Ferroelectric crystals, Change in crystal structure during polarization. Theory of Ferro-electricity, Ferroelectric domain, difference between ferroelectric and ferromagnetic domain. Use of ferroelectric materials.	5
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	Saxena , Gupta , Saxena /Solid State Physics/ Pragati Prakashan	2002
2	W. D. Calister /Material Science and Engineering/Wiley India	2006

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	L.V. Azaroff /Introduction to Solids/ Tata McGraw Hill Publishing Co. Ltd	1977
2	C. Kittel/Introduction to Solid State Physics/ Jhon Wiley & Sons/Inc. Singapore/ New York	2005
3	W. F. Smith/ Foundations of Materials Science and Engineering/ McGraw-Hill Professional	2003

#### 4CR5A: ADVANCED ENGG. MATHEMATICS-2

B.Tech. (Ceramic) 4<sup>th</sup> Semester  
3L+1T

Max. Marks: 80

UNIT	CONTENTS	CONTACT HOURS
I	<b>Numerical Analysis</b> - Finite differences – Forward, Backward and Central differences. Newton’s forward and backward differences,	4
	<b>Interpolation formulae:</b> Stirling’s formula, Lagrange’s interpolation formula	4
II	<b>Numerical Analysis 1:</b> Integration-Trapezoidal rule, Simpson’s one third and three-eighth rules. Numerical solution of ordinary differential equations of first order - Picard’s method,	4
	<b>Numerical Analysis 2:</b> Euler’s and modified Euler’s methods, Milne’s method and Runge-Kutta fourth order method. Differentiation	4
III	<b>Special Functions:</b> Bessel’s functions of first and second kind, simple recurrence relations, orthogonal property of Bessel’s ,	4

	Transformation, Generating functions,	
	<b>Legendre's function of first kind:</b> Simple recurrence relations, Orthogonal property, Generating function	4
IV	<b>Statistics and Probability</b> - Elementary theory of probability, Baye's theorem with simple applications,	4
	<b>Expected value:</b> theoretical probability distributions-Binomial, Poisson and Normal distributions. Lines of regression, co-relation and rank correlation	4
V	<b>Calculus of Variations:</b> Functional, strong and weak variations simple variation problems,	4
	<b>The Euler's equation:</b> The Euler's equation.	4
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	K.C. Jain and Rawat/Advanced Engineering Mathematics/CBC	2007
2	Gokhroo Saini/Engineering Mathematics	-
3	S.K.Dadhich, N.K./Advanced Engg. Mathematics-4	-
4	Dr. Kantesh Gupta/Advanced Engineering Mathematics-4.	-

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	Irvin Kreyszig/Advanced Engg. Mathematics/Wiley	2011
2	Montgomery/Applied Statics & Probability/Wiley	2006

**4CR6A: DATA BASE MANAGEMENT SYSTEM****B.Tech. (Ceramic) 4<sup>th</sup> Semester****Max. Marks: 80****3L****Exam Hours: 3**

<b>UNIT</b>	<b>CONTENTS</b>	<b>CONTACT HOURS</b>
I	Introduction Need, purpose and goals of DBMS	1
	DBMS Architecture, Concept of keys, Generalisation and specialization	3
	Introduction to Relational data model, ER Modeling, Relational algebra.	3
II	Conceptual Data Base design. Theory of normalization	4
	Primitive and composite data types, concept of physical and logical databases	2
	Data abstraction and data independence,. Relational calculus	4
III	DDL and DML. Constraints assertions, views, data base security	2
	Application Development using SQL : Host language interface, embedded SQL programming	3
	GL's, Forms management and report writers. Stored procedures and triggers	3
IV	Physical data organization in sequential, indexed, random and hashed files	3
	Inverted and multilist structures	3
V	Transaction processing, concurrency control	3
	Transaction model properties and state serialisability	3
	Lock base protocols, two phase locking, Log based recovery Management	3
	<b>TOTAL</b>	<b>40</b>

## TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	Raghu Rama/ata Base Management System.	2002
2	Maheshwari Jain/DBMS: Complete Practical Approach/Firewall Media, New Delhi.	2005
3	Kroenke/Database Processing: Fundamentals, Design and Implementation/Pearson Education.	2006
4	Ramakrishnan, Gehrke/Database Management System/McGraw Hill	2002
5	Majumdar & Bhattacharya/Database Management System/TMH	2001
6	Bipin C. Desai/An introduction to Database Systems/Galgotia Publication	-

## REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	Leon & Leon/Database Management System/Vikas Publishing House.	2002
2	Date C J/An Introduction To Database System/Addison Wesley	2003
3	Elmasri, Navathe/Fundamentals Of Database Systems/Addison Wesley	1999
4	Korth, Silbertz, Sudarshan/Database Concepts/McGraw Hill	2001

## 4CR7: CERAMIC ANALYSIS & INSTRUMENTATION LAB

1. Demonstration of DTA/Differential Enthalpy Analysis and determination of the enthalpy of a reaction and percentage weight change.
2. Demonstration of X-ray diffractometer.
3. Indexing of XRD patterns and calculation of lattice parameter for cubic crystal system.
4. Sample preparation of ceramic Materials for microstructure observation by optical microscope.
5. Spectrophotometric analysis of ceramic samples and glasses.
6. Demonstration of SEM/EPMA/TEM.
7. Determination of the following elements using Flame Photometer:
  - a. Sodium and Potassium when present together.
  - b. Lithium/calcium/barium/strontium.
  - c. Cadmium and magnesium in tap water.
8. Thin layer chromatographic separation and identification of nickel, manganese, cobalt and zinc.
9. Determination of particles size in the given sample by using sedimentation laser method/Andresen Pipette.
10. Determination of porosity in the given ceramic samples by using mercury porosity meter/pycnometer.
11. Measurement of dissolve oxygen in given sample using Dissolve Oxygen Meter.
12. Determination of conductance and specific conductance of given sample using Conductivity Meter.

#### **4CR8: HEAT AND MASS TRANSFER LAB**

- 1&2 To determine (a) Thermal conductivity (b) Critical thickness (c) Thermal resistance of given ceramic material / insulating powder.
3. To determine the Stefan-Boltzmann constant.
4. Determination of heat transfer coefficient in natural and forced convection.
5. Determination of overall heat transfer coefficient and effectiveness for parallel and counter flow heat exchangers.
6. Determination of emissivity of a given test plate made by ceramic material with respect to black plate  
(standard).
7. Obtain the extraction efficiency of an agitating extractor for liquid- liquid system.
8. Study of (I) Gas inducing type agitators & (II) Cyclone separators.
9. Demonstration of effect of direction of mass heat transfer on coalescence foaming.

#### **4CR9: PARTICLE AND FLUID MECHANICS LAB**

1. To classify particles/grains based on size, shape, density and surface properties.
2. To determine the terminal velocity of Cyclone separator.
3. Size reduction using Jaw crusher and calculation of equivalent diameter of solid particle.
4. Size reduction using roller crusher and calculation of equivalent diameter of solid particle.
5. To analyze the given product for its particle size distribution using Sieve shaker.
6. To determine coefficient of viscosity of a given sample.
7. Determination of pressure using pressure gauge and other devices.
8. To verify Bernoulli's equation experimentally.
9. To determine the flow rate and coefficient of discharge using Venturimeter.
10. To determine the flow rate and coefficient of discharge using Orificemeter.
11. Calibration of orifice/notch.
12. Study of nature of flow using Heleshow's apparatus.

#### **4CR10: COMPUTER PROGRAMMING LAB**

##### **Programs in C++**

1. Write a program to perform the complex arithmetic.
2. Write a program to perform the rational number arithmetic.
3. Write a program to perform the matrix operations. (Transpose, addition, subtraction, multiplication, test  
if a matrix is symmetric/ lower triangular/ upper triangular)
4. Implement Morse code to text conversion and vice-versa.
5. To calculate Greatest Common Divisor of given numbers.
6. To implement tower of Hanoi problem.

##### **Program in Java**

7. To implement spell checker using dictionary.
8. To implement a color selector from a given set of colors.
9. To implement a shape selector from a given set of shapes.
10. By mapping keys to pens of different colors, implement turtle graphics.
11. To implement a calculator with its functionality.
12. To implement a graph and display BFS/DFS order of nodes.

#### **4CRDC: DISCIPLINE & EXTRA CURRICULAR ACTIVITY**

**5CR1A: RED CLAY (TERRACOTTA) TECHNOLOGY**

**B.Tech. (Ceramic) 5<sup>th</sup> Semester**  
**3L**

**Max. Marks: 80**  
**Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	<b>Introduction &amp; Raw Materials:</b> Red Clay Pottery, Pre-historic Back ground; Assumption, Mythological, Archeological, Raw-materials & Their types, Mode of Occurrence & Location of Red Clay in India, Different Additives & Their Function	5
	<b>Physical &amp; Chemical Properties of raw materials:</b> Physical & Chemical Properties of raw materials, General Equipment & Their Specifications.	4
II	<b>Batch Preparation:</b> Crushing & Grinding of Raw Materials, Clay Processing & Body mixes, Beating & Pugging System, Tank & Sieve System, Ball Milling & Sieve, Tank- Blunger Sieve System, Improved Industrial System.	4
	<b>Fabrication techniques for different red clay products;</b> Slip Casting, Plastic forming method, Semi dry & Dry pressing method	3
	<b>Different types of Wheel used in Red Clay Technology;</b> Traditional Wheel, An Improved Wheel, Kick & Chain Wheel, Motorized Wheel, Jiggering and Jollying.	3
III	<b>Drying &amp; Firing:</b> Drying & Firing Processes, Kilns & Kiln construction; Bonfire, Pit Kiln with Walls, Open Top Updraught, Permanent Updraught, European Up-draught, Down draught, Gas fired, Oil fired and Electric kilns.	6
IV	<b>Classification of Red Clay (Terracotta) Products</b> and their qualities,, Common building bricks, roofing tiles. Value up-gradation of Red clay products.	7
V	<b>Glazes &amp; Glazing.</b> Introduction, The nature of glazes, General properties of glazes; Additive character, crystallization ability, mechanical strength, surface tension, viscosity, thermal properties, chemical resistance, optical properties,	4
	<b>Raw materials, types &amp; Firing &amp; Decoration techniques of glazes:</b> raw materials of glazes, types of glazes, Firing & Decoration techniques	4
	TOTAL	40

**TEXT BOOK**

SN	Name of Authors/Books/Publishers	Year of Publication
1	Er. A. K. Gupta/Hand Book on Red Clay Technology /KVIC	2002

**REFERENCE BOOKS**

SN	Name of Authors/Books/Publishers	Year of Publication
1	S. Mirmira./Indian Pottery/ Published by Gramodaya Sangh Bhadrawati, Maharashtra State, India	1973
2	Sumner/Hand Book of Soil Science /CRC	1999
3	R. A. Eppler and D. R. Eppler/Glazes and Ceramic Coatings/American Ceramic Society	2000
4	W. Trinks and M. H. Macwhinney, A. Shannon, R. J. Reed and J. R. Garvey/Industrial Furnaces/6th Ed., Wiley-Interscience,	2003
5	Philippe Boch and Jean-Claude Niepce/ Ceramic Materials Processes, Properties and Applications/ISTE USA	2007

**5CR2A: POTTERY & HEAVY CLAYWARE**

**B.Tech. (Ceramic) 5<sup>th</sup> Semester**  
3L

**Max. Marks: 80**  
**Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	<b>Plastic Raw materials</b> -Clays geology & Mineralogy, Ries Classification, Properties of clays- Adsorption, Cation exchange, Flow properties, Thixotropy, Plasticity, Permeability, Green shrinkage & strength, Fired shrinkage & strength	5
	<b>Non- clay Plastic raw materials:</b> Talc & Steatite, Pyrophyllite,	2
II	<b>Non-Plastic raw materials:</b> Silicon atom & its building Silica, Feldspar, Nepheline Syenite. Sillimanite, Bone ash, Wollastonite other fluxes- Lithium, Sodium, Potassium, Magnesium, Calcium, Barium & Boron Compounds.	4
	<b>Auxiliary raw-materials:</b> water, Deflocculates, Flocculants, Organic Binders, Lubricants and sticking agents, Drying aids, Plaster of Paris,	4

III	<b>Winning &amp; Purification of Clays:</b> Mining & Winning of clays,- China clay, Sedimentary clays	4
	<b>Machinery used in clay mining :</b> Machinery used in clay mining, Treatment of clays	4
IV	<b>Action of Heat on Ceramic Raw-Materials:</b> Action of Heat on Ceramic Raw-Materials- Changes non-altering Chemical composition, Changes Altering chemical composition, Incomplete & complete reaction, Melting ,Crystallization & glass formation, Structure of Glasses & Glazes,	5
	<b>Phase diagram :</b> Phase diagram in Ceramic Bodies,	3
V	<b>Ceramic Bodies:</b> Composition of Ceramic Bodies, Brick wares, Stoneware, Fine stoneware, White Stoneware, Electrical stoneware, Earthenware, Vitreous China, Soft Porcelain, Bone China, Hard Porcelain, Chemical Porcelain, Electrical Porcelain,	5
	<b>Methods of Fabrication:</b> Throwing, jiggering and jollying, soft plastic methods, extrusion methods, stiff-plastic methods.	4
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	Felix Singer & Sonja S. Singer/ Industrial Ceramic/ Chemical Publishing Co	1963

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	W. Ryan and C. Radford/ Whitewares: Production, Properties and Quality Control/ Pergamon Press, Oxford	1987
2	W. M. Carty, C. W. Sinton/ Science of Whitewares II/ American Ceramic Society	1999
3	F. H. Norton/ Fine Ceramics: Technology and Application/McGraw Hill, NY	1970
4	R. A. Eppler and M. Obstler/Understanding Glazes/ The American Ceramic Society	2005
5	V. E. Henkes, George Y. Onoda, W. M. Carty/ Science of White wares/ The American Ceramic Society	1996
6	Philippe Boch and Jean-Claude Niepce/Ceramic Materials Processes, Properties and Applications/ ISTE USA	2007



7	Paul Bormans/Ceramics are More Than Clay Alone/ Cambridge International Science Publishing	2004
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### 5CR3A: REFRACTORIES

B.Tech. (Ceramic) 5<sup>th</sup> Semester  
3L

Max. Marks: 80  
Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Introduction:</b> Definition of refractory, properties of refractories, classification of Refractory, Ingredient of Refractory, manufacturing process and unit operation.	4
	<b>Monolithic refractory:</b> classification of monolithic refractory, bonding of monolithic Refractory, formulation of monolithic refractory, process control in monolithic production	4
II	<b>Manufacture, properties, and application:</b> silica, high alumina, dolomite, Magnesite, zircon, Zirconia refractory, fusion cast refractory, ceramic fiber and heat insulating refractory	5
	<b>Composite Refractories:</b> Alumina-carbon, magnesia-carbon, Spinel, alumina-silicon carbide- carbon, zirconia-carbon;	4
III	<b>Properties and Measurement:</b> Chemical Analysis, Mineralogical Analysis by X-Ray Diffraction, Microscopic Examination, Bulk Density and Apparent Porosity, True Density and True Porosity, fusion point, permeability, cold crushing strength	5
	<b>Properties and Measurement :</b> Refractory under load, hot modulus of rupture, Pyrometric Cone Equivalent (P.C.E.), Creep behavior, Abrasion resistance, Thermal Shock Resistance, thermal conductivity, thermal expansion and spalling, slag resistance.	4
IV	<b>Refractory Applications:</b> Blast furnace refractories, Refractories for steel making, Ladle refractories,	2
	<b>Refractory Applications:</b> Refractories for the refineries and circulating fluid beds	2
	<b>Refractory Applications:</b> Refractories in cement industries. Refractories in glass industries. Petrochemical Industries.	3
V	<b>Reaction of Refractory:</b> slag, glasses, carbon monoxide, acids, alkalis, flue gases, corrosion of regenerator's Refractory by flue gases.	7
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	J. H. Chesters/ Refractories- Production and Properties/ The Iron and Steel Institute, London	1973
2	S. Banerjee/Monolithic Refractories: A Comprehensive Handbook/ Wiley-	1998

	American Ceramic Society	
3	C. A. Schacht/ Refractories Handbook/ CRC Press	2004

## REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	S. Kumar/ Hand Book of Ceramics/Kumar and Associates	1995
2	P. P. Budnikov/ The Technology of Ceramics and Refractories/ Translated by Scripta Technica, Edward Arnold, The MIT Press, 4th Ed,	2003
3	C. A. Schacht/ Refractory Linings: Thermo-mechanical Design and Applications, CRC Press	1995
4	Philippe Boch and Jean-Claude Niepce/ Ceramic Materials Processes, Properties and Applications/ ISTE USA.	2007
5	S. C. Caniglia and G. L. Barna/ Handbook of Industrial Refractories Technology: Principles, Types, Properties and Applications/ William Andrews Inc.	1992
6	R. Amavis/ Refractories for the Steel Industry/ Elsevier Applied Science, Springer.	1990
7	S. Banerjee, The Changing Refractories Industry: New Technologies, Materials and Markets/Business Communication Co.	1999

### 5CR4A: ELECTRO CERAMICS -1

B.Tech. (Ceramic) 5<sup>th</sup> Semester  
3L+1T

Max. Marks: 80  
Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Ceramic Capacitors:</b> Historical Background, Ferro Electricity in Capacitors Technology,	2
	Dielectric Properties of Multi-Phase systems, Basic Dielectric Materials, Varieties of Ceramic capacitor,	3
	Capacitor performance Parameters, Packaging of Ceramic Capacitors, Typical Ceramic Dielectric Compositions,	3
II	<b>Piezo-electric and Electro-optic Ceramics:</b> Piezoelectric Ceramic, Ferroelectric ceramic, Electrooptic Ceramic, ,	4
	Composition, Processing & Properties, Applications of Piezoelectric & Electrooptic ceramic,	4

III	<b>Magnetic Ceramics:</b> Spinal ferrites, Hexagonal ferrites, Rare earth-Garnet,	4
	Processing & application in various fields.	4
IV	<b>Ceramic Sensors:</b> Theory & Transducer classification, Transition from theory to Practice, Future Prospects,	5
	<b>Thermo-physical Properties :</b> Thermo-physical Properties	3
V	<b>ZnO Varistors:</b> Varistors electrical characteristics, Varistors Microstructure & Fabrication, Varistors equivalent circuit,	6
	Mechanics of Varistors behavior, Varistors applications.	2
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	R. C. Buchanan/Ceramic Materials for Electronics: processing, properties and applications/ Marcel Dekker, NY	1986
2	L. M. Levinson/ Electronic Ceramics: properties, device and applications/ CRC Press	1987

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	J. Moulson and J. M. Herbert/ Electroceramics: Materials, Properties and Applications/ Springer	1990
2	Philippe Boch and Jean-Claude Niepce/ Ceramic Materials Processes, Properties and Applications/ ISTE USA	2007
3	B. Jaffe, W. R. Cook, H. Jaffe and H. L. C. Jaffe/Piezoelectric Ceramics/ R.A.N Publishers	1990

#### 5CR5A: GLASS & GLASS CERAMICS

B.Tech. (Ceramic) 5<sup>th</sup> Semester  
3L+1T

Max. Marks: 80  
Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Glass:</b> Definition of glass, Model of glass structure, Types and composition of glass	3
	<b>Glass constituents:</b> Glass constituents and batch ingredients, decolourisers and refining agents, batch calculation, batch preparation.	5

II	<b>Glass melting:</b> Fundamental of Glass formation, Factors that influence glass formation, Zachariasen's rules, Kinetic & Thermodynamic criteria for Glass formation, Nucleation and crystal growth	4
	<b>TTT diagram</b> Structural models of silicate and non silicate glasses, bridging and non-bridging oxygen, Tank furnaces, feeding of glass batches, melting process, refining of glass, batch Redox number, electric heating, cold top furnace, pot melting	4
III	<b>Quality control of glasses:</b> control of compositions, measurement of density, thermal expansion, viscosity,	2
	<b>Liquid immiscibility and phase separation in glasses</b> structural theories of liquid immiscibility, thermodynamics of liquid immiscibility, mechanism of phase separation, chemical durability of glass.	5
IV	<b>Fabrication:</b> pressed and blown wares, flat glass, tubing and bulbs, fiber glass	5
	<b>Defect:</b> Defect in glass, Stones, Seeds, Cords and Blisters, gas inclusion, entrapped gas in batch, decomposition of batch materials, bubbles from refractory, nucleation and growth of bubbles from a supersaturated, detection of gases contained in bubble, detection of vitreous inclusions, removal of vitreous inclusion, crystalline inclusion, batch stones, refractory inclusion.	4
V	<b>Glass–Ceramics:</b> Definition, Production of Glass-ceramics, Description & application of various Glass ceramics	4
	<b>Types of Glass-Ceramic:</b> Photosensitive lithium Aluminum Silicate, Magnesium Aluminum Silicate, Machinable Glass ceramics, Bio-active Glass ceramics, Sintered Glass ceramics,	4
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	Paul/Chemistry of Glasses 2nd Ed./ Springer	1990
2	S. Kumar/ Hand Book of Ceramics/Kumar and Associates	1995
3	J. E. Shelby/ Introduction to Glass Science and Technology/The Royal Society of Chemistry	2005
4	Sinton/Raw Materials for Glass and Ceramics /Wiley	2006

## REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	P. W. McMillan/ Glass Ceramics/ 2nd Ed., Academic Press, NY	1979
2	M. H. Lewis/ Glass & Glass Ceramics/Chapman & Hall, London	1989
3	A. R. West/ Solid State Chemistry/John Wiley&Sons	2003
4	H. Bachs and D. Krause/ Low Thermal Expansion Glass Ceramics/ Springer	2005
5	K. Varshneya/ Fundamentals of Inorganic Glass/Academic press	1994

### SCR6.1A: FUELS, FURNACES AND PYROMETERS

B.Tech. (Ceramic) 5<sup>th</sup> Semester  
3L

Max. Marks: 80  
Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>History of kilns:</b> Traditional & Energy Efficient Kilns.	6
II	<b>Fuel:</b> Characteristics & Classification of Solid, Liquid & Gaseous fuels, Solid fuels-wood& charcoals, coal, Liquid -Petroleum fuels, Gaseous fuels –Coal Gas, water gas, Producer Gas, Natural Gas, LPG,	4
	<b>Electrical Heating-</b> Nichrome & Kanthal, Silicon Carbide, Molybdenum Silicide	3
	<b>Selection of fuels:</b> Selection of fuels in ceramic Industries.	2
III	<b>Combustion &amp; Heat saving devices:</b> Chemistry of combustion, types of combustion, combustion of solids, liquid and gaseous fuels,	4
	<b>Fuels-flame Characteristics,</b> Fluidized bed, Combustion devices. Regenerators, Recuperators.	4
IV	<b>Firing:</b> Firing of Ceramic Wares, Ideal firing curves, setting of wares in kilns, Operation & Trouble shooting in Ceramic kilns	4
	<b>Temperature measuring devices</b> i.e. thermocouple, radiation and optical pyrometer.	4
V	<b>Kilns:</b> Classification, design and description of different types of furnaces used in ceramic Industries as downdraft kiln, Shuttle kiln, chamber furnace, tunnel kiln, Roller kilns, , glass tank furnace, rotary kiln,	5
	<b>Energy auditing &amp; Management in Oil &amp; Gas fired kilns.</b> Heat Balance in Shuttle & Tunnel kilns	4
	TOTAL	40

**TEXT BOOK**

SN	Name of Authors/Books/Publishers	Year of Publication
1	A. R. West/ Solid State Chemistry/John Wiley&Sons	2003
2	S. Sarkar/Fuels and Combustion 2nd Ed / Orient Longman, Mumbai	1990

**REFERENCE BOOKS**

SN	Name of Authors/Books/Publishers	Year of Publication
1	R. M. Felder and R.W. Rousseau/ Elementary Principles of Chemical Processes Third Edition /Wiley	2004
2	G. B. Remmy Jr./ Firing of Ceramics/ World Scientific,	1994
3	D. R. Dinger/ Particle Calculations for Ceramists/ Dinger Ceramic Consulting Services Clemson,US,	2001
4	R. A. Eppler and D. R. Eppler/ Glazes and Ceramic Coatings/American Ceramic Society	2000
5	W. Trinks and M. H. Macwhinney, A. Shannon, R. J. Reed and J. R. Garvey/Industrial Furnaces 6th Ed. /Wiley-Interscience	2003

**5CR6.2A: INTRODUCTION TO NANO-TECHNOLOGY**B.Tech. (Ceramic)5<sup>th</sup>Semester

Max. Marks: 80

3L

Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Properties of Individual Nano-Particles</b> - Meaning of nano-particle, metal nanoclusters, magic numbers, theoretical modeling of nano particles, geometric structure, electronic structure, reactivity, fluctuations, magnetic clusters, bulk to nano-transition ; semi-conducting nanoparticles optical properties, photofragmentation, coulombic explosion; rare gas and molecular clusters inert gas clusters, superfluid clusters, molecular clusters;	4
	<b>Methods of synthesis:</b> R F plasma, chemical methods, thermolysis, pulsed laser methods	4
II	<b>Carbon Nano Structures Carbon Molecules:</b> Nature of the carbon bond, new carbon structures; carbon clusters, carbon nanotubes: fabrication, structure, electrical mechanical and vibrational properties, applications of nanotubes including those in chemical sensors, catalysis, mechanical reinforcement.	4
	<b>Bulk Nano-Structured Materials Solid Disordered Nanostructures:</b> Methods of synthesis, failure mechanisms of conventional grain sized materials, mechanical properties, nanostructured multilayers, electrical properties, arrays of nanoparticles in zeolites, porous silicon; nano-structured crystals including nanoparticle lattices in colloidal suspensions	4

III	<b>Nano Structured Ferromagnetism-</b> Basics of ferromagnetism, effect of bulk nanostructuring on magnetic properties, dynamics of nano magnets, nano pore containment of magnetic particles, nanocarbon ferro-magnets, giant and colossal magneto-resistance, ferro-fluids.	5
	<b>Nano-machines and Nanodevices:</b> Micro-electromechanical systems (MEMSs). nanoelectromechanical systems (NEMSs), nanodevices and nano-machines.	3
IV	<b>Quantum Wells, Wires and Dots</b> - Preparation of quantum nanostructures, size and dimensionality effects, excitations, applications including superconductivity	3
	<b>Self-Assembly and Catalysis:</b> Process of self-assembly, semiconductor islands, monolayers;	2
	<b>Catalysis:</b> nature of catalysis, surface area of nano particles, porous materials, pillared clays, colloids.	2
V	<b>Polymers:</b> Hydrocarbons, forming and characterizing polymers: polymerisation, sizes of polymers	3
	<b>Nanocrystals:</b> condensed ring types, polydiacetylene types ; polymers: conductive polymers, block co-polymers	3
	<b>Supramolecular structures:</b> transition metal-mediated types, dendritic molecules, supramolecular dendrimers, micelles. Biological materials including biological building blocks.	3
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	N. R. Rao, A. Müller and A. K. Cheetham/The Chemistry of Nanomaterials: Volume 1, Synthesis, Properties and Applications/ Wiley-VCH	2006
2	M. Wilson, K. Kannangara, G. Smith and M. Simmons/ Nanotechnology: Basic Science and Emerging Technologies/CRC Press,	2002
3	R. Freer/Nanoceramics: A British Ceramic Proceedings/ British Ceramic Society	1993

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	S. Edelstein, R. C. Cammarata/Nanomaterials: synthesis, properties and applications/ CRC Press	1998
2	Schutte/Nanotechnology	2007
3	H. G Rubahn/ Basics of Nanotechnology 3rd Edition/ Wiley	2008
4	G. Cao/Nanostructures and Nanomaterials: Synthesis, Properties and Applications/Imperial College Press	2004
5	M. A. Ratner and D. Ratner/ Nanotechnology: A Gentle Introduction to the Next Big Idea/Prentice Hall PTR,	2003

**5CR6.3A: NEWER MACHINING METHODS**B.Tech. (Ceramic)5<sup>th</sup>Semester

Max. Marks: 80

3L

Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Introduction and classification of Advanced Machining Process</b> , consideration in processselection,	4
	<b>Difference between traditional and non-traditional process:</b> Difference between traditional and non-traditional process, Hybrid process.	4
II	<b>Mechanical Advanced Machining Process</b> - Introdution, Mechanics of Metal Removal,Process, Principle,	5
	<b>Advantages, Disadvantages and applications of AJM, USM, WJC:</b> Advantages, Disadvantages and applications of AJM, USM, WJC	3
III	<b>Thermo Electric Advanced Machining Process</b> - Introduction, Principle, Process, Parameters	5
	<b>Advantages and Disadvantages about EDM,EDG,LBM,PAM, EBM:</b> Advantages and Disadvantages about EDM,EDG,LBM,PAM, EBM	3
IV	<b>Electrochemical and Chemical Advanced Machining Process</b> - ECM, ECG, ESD, ChemicalMachining,	4
	<b>Anode Shape Prediction and tool design for ECM process.</b> Tools (cathode) design for ECM process.	4
V	<b>Non-Conventional Abrasive Finishing Process</b> - Abrasive flow machining, Magnetic abrasive finishing (for plain and cylindrical surfaces)	8
	TOTAL	40

**TEXT BOOK**

SN	Name of Authors/Books/Publishers	Year of Publication
1	Prof. Vijay Kumar Jain/Advance Machining Process/Allied Publishers	2009
2	Ghosh, Malik/Manufacturing Science	1999

**REFERENCE BOOKS**

SN	Name of Authors/Books/Publishers	Year of Publication
1	Pandey, Shan/Modern Machining Methods	1980
2	J.A. McGeough/Advanced Methods of Maching/University Press Cambridge	1988
3	El-Hofy, Hassan Abdel-Gawad/Advance Machining Process: Nontraditional and Hybrid Machining Processes/MCGRAW HILL	2005



**5CR7: RED CLAY LAB**

1. Chemical & Rational Analysis of any Red clay product,,
2. Chemical & Rational Analysis of Quartz clay,
3. Chemical & Rational Analysis of Feldspar clay,
4. Chemical & Mineral Analysis of Red Clay
5. Compounding & manufacturing of Stoneware Terracotta.
6. Compounding & manufacturing of Earthen ware Terracotta.
7. Compounding & manufacturing of Vitrified Terracotta.
8. Determination of Dry & Fired properties of Stoneware Terracotta
9. Determination of Dry & Fired properties of Earthenware Terracotta
10. Determination of Dry & Fired properties of Vitrified Terracotta.

**5CR8: POTTERY & HEAVY CLAYWARE LAB**

1. Determination of Plasticity of Ceramic Body mixes.
2. Study of Filter Press and preparation of filter cake.
3. Study and operation of De-airing Pug Mill and preparation of extruded body.
4. Determination of Dry Linear Shrinkage and Fired Shrinkage of Ceramic Body mixes ,
5. Determination of Tensile strength of Insulator.
6. Determination of Porosity of Heavy clay ware.
7. Shaping of articles by throwing.
8. Shaping of articles by jigger and jollying.
9. Shaping of articles by slip casting.
10. Shaping of articles by Pressing.
11. Making of Ceramic Body Mixes.
12. Quantitative chemical analysis of tri-axial porcelain body.

**5CR9: REFRACTORY LAB**

1. Determination of size of refractory brick,
2. Determination of Apparent porosity.
3. Determination of Bulk density.
4. Determination of True Density and True Porosity of given refractory.
5. Determination of Specific gravity,
6. Determination of Spalling resistance,
7. Determination of Cold crushing strength.
8. To prepare the sample of refractory by dry press method.
9. To find the action of HF+H<sub>2</sub>SO<sub>4</sub> mixture on free silica in refractory bricks by Bow-Maker's method.
10. Determination of Modulus of Rupture of refractory block.
11. To prepare the sample of refractory by Pressing.
12. Determine RUL of given refractory.

**5CR10: GLASS & ELECTRO CERAMIC LAB.**

1. Preparation of barium titanate based ceramic compositions by solid state method.
2. Preparation of Spinel ferrite by ceramic method.
3. Measurement of permeability on ferrite toroid.
4. Study and operation of Hydraulic Press and determination of green density.
5. Measurement of ionic conductivity of a ceramic solid electrolyte.
6. Determination of Curie temperature for ferroelectric materials.
7. Measurement of electric conductivity of ceramic samples by two probe and four probe method.
8. Measurement of dielectric constant.
9. Chemical analysis of ordinary soda-lime-silicate glass.
10. Melting of simple glasses.
11. Measurements of Density of given Glass sample.

**5CRDC: DISCIPLINE & EXTRA CURRICULAR ACTIVITY**

**6CR1A: THERMODYNAMICS AND PHASE EQUILIBRIA**

**B.Tech. (Ceramic) 6<sup>th</sup> Semester**  
3L

**Max. Marks: 80**  
**Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	<b>Introduction:</b> Basic Terminology and concepts, Brief introduction to laws of thermodynamics, concept of states of matter, intensive and extensive properties of systems, thermal and statistical entropy.	4
	<b>Auxiliary Functions:</b> Thermodynamic functions, Maxwell's equations and their applications in solution of problems.	4
II	<b>Phase Equilibria:</b> Component, Solubility limit, phases, microstructure, phase equilibria, binary isomorphous systems, interpretation of phase diagrams, lever rule, development of microstructure on isomorphous alloys, mechanical properties of isomorphous alloys, binary eutectic systems.	7
III	<b>Thermodynamic stability of Materials.</b> Equilibrium Diagrams having Intermediate phases & Compound, Eutectoid and Peritectic Reactions Congruent Phase transformation, Ceramic & Ternary Phase Diagrams,	5
	<b>Ellingham diagram</b> and its importance, application of electrochemical series in ceramics	2
IV	<b>Behavior of gases:</b> Equation of state of gas, internal energy of real gas, Ideal gases, experimental determination of heat capacities, quasi adiabatic process, Ruchhardts method of measuring gama, velocity of longitudinal waves, kinetic theory of ideal gas.	8
V	<b>Chemical equilibrium:</b> Daltons law, semi permeable membrane, Gibbs theorem, Gibbs Helmholtz Equation entropy of a mixture of inert ideal gases, Gibbs function of a mixture of inert ideal gases, chemical equilibrium, condition for mechanical stability	5
	<b>Thermodynamics equations for a phase:</b> Thermodynamics equations for a phase, chemical potentials, Degree of reactions, equation of reaction equilibrium	5
	<b>TOTAL</b>	<b>40</b>

**TEXT BOOK**

SN	Name of Authors/Books/Publishers	Year of Publication
1	W. D. Calister/Material Science and Engineering/ Wiley India	2007
2	F. A. Hummel/ Introduction to Phase Equilibrium in Ceramic Systems/ First Edition/CRC Press	1984
3	G. Smith, R. S. Roth, T. Negas and L. P. Cook/ Phase Diagrams for Ceramists/ American Ceramic Society	1983
4	Richard H. Dittman/ Heat and Thermodynamics/TMGH	2007

## REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	D. R. F. West/ Ternary Phase Diagrams in Materials Science/ Maney Publishing; 3rd edition	2002
2	D. R. Gaskell/ Introduction to the Thermodynamics of Materials/ Taylor & Francis	2003
3	J. M. Smith, H. C. V. Ness, and M. M. Abbott/ Introduction to Chemical Engineering Thermodynamics/ 7th Ed, McGraw-Hill Professional	2005
4	Ghosh/Textbook of Materials and Metallurgical Thermodynamics/PHI Learning Pvt. Ltd	2004
5	Y. M. Chiang, D. Birnie III and W. D. Kingery/ Physical Ceramics: Principles for Ceramic Science and Engineering/ Wiley	1996
6	M. Alper (Editor), G. Kostorz (Series Editor), H. Herman (Series Editor)/ Phase Diagrams in Advanced Ceramics/ Treatise on Materials Science and Technology Academic Press	1995
7	E. M. Levin, R. S. Roth, G. Smith, C. R. Robbins, H. F. McMurdie, L. P. Cook and M. K. Reser/ Phase Diagram for Ceramists: salts/ The American Ceramic Society,	1975

### 6CR2A: THERMAL AND MECHANICAL PROPERTIES OF CERAMIC MATERIALS

B.Tech. (Ceramic) 6<sup>th</sup> Semester  
3L+1T

Max. Marks: 80  
Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Thermal Properties:</b> Introduction, Heat capacity, Density and thermal expansion of crystal, Thermal Expansion, Density and Thermal expansion of Glasses,	4
	<b>Effect of Heat Treatment:</b> Effect of Heat Treatment, Thermal Expansion of Composite Bodies, Effect of polymorphic transformation.	4
II	<b>Thermal &amp; Compositional Stresses 1:</b> Thermal Expansion & Thermal stresses, Temperature Gradient & Thermal stresses, Micro-stresses, Glaze Stresses, Resistance to thermal shock & thermal spalling, Thermally tempered Glass, Annealing, Chemical strengthening.	5
	<b>Thermal &amp; Compositional Stresses 2:</b> Resistance to thermal shock & thermal spalling, Thermally tempered Glass, Annealing, Chemical strengthening.	3
III	<b>Thermal Conduction Processes in Phonon 1:</b> Phonon Conductivity of Single phase crystalline, Temperature dependence, influence of structure and composition of pure materials, Boundary effect, Impurities and solid solutions, Effect of boundaries, Conductivity of multiphase ceramics.	4

	<b>Thermal Conduction Processes in Phonon 2:</b> Phonon conductivity of single-phase glasses, Temperature dependence of glass conductivity, Effect of compositions, Photon Conductivity, The Photon Mean Free Path, Temperature dependence	5
IV	<b>Viscous Flow, Plastic Deformation, and Creep:</b> Introduction, plastic deformation, creep deformation, viscous deformation,	3
	<b>Plastic deformation:</b> of rock salt, fluorite crystal and Al <sub>2</sub> O <sub>3</sub> , Creep of single crystal and polycrystalline ceramics.	4
V	<b>Elasticity, Anelasticity and Strength:</b> Fracture Process, Elastic Deformation & Elasticity, Elastic Moduli, Anelasticity Behavior, Brittle Fracture & Crack propagation	5
	<b>Theoretical strength,</b> Griffith-Orwan criteria, Statistical nature of strength, Strength & Fracture surface, Static fatigue, Creep fracture, Effect of microstructure.	3
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	W. D. Kingery, H. K. Bowen and D. R. Uhlmann/Introduction to Ceramics/ 2nd Ed., John Wiley & Sons Pte Ltd., Singapore	1991
2	Michel Barsoum/Fundamental of Ceramics/Taylor & Francis Group	2002

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	W. D. Calister/Material Science and Engineering/ Wiley India	2007
2	Raghvan/Material Science and Engineering/ Prentice Hall of India	2004
3	Y. M. Chiang, D. Birnie III and W. D. Kingery/ Physical Ceramics: Principles for Ceramic Science and Engineering/ Wiley	1996
4	W. F. Smith, Foundations of Materials Science and Engineering/ McGraw-Hill Professional	2003
5	Philippe Boch and Jean-Claude Niepce/ Ceramic Materials Processes, Properties and Applications/ ISTE USA	2007

**6CR3A: ELECTRICAL, MAGNETIC AND OPTICAL PROPERTIES OF CERAMIC MATERIALS**

B.Tech. (Ceramic) 6<sup>th</sup> Semester

Max. Marks: 80

3L+1T

Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Electrical Conductivity 1:</b> Electrical Conduction Phenomena, Ionic Conduction in crystal, Nernst- Einstein equation for diffusion and conductivity in ionic solids. Applications of ionic conductors, Electronic conduction in Crystals, Ionic conductance in Glasses, Absorption Current, Electrode Polarization	5
	<b>Electrical Conductivity 2:</b> Temperature dependence, Effect of composition, Mix Alkali effects, Electronic conduction in Glasses, Non-stoichiometric, Solute-controlled Electronic conduction, Band structure of Zinc & Copper oxide. Valency controlled semi conductors, Mixed Conductors in poor Conductors. Polycrystalline Ceramics.	4
II	<b>Dielectric Properties:</b> Electrical Phenomena Dielectric constant of Crystal & Glasses, Dielectric loss factor for crystal & Glasses,	4
	<b>Dielectric Conductivity:</b> Dielectric Conductivity, Poly crystalline & Poly face Ceramics, Dielectric Strength, Ferro-electric Ceramics,	3
III	<b>Magnetics Properties Phenomena:</b> Origin of Interaction in Ferrimagnetic materials. Direct Exchange Interaction and super exchange interactions, Double exchange Interaction,	4
	<b>Ferrites:</b> Spinal ferrite, Rare earth garnet and hexagonal ferrites. Polycrystalline Ferrites, Effects of composition & Grain size & Porosity on the magnetic behavior.	4
IV	<b>Optical Properties (a):</b> Electromagnetic waves in ceramics, Refractive Index & Dispersion, Reflection & Refraction. Scattering, Refractive Index & Dispersion in Dielectric materials, Boundary Reflectance & Surface gloss	8
V	<b>Optical Properties (b):</b> Opacity & Translucency, Absorption & Color, Bands, Color, Ligand-Field Chemistry Colorants, Ceramic Stains, Color specifications, Lasers, Phosphors, Fiber optics.	8
	TOTAL	40

**TEXT BOOK**

SN	Name of Authors/Books/Publishers	Year of Publication
1	W. D. Kingery, H. K. Bowen and D. R. Uhlmann/Introduction to Ceramics, 2nd Ed., John Wiley & Sons Pte Ltd., Singapore	1991
2	L. M. Levinson/ Electronic Ceramics: properties, device and applications/ CRC	1987

## REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	Michel Barsoum/Fundamental of Ceramics/Taylor & Francis Group	2002
2	A. J. Moulson and J. M. Herbert/Electroceramics: Materials, Properties and Applications	2003
3	R. Valenzuela/Magnetic Ceramics, Cambridge University press,	1994
4	W. D. Calister/Material Science and Engineering /Wiley India	2007
5	Raghvan/ Material Science and Engineering /Prentice Hall of India	2004
6	J. Smit and H. P. J. Wijn/ Ferrites/ Wiley	1959
7	Philippe Boch and Jean-Claude Niepce/ Ceramic Materials Processes, Properties and Applications/ ISTE USA	2007

### 6CR4A: CEMENT TECHNOLOGY

B.Tech. (Ceramic) 6<sup>th</sup> Semester  
3L

Max. Marks: 80  
Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Introduction:</b> Origin and development of cement and cementitious materials	2
	<b>Batch preparation:</b> Raw materials and their classification, selection of raw materials, crushing of lime stone and other calcareous materials, proportioning of raw materials, grinding of raw materials and preparation of raw meal, blending & beneficiations of raw materials.	5
	<b>Lime:</b> Different classes of building lime and their properties	2
II	<b>Processing:</b> Burning of raw mix, reactions occurring in cement making at different temperature. Preheater and pre-calcinators in cement industry, heat recovery devices and waste heat utilization. Firing system and kiln residence time.	3
	working of rotary kiln and clinkering reactions, clinker coolers. Clinker and their storage, cement grinding mills, cement storage and silos, conveying, packing and dispatch of cement, cement packing machines. Dust and dust collection in cement industries.	4
III	<b>Concrete &amp; Testing:</b> Introduction, Classification, Properties of concrete, grades of concrete, advantages and disadvantages of concrete, concept of quality control, concrete industry, challenges faced by concrete industries.	4
	<b>Testing of cement:</b> Testing of cement.	4
IV	<b>Types of cements 1:</b> Different types of cement:- Quick setting cement, low heat cement, Blast furnace slag cement, Trief cement , Sorrel cement, White and colored cement, Iron ore cement, Oil well cement, Hydrophobic cement, Water proof cement	5

	<b>Types of cements 2:</b> Masonry cement, expanding and self stressing cement, Sulphate resisting cement, Super sulphate cement, High alumina and other refractory cements, refractory castables. Pozzolana and Pozzolanic cements.	5
V	<b>Gypsum:</b> Gypsum, Plaster of paris, its properties and uses, manufacture of plaster of paris, setting and hardening of plaster of paris.	6
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	P. Hewlett/Lea's Chemistry of Cement and Concrete/ Fourth Edition, Butterworth Heinemann	2004

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	H. F. W. Taylor/ Chemistry of Cement/ Thomas Telford	1997
2	M.L. Gambhir/ Concrete Technology/ Tata Mcgraw Hill Education Private Limited, New Delhi	2009
3	K.E. Peray/ Cement Manufacturer's Handbook/Chemical Publishing Company	1979
4	E. M. Gartner and M. Uchikawa/Cement Technology/ The American Ceramic Society	1994

#### 6CR5A: CERAMIC COATING - ENAMEL & GLAZES

B.Tech. (Ceramic) 6<sup>th</sup> Semester  
3L

Max. Marks: 80  
Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Enameling:</b> Brief description of raw materials used in enamel. Batch calculations of frit making, Milling and Slip Preparation. Preparation of metal parts, Applications of Slip.	5
	<b>Firing process:</b> Firing process, colored enamels, properties and defects of enamel coating.	4
II	<b>General information on Glaze:</b> Nature, Origin and Importance of Ceramic Glazes, Ceramic Glazes as a Glassy State	4
	<b>Properties of Glass:</b> Properties of Glass, Composing and Optimization of Glazes,	4

III	<b>Raw Materials:</b> Raw materials for Acidic Oxides, Basic Oxides, for simultaneously introducing Basic oxides & Acidic oxides, for amphoteric oxides.	4
	<b>Auxiliary materials:</b> Auxiliary materials for opacifiers, Binders, Fixing agents, Water as a glaze component, Toxicity of raw materials. Adhesive agents & Stabilizers. Selection of raw materials	4
IV	<b>Technology of Glaze:</b> Seger Formula, Glaze Calculation based on pure raw materials and based on fritted glaze and mill additives, application of Glazes, Firing of Glazes, Cooling & Tensions in glaze layer.	5
	<b>Coloring of Glazes:</b> Coloring of Glazes, Molecular, Colloidal and Glaze Staining. Decolorization of glazes, Matting of Glazes, pacification of Glazes	4
V	<b>Classification of Glazes:</b> Classification, The nature of glazes, General properties of glazes Based on Body to be glazed, Based on Glaze Composition.	6
TOTAL		40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	R. A. Eppler and M. Obstler/Understanding Glazes/ The American Ceramic Society	2005

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	R. A. Eppler and D. R. Eppler/Glazes and Ceramic Coatings/ American Ceramic Society	2000
2	Fritz /Glazes- Frits & Receipts	-
3	Pralmee/ Industrial Glazes	-
4	Andrew I. Andrews/ Enamels	1961

#### 6CR6.1A: INDUSTRIAL ECONOMICS & FACTORY MANAGEMENT

B.Tech. (Ceramic) 6<sup>th</sup> Semester  
3L

Max. Marks: 80  
Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Accounts:</b> Types of accounts, book keeping, single entry and double entry, trading account, profit and loss account and balance sheet	7



II	<b>Cost Accounting:</b> cost accounting and cost control. Economic laws, increasing and diminishing return, utility, total and marginal,	8
III	<b>Business Organization 1:</b> Forms of business organization, private, partnership, joint stock companies and cooperative societies, limited and unlimited liabilities	5
	<b>Business Organization 2:</b> shares, debentures, bonds, valuation and depreciation. Fixed cost and variable cost, business	4
IV	<b>Management:</b> Principle of management, management process schools, human factors, management by objective	4
	<b>Type of organization charts:</b> Type of organization charts	4
V	<b>Materials management:</b> purchase, inventory, control, ABC analysis, Break-even analysis, stores, sales and material handling, S.Q.C. and standardization, PERT and planning. Site selection and factory layout.	8
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	M.N. Arora/ Management Acc./Cost Acc./Vikash Publishing House	2009
2	Misra & Puri /Business Environment	2000

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	L.M. Prasad/ Principles and Practices of Management/ Sultan Chand & Sons	2007
2	S.N. Cherry. Anil Kumar & N.Suresh/Production Planning & Management/ Himalaya Publication	-
3	Agrawal & Agrawal/ Financial Accounting/ Pragati Publication	-
4	Narasimhan/Production Planning and Inventory Control/Prentice Hall	1995
5		

**6CR6.2A: HISTORY OF CERAMIC SCIENCE & TECHNOLOGY**B.Tech. (Ceramic)6<sup>th</sup> Semester  
3L

Max. Marks: 80

Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>History of Red Clay Pottery &amp; its technology:</b> Rural Pottery,	4
	Studio Pottery	4
II	<b>History of White clay Pottery &amp; its technology:</b> Stoneware, Earthenware,	4
	Vitrified Porcelain, Bone china	4
III	<b>History of Glass &amp; its technology:</b> Tableware, float glass	4
	Scientific Glasswares	4
IV	<b>History of Refractory products &amp; its technology:</b> Acid & Basic Refractories etc	8
V	<b>History of Cement &amp; its technology:</b> Portland, Pozzolana & Pozzolanic Cements.	8
	TOTAL	40

**TEXT BOOK**

SN	Name of Authors/Books/Publishers	Year of Publication
1	W. D. Kingery, H. K. Bowen and D. R. Uhlmann/Introduction to Ceramics, 2nd Ed./ John Wiley & Sons, Singapore	1991
2	D. W. Richardson, B. J. Dunbar/The Magic of Ceramics/ American Ceramic Society	2000

**REFERENCE BOOKS**

SN	Name of Authors/Books/Publishers	Year of Publication
1	J. B. Wachtman Jr./ Ceramic Innovations in the 20th Century/American Ceramic Society	1999
2	Philippe Boch and Jean-Claude Niepce/Ceramic Materials Processes, Properties and Applications/ISTE USA	2007
3	Paul Bormans/Ceramics are More Than Clay Alone/Cambridge International Science Publishing	2004

### 6CR6.3A: THIN FILM & COATINGS

B.Tech. (Ceramic) 6<sup>th</sup> Semester

Max. Marks: 80

3L

Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Film deposition techniques and processes:</b> Introduction, Gas kinetics: vapours and gases, distribution function, transport properties.	4
	<b>Vacuum technology:</b> pump selection and exhaust handling, contamination sources and pressure measurement	4
II	<b>Evaporation:</b> thermodynamics of evaporation, sources, deposition monitoring.	3
	<b>Deposition:</b> adsorption, surface diffusion, nucleation, structure development, interfaces, adhesion, temperature control. Molecular beam epitaxy: process overview, deposition system, application, Sputter deposition, introduction, sputter sources, applications.	5
III	<b>Chemical Vapour deposition, Laser ablation, Plating:</b> electroplating, electro-less plating, and application. Sol-gel coating,	4
	<b>Pattern generation techniques:</b> microlithography, optical tools for microlithography, etching, advanced process.	4
IV	<b>Properties of Thin Film Materials:</b> Substrates for thin film applications, thin film conductive materials, Resistors for thin film applications, thin film dielectrics, Thin film magnetics, advanced thin film materials.	4
	<b>Characterization of Thin Film:</b> Electro-Optical measurements, Chemical composition and Structural characterizations, nano-scale and atomic scale measurements. Thermal barrier coatings.	4
V	<b>Diamond films:</b> nucleation and growth, properties of diamond, applications.	3
	<b>Thin film optical materials:</b> behavior of light at the interface, multilayer optical coating, preparation and formulation of optical thin films, applications, recent developments in this area.	5
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	K. Seshan/Hand Book of Thin Film Deposition Technique/ William Andrew INC	2002
2	D. L. Smith/ Thin film deposition/McGraw-Hill Professional	1995

## REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	Elshabini-Riad and F. D. Barlow/Thin Film Technology Hand Book/McGraw-Hill Professional,	1997
2	R. C. Buchanan/Ceramic Materials for Electronics: processing, properties and applications/Marcel Dekker, NY	1986
3	L. M. Levinson/Electronic Ceramics: properties, device and applications/CRC Press	1987

### 6CR 7: CERAMIC PROPERTIES LAB

1. Dimensional Analysis of Ceramic Products.
2. Determination of Whiteness of Ceramic materials.
3. Testing the ceramic sample for Craze Test as per BIS standard.
4. The reflectance test of various Tile.
5. Determine the tensile strength of a given ceramic product.
6. Determine the compressive strength of a given ceramic product.
7. Determine the activation energy for a given ceramic product using resistivity meter
8. Study the Dielectric properties for ceramic capacitor using LCR meter.
9. Determination of Impact strength of Given Ceramic sample.
10. Determination of bending strength by three point bending methods of a given ceramic specimen.

### 6CR 8: CERAMIC COATINGS LAB

1. Preparation of Enamel batches, melting, fritting.
2. Preparation of Iron Sheet for enameling.
3. Preparation & Application of Enamel on Iron Sheet.
4. Testing of the enamel led plate for Acid Resistance as per BIS Standards.
5. Preparation & Application of Stoneware Glaze.
6. Preparation & Application of Insulator Glaze.
7. Preparation & Application of Bone china Glaze.
8. Preparation & Application of Terracotta Glaze.
9. Study & Description of defects in Glazes.
10. Determination of chemical analysis of glaze frit.

### 6CR 9: CEMENT LAB

1. Determination of consistency of standard cement paste,
2. Determination of Initial setting time and final setting time of given mix.,
3. Determination of Fineness of cement by dry sieving,
4. Determination of specific gravity of cement,
5. Determination of Tensile strength of cement.
6. Mixing of Plaster & making of moulds for slip Casting.
7. Determination of setting time of given Plaster of Paris
8. Determination of Soundness of cement by autoclave test method.
9. Determination of Compressive strength of cement.
10. Workability of concrete.
11. Chemical analysis of ordinary Portland cement.

### 6CR 10: MORAL VALUES, PROFESSIONAL ETHICS AND DISASTER MANAGEMENT

### 6CRDC: DISCIPLINE & EXTRA CURRICULAR ACTIVITIY

**7CR1A: TRADITIONAL CERAMICS & PROCESSING TECHNIQUES**

**B.Tech. (Ceramic) 7<sup>th</sup> Semester**  
3L

**Max. Marks: 80**  
**Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	<b>Ceramic Building Materials:</b> Common Bricks, Facing & Stock Bricks, Engineering Bricks, Blue Bricks, Hollow Bricks, Perforated Bricks, Hollow tiles, Glazed Bricks, Roofing Tiles, Flower Pots	5
	<b>Ceramic Building Materials:</b> Salt Glazed Stoneware Pipes, Floor Tiles, Wall Tiles, Exterior Decorated Tiles. Sanitary Earthen wares, Vitreous China Sanitary wares, Fireclay & Stoneware sanitary wares	5
II	<b>Ceramics in Home:</b> Stoneware Table wares, Earthenware tableware vases etc, Semi-vitreous China wares, Hotel China wares	4
	<b>Ceramics in Home:</b> Bone china Dinnerware, Hard Porcelain tableware, Heat Resistant wares, Stoneware Kitchen wares, Art wares, Dental Porcelain.	4
III	<b>Chemical Ceramics:</b> Stoneware, Chemical Stoneware, White Chemical Stoneware, Chemical Porcelain,	4
	<b>Technical Ceramics:</b> Carbon & Graphite Shapes, Delanium Carbon, & Graphite, Kemite & Karcite laboratory equipments & Filters .	4
IV	<b>Engineering Wares:</b> Mullite Porcelain, Steatite Porcelain, Sintered Boron Carbide, Sintered Silicon Carbide,	4
	<b>Engineering Wares:</b> Thoria & Uranium Dioxide Ceramics. Fused Alumina Grinding Wheels, Ceramic Cutting Tools.	3
V	<b>Ceramics in Electrical Industries:</b> Low Tension Insulators, High Tension Insulator, High Temperature Insulators, Sparking Plug Insulators, High Frequency Ceramic Insulators,	4
	<b>Ceramics in Electrical Industries:</b> Low Loss Steatite, Alumina, Zircon & Cordierite Ceramics.	3
	TOTAL	40

**TEXT BOOK**

SN	Name of Authors/Books/Publishers	Year of Publication
1	Felix Singer & Sonja S. Singer/Industrial Ceramics	1971

**REFERENCE BOOKS**

SN	Name of Authors/Books/Publishers	Year of Publication
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1	W. Ryan and C. Radford/ Whitewares: Production, Properties and Quality Control/Pergamon Press, Oxford,	1987
2	V. E. Henkes, George Y. Onoda, W. M. Carty/Science of Whitewares/ The American Ceramic Society,	1996
3	F. H. Norton/ Fine Ceramics: Technology and Application/ McGraw Hill, NY	1970
4	W. M. Carty, C. W. Sinton/ Science of Whitewares II/ American Ceramic Society	1999

### 7CR2A: ADVANCED CERAMICS & PROCESSING TECHNIQUES

B.Tech. (Ceramic) 7<sup>th</sup> Semester

Max. Marks: 80

3L

Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Science of Colloidal Processing:</b> Vander Waals forces between macroscopic bodies, Effect of intervening media, Lyophobic collides	3
	<b>Stabilization Phenomena:</b> Electrostatic stabilization in double layer and surface charges, Repulsion between two double layers, Stability of electrostatically colloids, Electrokinetic Phenomena, Polymeric Stabilization.	5
II	<b>Sol-Gel Processing:</b> Polymeric Gel Route, Metal Alkoxides - Preparation & its Properties, SolGel Process for metal Alkoxides, Sol-Gel preparation techniques for Colloidal gel & polymeric gel	5
	<b>Application of Sol-Gel:</b> Application in thin film & coating, fiber & Monolithics.	3
III	<b>Solid –State and Viscous sintering:</b> Sintering of Polycrystalline & amorphous materials	3
	<b>Analysis of sintering :</b> Theoretical analysis of sintering, Numerical simulations of sintering, Phenomenological sintering equations,	4
	<b>Sintering stresses:</b> Sintering stresses and its measurement	2
IV	<b>Powders synthesizing:</b> Powder Characteristics	3
	<b>Powder preparation methods:</b> Mechanical Synthesis, Mechnochemical Synthesis, Chemical methods, Vapor phase reactions.	5
V	<b>Liquid Phase Sintering:</b> Introduction, Elementary features of liquid Phase sintering, Microstructure produced by liquid phase sintering,	4
	<b>Stages in liquid Phase sintering :</b> Stages in liquid Phase sintering, Controlling factors	3
	TOTAL	40

**TEXT BOOK**

SN	Name of Authors/Books/Publishers	Year of Publication
1	M. N. Rahaman/ Ceramic Processing and Sintering/ 2nd Ed/ CRC Press,	2003
2	J.S. Reed/ Introduction to the Principles of Ceramic Processing/ 2nd Ed./ John Wiley & Sons.	1995

**REFERENCE BOOKS**

SN	Name of Authors/Books/Publishers	Year of Publication
1	Charles A. Harper/ Handbook of Ceramics, Glasses, and Diamonds/ McGraw-Hill	2001
2	Philippe Boch and Jean-Claude Niepce/ Ceramic Materials Processes, Properties and Applications/ ISTE USA	2007
3	David Segal/ Chemical Synthesis of Advanced Ceramic Materials/ Cambridge University Press	1989

**7CR3A: ELECTRO- CERAMICS-2**

**B.Tech. (Ceramic) 7<sup>th</sup> Semester**  
3L

**Max. Marks: 80**  
**Exam Hours: 3**

UNIT	CONTENTS	CONTACT HOURS
I	<b>Ionically conducting ceramics:</b> Kroger Vink Notation used for atomic defects, Formulation of reaction equations, Defect Equilibria and Kroger-Vink Diagrams for different systems.	5
	<b>Diffusion:</b> Diffusion in stoichiometric and Nonstoichiometric oxides.	3
II	<b>Super ionic solid:</b> Classification of super ionic solids, Structures, Agl based, $\beta$ -Alumina, Halide ion conductors and oxide based super ionic conductors and their applications in fuel cells and batteries, conductivity measurements.	8
III	<b>Highly Conductive Ceramics:</b> Defects Controlled transport, Fast Ions Conduction, Fast Ions Conduction in Glasses, Highly defective Solids	4
	<b>Application of High Conductive Ceramics:</b> Application of High Conductive Ceramics	4
IV	<b>Superconductivity:</b> Superconductors, Meissner effect, Types of superconductors, BCS theory for superconductivity	4
	<b>Synthesis, characteristics and applications of High Tc Superconductors:</b> Synthesis, characteristics and applications of High Tc Superconductors.	4

V	<b>Thick Film Technology:</b> Initial Materials, Processing, Conductors, Dielectrics, Resisters,Hybrids	8
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	R. C. Buchanan/Ceramic Materials for Electronics: processing, properties and applications, Marcel Dekker, NY	1986
2	L. M. Levinson/ Electronic Ceramics: properties, device and applications/ CRC	1987

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	E. Dorre and H. Hubner/Alumina: Processing, Properties and Application/, Springer- Verlag, Berlin Heidelberg,	1984
2	J. Moulson and J. M. Herbert/ Electroceramics: Materials, Properties and Applications/ Springer,	1990
3	Jaffe, W. R. Cook, H. Jaffe and H. L. C. Jaffe/Piezoelectric Ceramics/ R.A.N Publishers,	1990
4	A.R. West/ Solid State Chemistry/Wiley India	1985

#### 7CR4A: BIO-CERAMICS

B.Tech. (Ceramic) 7<sup>th</sup> Semester  
3L

Max. Marks: 80  
Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Bio-Ceramics Introduction:</b> Classification of Bio Ceramics materials. Bio ceramics as implant in human body,	4
	<b>Characterization of biomaterials:</b> Characterization of biomaterials.	4
II	<b>Hard Tissues:</b> Structure of Proteins, Structure Property relationship, Hard tissue – Healing & Remodeling, Biocompatibility	4
	Physics of bone and structure of tooth, cortical bone versus trabecular bone structure	3
III	<b>Hydroxyapatite, Alumina and Zirconia in surgical implants:</b> Source , Composition & Structure, Properties of Hydroxyapatite, Applications, biomaterials for artificial implant	4



	<b>Alumina and Zirconia;</b> Source, Composition & Structure, Mechanical Properties, Fatigue Properties and Service life, Applications	4
IV	<b>Introduction to biological environments,</b> function and degradation of biomaterials in vivoswelling and leaching, corrosion and dissolution reactions of biological molecules with biomaterials surfaces	5
	<b>Mechanics of materials-deformation and failure:</b> Mechanics of materials-deformation and failure, friction and wear. Biological effect of implants inflammatory process, adaption, allergic foreign body response.	5
V	<b>Glass-Ceramics, Carbon Implants:</b> Formation of Glass-Ceramics, Properties of GlassCeramics,	4
	<b>Coating &amp; Composites:</b> Source & Structure of Carbons, Manufacturing of carbon implants	4
	<b>TOTAL</b>	<b>40</b>

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	J. B. Park and J. D. Bronzino/ Biomaterials: Principles and Applications/ CRC Press	2002
2	S. V Bhat/ Biomaterials/ Kluwer Academic Publishers,	2002

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	L. L. Hench and J. R. Jones/ Biomaterials/ Artificial Organs and Tissue Engineering/ Taylor & Francis	2007
2	Wereszczak, M. Mizuno and E. L. Curzio/ Advances in Bioceramics and Biocomposites II/ John Wiley & Sons,	2007
3	J. F. Shackelford/ Advanced Ceramics (vol.1) Bioceramics/ Gordon and Breach Science Publishers, New York	1999
4	D. L. Wise, D.J. Trantolo, D. E. Altobelli, M. J. Yaszemski and J. D. Gresser/ Human Biomaterials Applications/Humana Press,	1996

#### 7CR5A: MATERIAL SCIENCE & ENGINEERING

B.Tech. (Ceramic) 7<sup>th</sup> Semester  
3L+1T

Max. Marks: 80  
Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Nano-Science:</b> Meaning of nano-particle, metal nano-clusters: magic numbers, theoretical modeling of nano-particles, geometric structure, electronic structure, reactivity, fluctuations, magnetic clusters. Carbon, Diamond, Graphite, Fullerenes	5

	<b>Carbon Nano tubes- methods of synthesis:</b> R F plasma, chemical methods, thermolysis, pulsed laser methods.	3
II	<b>Polymer Structure:</b> Hydrocarbon Molecules, Polymer Molecules, Chemistry of Polymer molecules, Molecular weight, shape, Structure & Configuration.	4
	<b>Polymer 2:</b> Thermoplastic & Thermosetting Polymers, Co- Polymers, Polymer Crystallinity, Polymer Crystals, Defects in Polymers, Diffusion in Polymeric materials.	4
III	<b>Polymer's Characteristics, Applications, &amp; Processing:</b> Stress –Strain behavior, Macroscopic Deformation, Viscoelastic Deformation, Viscoelastic Relaxation Modulus, Viscoelastic Creep, Fracture of Polymers,	3
	<b>Characteristics polymers</b> Viz Impact Strength, Fatigue, Tear Strength, Hardness. Mechanism of Deformation strengthening, Crystallization, Melting & Glass Transition Phenomena in Polymers	3
	<b>Polymer types,</b> Polymer synthesis & Processing, Polymer's applications.	2
IV	<b>Composites:</b> Introduction, Particle reinforced composites: Large Particle composites, Dispersion strengthened Composites. Fiber Reinforced Composites: Influence of Fiber length, Fiber orientation,	4
	<b>Applications.</b> The fiber phase, The matrix phase, polymer matrix, metal matrix, ceramic matrix, carbon– carbon, hybrid composites, processing of fiber reinforced composites, structural composites.	4
V	<b>Corrosion &amp; Degradation Of Materials:</b> Corrosion of Metals: Electro Chemical Consideration, Electrode Potential, Corrosion Rates, Passivity, Environmental effects, Forms of Quotation, Corrosion environments,	5
	<b>Corrosion prevention:</b> Corrosion prevention, Oxidation, Corrosion of Ceramic materials & Degradation of Polymers.	3
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	W. D. Calister/Material Science and Engineering / Willy India	2007
2	V. Raghavan/ Materials Science and Engineering 4th Ed/ Prentice-Hall of India Pvt. Ltd, New Delhi.	2004

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	G. F. Carter and D. F. Paul/Materials Science and Engineering/ ASM International	1991
2	K. K. Chawla/ Composite Materials: Science and Engineering/ Springer	2001

3	F. L. Matthews and R. D. Rawlings/ Composite Materials: Engineering and Science/ Woodhead Publishing,	1999
4	J. F. Shackelford and M. Meier/ Introduction to Materials Science for Engineers/ Prentice Hall PTR,	2005
5	Chung/ Introduction to Materials Science and Engineering /CRC Press	2006
6	Shackelford /Introduction to Materials Science for Engineers/ Prentice Hall	2008

### 7CRE 6.1A: ENERGY & ENERGY MANAGEMENT

B.Tech. (Ceramic) 7<sup>th</sup> Semester

Max. Marks: 80

3L

Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Energy:</b> Energy and related units, its resources and demands with economic prosperity and patterns of energy consumption, fossil fuel and energy resources. Sectorial energy demand and conservation.	4
	<b>Energy problem in India:</b> Energy problem in India in different sectors like domestic, transportation, industrial.	4
II	<b>Electrical Energy</b> trends in India and electric power generation, its forecasting and efficiency with cost reduction, related to its production. Role of electrical energy in ceramic industries,	4
	<b>Nuclear energy:</b> Its application of input-output methods to energy problems.	3
III	<b>Nonconventional resources of energies</b> like waste and scrap, solar energy, geothermal power, wind mill energy, utilization of oceanic energy, bio-mass energy, total energy systems.	8
IV	<b>Energy management (a) :</b> Introduction, Energy Auditing in Thermal Systems & Measures, Use of Non-Conventional Ceramic Raw-materials, Area of Activities. Limitations in energy treatment, Start up activities, Finalization of steps of energy management, Incentives to approach, Geographical locations.	5
	<b>Energy policies:</b> Fuel energy in ceramic kilns, Energy audit in ceramic industries. Role of oxide ceramics in energy management, SOFC.	4
V	<b>Energy management (b):</b> Adjustment of Burning conditions, pressure conditions, firing curves, entrance & exit locks, Excess air etc. Heat recovery from heat load from cooling zone, increased output through quality improvement, low rejection, shorter firing cycle. Hot air extraction from cooling zone, Kiln wall's Insulation, Excess combustion space, sizing of blowers, Multi bottom flue outlets, Air-injectors, designing of kiln cars.	8
TOTAL		40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of
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		<b>Publication</b>
1	P. V. Rao/ A Text Book of Environmental Engineering/Prentice Hall of India Private Limited	2002
2	C. C. Herman (Editor), S. Marra (Editor), D. R. Spearing (Editor), L. Vance (Editor) and J. D. Vienna (Editor), Environmental Issues and Waste Management Technologies XI, Ceramic Transactions, Volume 176. John Wiley & Sons, edition	2005
3	Mcelroy/Energy/ Oxford University Press	2009

#### REFERENCE BOOKS

<b>SN</b>	<b>Name of Authors/Books/Publishers</b>	<b>Year of Publication</b>
1	S.K. Sundaram, D. R. Spearing, and J. D. Vienna, Environmental Issues and Waste Management Technology in the Ceramic and Nuclear Industries VIII, Ceramic Transactions, Volume 143, The American Ceramic Society,	2002
2	Priya/ Energy Harvesting Technologies/Springer	2009
3	S. M. Khopkar, Environmental Pollution: Monitoring and Control, New Age International (P) Ltd	2004

#### 7CR6.2A: COMPUTER PROGRAMMING & APPLICATION IN CERAMIC ENGINEERING

B.Tech. (Ceramic) 7<sup>th</sup>Semester

Max. Marks: 80

3L

Exam Hours: 3

<b>UNIT</b>	<b>CONTENTS</b>	<b>CONTACT HOURS</b>
I	<b>Modeling and simulation:</b> Basic concepts of modeling	8
II	<b>Models based on mass and heat transfer (conduction, convection transport, radiation):</b> Logic based industrial flow sheet with recycling	8
III	<b>Optimization:</b> Optimization aspect from Linear and non-linear point of view, evolutionary approach to global optimization: Genetic algorithm, etc.	8
IV	<b>Simulation strategies:</b> Sequential, equation solving approach, modular approach. Simulation software, object oriented programming	8
V	<b>Web based technology:</b> Computer application in	8

	controlling ceramic processes and furnaces and other relevant accessories.	
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	Luyben W.L., Process Modeling, Simulation & Control for Chemical Engineers	1990
2	Pankaj Jalote/Modular Approach: Software Engineering	1997

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	Balagurusamy/Object Oriented Programming	2006
2	NarsinghDeo/ Simulation & Modeling	1978
3	Iron & steel technology, Volume 1 University of Michigan	2005

#### 7CR6.3A: PLANT, EQUIPMENT AND FURNACE DESIGN

B.Tech. (Ceramic) 7<sup>th</sup> Semester

Max. Marks: 80

3L

Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Plant Design:</b> Plant location, plant layout, assembling of economic and engineering data, calculations pertaining to the processes, process vessels, etc.	3
	<b>Flow Diagrams:</b> Piping and instrument flow diagrams, process flow diagrams, design of a ceramic plant,	3
	<b>Feasibility report and cost estimation of the plant.</b> Economics of the plant, commercial aspects etc	2
II	<b>Equipment Design:</b> Principles of design of the following process equipments: Crushers, materials handling systems, filter press, sieves and pug-mills, moulding equipments.	3
	<b>Principles of design of glass moulds</b> such as blank mould, blow mould and neckring moulds.	2
	<b>Drying and different types of driers used in Ceramic industries:</b> Drying and	3

	different types of driers used in Ceramic industries	
III	<b>Principles of design of simple supports:</b> footings and foundations for process equipments such as overhead tanks, motors, compressors and crushers.	4
	<b>Different types of size-radiation equipment used in ceramic industry:</b> Crushers and grinders including their design calculations	4
IV	<b>Chimney foundations:</b> Essential operations of a furnace i.e. firing, charging, melting, reversal. Preheating of air, gas and fuel oil,	4
	<b>Flame systems:</b> Temperature and its control. Thermal current in a glass melting furnace. Furnace atmosphere.	4
V	<b>Furnace life and selection of refractories:</b> Heating up and cooling down of a furnace, furnace construction, furnace capacity, fuel efficiency and firing efficiency,	4
	<b>Design, construction and thermal calculation pertaining to glass melting furnaces:</b> Design, construction and thermal calculation pertaining to glass melting furnaces.	4
	<b>TOTAL</b>	<b>40</b>

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	S. M. Walas/Chemical Process Equipment: Selection and Design/ Butterworths -Heinemann	1988
2	H.J. Sandler, and E.T. Luckiewicz/Practical Process Engineering: A Working Approach to PlantDesign/McGraw Hill Book Company	1987

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	V. C. Davis/Calculation in Furnace Technology/Pergamon Press ltd	1970
2	W. L. McCabe, J. C. Smith and P. Harriot/Unit Operations of Chemical Engineering/McGraw Hill professional	2005
3	W. Trinks and M. H. Macwhinney, A. Shannon, R. J. Reed and J. R. Garvey/Industrial Furnaces, 6th Ed./ Wiley-Interscience,	2003

#### 7CR 7: TRADITIONAL CERAMIC PROCESSING LAB

1. Compounding & Fabrication of Earthen wares.
2. Determination of Dry & Fired Properties of Earthen wares.
3. Compounding & Fabrication of Stoneware Table wares.
4. Determination of Dry & Fired Properties of Stoneware Table wares.
5. Compounding & Fabrication of Chemical Stoneware,
6. Determination of Dry & Fired Properties of Chemical Stoneware.

7. Compounding & Fabrication of Electrical Porcelain
8. Determination of Dry & Fired Properties of Electrical Porcelain.
9. Determination of Electrical Properties of an Insulator by Impulse test equipment.
10. Determination of Mechanical properties of Insulator by UTM machine.

#### 7CR 8: ADVANCED CERAMIC PROCESSING LAB

1. Synthesis of advanced ceramic sample by citrate-nitrate method.
2. Study of grain and grain boundary resistivity by Cole-Cole plot.
3. Synthesis of advanced ceramic sample by co-precipitation method.
4. Determination of B-H curve, permeability and magnetic loss of ferrite.
5. Synthesis of advanced ceramic sample by combustion method.
6. Arrhenius plot for determination of activation energy of conduction.
7. Synthesis the varistors sample through solid state ceramic route.
8. Study the varistors characteristics.
9. Determination of Curie temperature for ferro-magnetic materials.
10. Temperature dependent conductivity of insulators/ semiconductors.

#### 7CR9: CERAMIC EQUIPMENT DESIGN LAB-I

1. Design of Ball Mill.
2. Design of Electric Heating Laboratory Furnace.
3. Design of Cement Rotary Kiln.
4. Design of Tunnel Kiln and its Bricks Lining for Industries.
5. Design of Tunnel Driers.
6. Design of Humidity Control Drier.

#### 8CR1A: SCIENCE & TECHNOLOGY OF SPECIAL GLASSES

B.Tech. (Ceramic) 8<sup>th</sup> Semester

Max. Marks: 80

3L

Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Non conventional processing of glasses;</b> Sol-Gel method, Chemical vapor deposition method.	4
	<b>Advantages and disadvantages</b> of non conventional processing of glasses, Acid-base concept in glass.	4
II	<b>Special Glasses:</b> Technology of making radiation shielding glasses, Heat absorbing glasses, Solder glasses	4
	<b>Optical properties of glass,</b> optical glass, photosensitive glasses, coating of glass, coloured glass including photochromic and electrochromic glass	4
III	<b>Chalcogenide and Halide glasses</b> and their applications, LASER glasses and their use, Solarized glasses,	4
	<b>Glasses for domestic purposes:</b> Glasses for domestic purposes	3
IV	<b>Low durability glasses</b> for agricultural purpose. Glass for optical fiber communication, TV picture tube, Glass filters.	4
	<b>Fixation of nuclear wastes in glass:</b> Fixation of nuclear wastes in glass:	4
V	<b>Special characteristics of optical glass ceramics-</b> dimensional stability, radiation stability and chemical durability.	3

	<b>Surface strengthening of glass ceramics</b> – thermal strengthening and chemical strengthening, refractory glass ceramics,	3
	<b>Application of Glass ceramics</b> - cooking systems, reflective optics, laser gyroscopes.	2
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	J. E. Shelby/Introduction to Glass Science and Technology/The Royal Society of Chemistry	2005
2	S. Kumar/ Hand Book of Ceramics/Kumar and Associates	1995
3	<i>M. H. Lewis/ Glass &amp; Glass Ceramics/Chapman &amp; Hall, London</i>	1989

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	Paul/ Chemistry of Glasses/Chapman and Hall/2nd Ed.	1990
2	H. Bachs and D. Krause/ Low Thermal Expansion Glass Ceramics/ Springer	2005
3	P. W. McMillan/Glass Ceramics/Academic Press, 2nd Ed., NY,	1979
4	K. Varshneya/ Fundamentals of Inorganic Glass/ Academic press,	1994
5	A. R. West/ Solid State Chemistry/John Wiley&Sons	2003

#### 8CR2A: ENGINEERING CERAMICS AND PROCESSING TECHNIQUES

B.Tech. (Ceramic) 8<sup>th</sup> Semester

Max. Marks: 80

3L

Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Densification Process Variables and Densification Practice:</b> Introduction, conventional sintering, microwave sintering, pressure sintering, hot pressing, hot isostatic pressing,	5
	<b>Ultra structure:</b> Ultra structure processing and its potential impact on ceramic industry.	4
II	<b>Grain Growth and microstructural control (a):</b> Introduction, grain growth; preliminary consideration, Ostwald ripening: The LSW theory, normal grain growth in dense solid, abnormal grain growth in dense solids, effect of inclusion and dopants on boundary mobility.	8
III	<b>Grain Growth and microstructural control (b):</b> Grain growth in porous solid, grain growth in very porous solid, pore evolution during sintering, interaction between densification and coarsening, fabrication routes for the production of ceramic with high density and controlled grain size.	8



IV	<b>Problems of sintering:</b> Inhomogeneties and their effects on sintering, constrained sintering; rigid inclusion, thin film, solid solution additives and the sintering	5
	<b>Sintering:</b> Sintering with chemical reaction, viscous sintering with crystallization.	4
V	<b>Application of Ceramics:</b> Electrical applications of ceramics- dielectric ceramics, semiconductors, conducting ceramics, ceramic superconductors. Magnetic ceramics, optical and optoelectronic applications of ceramics.	6
TOTAL		40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	J. B. Wachtman Jr./ Treatise on Materials Science & Technology/ Structural Ceramics Vol- 29, Academic Press Inc., New York	1989
2	M. N. Rahaman/ Ceramic Processing and Sintering/ 2nd Ed, CRC Press	2003
3	Michel Barsoum/Fundamental of Ceramics/Taylor & Francis Group	2002

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	D. W. Richerson/ Modern Ceramic Engineering: Properties, Processing, and Use in Design/ 3 <sup>rd</sup> ed, CRC Press,	2005
2	W. E. Lee and W. M. Rainforth/ Ceramic Microstructures: Property Control by Processing/ First Edition, Springer,	1994
3	S. Hampshire/ Non-Oxide Technical and Engineering Ceramics/ Elsevier Applied Science, London	1986
4	Philippe Boch and Jean-Claude Niepce/ Ceramic Materials Processes, Properties and Applications/ ISTE USA.	2007
5	A. J. Moulson and J. M. Herbert/Electroceramics: Materials, Properties and Applications	2003

#### 8CR3A: ENGINEERING CERAMIC PRODUCTS AND ABRASIVE

B.Tech. (Ceramic) 8<sup>th</sup> Semester

Max. Marks: 80

3L

Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Advanced ceramics for engineering application</b> -reliability consideration, toughening of Si-based ceramics by fiber reinforcement, laminated composite structure with enhanced fracture resistance.	5
	<b>High temperature</b> -carbide and nitride, ceramic bearing.	3
II	<b>Sialon</b> and other ceramics engineering applications, power generation, aerospace application, nuclear reactor	4

	<b>Ceramics for tribological application</b> , ceramic cutting tools. Porous ceramics and Ceramic fibers	4
III	<b>Ceramic materials for energy system</b> , extruded cordierite honeycomb ceramics for environmental application, ceramic matrix composite, intelligent ceramics, and decorative ceramics.	8
IV	<b>Abrasives</b> : abrasive operations, natural abrasives, abrasives like aluminum oxides, silicon carbide, diamond and boron nitride,	4
	<b>Miscellaneous synthetic abrasives</b> : Miscellaneous synthetic abrasives.	4
V	<b>Raw materials for abrasives</b> , their proportioning, processing, manufacture of abrasives, grinding wheels, their drying, firing and testing.	3
	<b>The use of abrasives</b> and grinding wheels in grinding. Evaluation of abrasives products. Loose abrasives operations, chemistry of grinding.	5
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	S. Kumar/ Hand Book of Ceramic/Kumar and Associates	1995
2	Aldinger /Handbook of Advanced Ceramics Vol. I & Vol II /Academic Press Elsevier	2003

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	J. B. Wachtman Jr./ Treatise on Materials Science & Technology/ Structural Ceramics Vol- 29, Academic Press Inc., New York	1989
2	S. Hampshire/ Non-Oxide Technical and Engineering Ceramics/Elsevier Applied Science, London,	1986
3	D. W. Richerson/ Modern Ceramic Engineering: Properties, Processing, and Use in Design/ 3 <sup>rd</sup> ed, CRC Press,	2005
4	Philippe Boch and Jean-Claude Niepce/ Ceramic Materials Processes, Properties and Applications/ ISTE USA	2007
5	A. R. West/ Solid State Chemistry/Wiley India	2005

**8CR4.1A: POLLUTION CONTROL IN CERAMIC INDUSTRIES**

**B.Tech. (Ceramic) 8<sup>th</sup> Semester**

**Max. Marks: 80**

**3L**

**Exam Hours: 3**

<b>UNIT</b>	<b>CONTENTS</b>	<b>CONTACT HOURS</b>
I	<b>Types of Pollution:</b> Different kinds of industrial pollution and their origin and influence on human being Indian environmental laws and WHO's norms.	4
	<b>Emissions from Fuels:</b> The emission from burning coal, furnace oil and their analysis.	2
	<b>Emission Control:</b> The improvement of combustion processes to reduce the formation of NO <sub>x</sub> , SO <sub>x</sub> , CO etc.	3
II	<b>Environment Waste:</b> Fine particles released from the crushing grinding of the ceramic raw materials.	4
	The equipment and methods to arrest the release of fine particulate materials and unwanted gases to atmosphere.	4
III	<b>Chemicals used in different ceramic industries:</b> Chemicals used in different ceramic industries e.g. Tiles, Potteries, Refractory, and Glass industries.	4
	<b>Leaching:</b> Possibility of leaching of the chemicals to ground water and to rivers and lakes. Possible ways to stop the leaching of suitable chemicals.	4
IV	<b>Types of pollution :</b> Different types of pollution Created from the solid wastes in the ceramic industries and the possibility of recycling them.	4
	<b>Types of pollution :</b> Sound and noise pollutions and their minimization techniques.	3
V	<b>Waste Utilization:</b> Nature and type of industrial waste useful for ceramic industries. Use of industrial wastes in ceramic industries; utilization of fly ash, rice husk, BF slag in the production of traditional, advanced ceramics. Utilization of red mud and recovery of metals from red mud.	8
	<b>TOTAL</b>	<b>40</b>

**TEXT BOOK**

<b>SN</b>	<b>Name of Authors/Books/Publishers</b>	<b>Year of Publication</b>
1	Dr. Suresh K. Dhameja/Environmental Engineering and Management/ S.K. Kataria & Sons	2009
2	C. C. Herman (Editor), S. Marra (Editor), D. R. Spearing (Editor), L. Vance (Editor) and J. D. Vienna (Editor)/ Environmental Issues and Waste Management Technologies XI/ Ceramic Transactions, Volume 176. John Wiley & Sons	2005.

## REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	S.K. Sundaram, D. R. Spearing, and J. D. Vienna/ Environmental Issues and Waste Management Technology in the Ceramic and Nuclear Industries VIII/ Ceramic Transactions, Volume 143, The American Ceramic Society	2002
2	S. M. Khopkar/ Environmental Pollution: Monitoring and Control/ New Age International (P) Ltd	2004
3	P. V. Rao/A Text Book of Environmental Engineering/Prentice Hall of India Private Limited	2002

### 8CR4.2A APPLICATIONS OF PHASE DIAGRAMS IN CERAMIC

B.Tech. (Ceramic) 8<sup>th</sup> Semester  
3L

Max. Marks: 80  
Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Ternary Phase Diagrams:</b> Phase diagram of some important three component systems- CaO–Al <sub>2</sub> O <sub>3</sub> –SiO <sub>2</sub> , MgO–Al <sub>2</sub> O <sub>3</sub> –SiO <sub>2</sub> , SiO <sub>2</sub> –FeO–Fe <sub>2</sub> O <sub>3</sub> , MgO–FeO–Fe <sub>2</sub> O <sub>3</sub> , and MgO–Al <sub>2</sub> O <sub>3</sub> –Cr <sub>2</sub> O <sub>3</sub> .	4
	<b>Quaternary Phase Diagrams:</b> Quaternary System- MgO–CaO–SiO <sub>2</sub> –Fe <sub>2</sub> O <sub>3</sub> , MgO–SiO <sub>2</sub> –CaO–B <sub>2</sub> O <sub>3</sub> , The relevance of above phase diagrams in the ceramic system	4
II	<b>Use of phase diagram in the sintering of ceramics:</b> Use of phase diagram in the sintering of ceramics; multiphase system containing a liquid phase	4
	<b>Phase Diagrams:</b> Tungsten-carbide-cobalt system, porcelain, silicon nitride.	4
III	<b>Single Crystals :</b> Crystal growing techniques and use of phase diagrams in crystal growth; growth from stoichiometric melts, impurity distribution coefficient, constitutional supercooling and non-stoichiometric melts,	4
	<b>Single Crystals:</b> single crystal growing of Yttrium-iron-garnet, cubic barium-titanate, gallium-phosphide, quartz crystal from hydrothermal solution	4
IV	<b>Phase diagrams in Refractories:</b> Phase diagrams in the development and use of refractories; Alumino-silicates, Silica and basic refractories, Fusion cast refractories.	4
	<b>Phase diagrams in Refractories :</b> Liquid immiscibility in oxide systems. Study of dissolution of refractories in molten slag	4

V	<b>Application of the phase diagrams</b> : Phase diagrams in glass making, iron-carbon system, in the stabilization of zirconia phases.	3
	<b>Application of the phase diagrams</b> : Phase diagrams in high pressure systems, recent developments in this area.	2
	<b>Application of the phase diagrams</b> : Application of the phase diagrams in cement chemistry; calcium-alluminate cement and Portland cement	3
TOTAL		40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	Y. M. Chiang, D. Birnie III and W. D. Kingery/Physical Ceramics: Principles for Ceramic Science and Engineering/Wiley	1996
2	E. M. Levin, R. S. Roth, G. Smith, C. R. Robbins, H. F. McMurdie, L. P. Cook and M. K. Reser/Phase Diagram for Ceramists: salts/The American Ceramic Society,	1975

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	A. M. Alper/Phase Diagrams: Materials Science and Technology, Vol. I, II and III/Academic Press,	1970
2	A. M. Alper (Editor), G. Kostorz (Series Editor), H. Herman (Series Editor)/Phase Diagrams in Advanced Ceramics/Treatise on Materials Science and Technology Academic Press	1995
3	D. R. F. West/Ternary Phase Diagrams in Materials Science/Maney Publishing; 3rd edition	2002

#### 8CR4.3A: FUEL CELL & BATTERIES

B.Tech. (Ceramic) 8<sup>th</sup> Semester  
3L

Max. Marks: 80  
Exam Hours: 3

UNIT	CONTENTS	CONTACT HOURS
I	<b>Introduction:</b> History, thermodynamics and electrochemical kinetics, fuel cell components and their impact on performance ;	4
	<b>Fuel cell systems:</b> Proton exchange membrane fuel cell; Direct methanol fuel cells; Molten carbonate fuel cells; Polymer electrolyte fuel cells; solid oxide fuel cells	4
II	<b>Electrical and Ionic Conductivity:</b> Fundamentals of electrical and ionic conductivity, fast ionic conductors, defect chemistry,	2
	<b>Electrolyte:</b> Material system, synthesis, properties, fabrication,	3

	applications ;	
	<b>Anode:</b> Material system, synthesis, properties, fabrication, applications.	3
III	<b>Cathode:</b> Material system, synthesis, properties, fabrication, applications,	2
	<b>Interconnects:</b> Material system, synthesis, properties, fabrication, applications,	3
	<b>Special materials:</b> Material system, synthesis, properties, fabrication, applications.	3
IV	<b>Stack design and fabrication techniques:</b> Stack design and fabrication techniques, Electrode polarization fundamentals, polarization kinetics.	4
	<b>Fuel cells and its components:</b> Testing and characterization of fuel cells and its components, Fuel processing and reforming of fuel.	4
V	<b>Batteries:</b> General terms and characteristics, battery parameters, Fundamental aspects of battery system. Battery component,	3
	<b>Batteries:</b> Electrolyte, catode, anode, material system, synthesis, properties, fabrication, applications. Stack design and fabrication techniques.	3
	<b>Batteries and its components:</b> Testing and characterization of batteries and its components.	2
	TOTAL	40

#### TEXT BOOK

SN	Name of Authors/Books/Publishers	Year of Publication
1	P. G. Bruce/Solid State Electrochemistry/Cambridge University Press	1997
2	J. S. Newman and K. E. Thomas-Alyea/Electrochemical Systems/Wiley-IEEE	2004

#### REFERENCE BOOKS

SN	Name of Authors/Books/Publishers	Year of Publication
1	G. Hoogers/Fuel Cell Technology Handbook/CRC Press	2003
2	H. A. Kiehne/Battery Technology Handbook/CRC Press	2003
3	C. Julien and G. A. Nazri/Solid State Batteries: materials design and optimization/Springer	1994

### **8CR 5: SPECIAL GLASS LAB**

1. To determine the softening point of given glass fiber.
2. To determine the coefficient of viscosity of the given glass sample.
3. To measure the chemical durability of glass by BIS method.
4. To determine the hardness by Rockwell method.
5. To determine the dielectric constant of given glass sample.
6. To prepare cobalt doped colored glass.
7. To prepare a Iron doped colored glass.
8. To determine the thermal conductivity of glass fiber.

### **8CR 6: ENGINEERING CERAMIC LAB**

1. To determine the Water permeability of porous ceramics.
2. Demonstration of ceramic tools in machining.
3. Demonstration of ceramic products in daily life.
4. Grading of abrasive materials of different mesh
5. Compounding a batch for feldspar bonded ceramic abrasive wheel.
6. Compounding a batch for clay bonded ceramic abrasive wheel.
7. To prepare an Epoxy based Grinding wheels for marble polishing.

### **8CR7: CERAMIC EQUIPMENT DESIGN LAB-II**

1. Design of LD Converter Lining.
2. Design of Electric Arc Furnace lining.
3. Design of Gas/Oil Fired Furnace.
4. Design of Spray Drier.
5. Design of Seebeck Coefficient Measurement Setup.
6. Design of Two/Four Probe Resistivity Measurement Setup.

### **8CR 8: ENGINEERING CERAMIC PROCESSING LAB**

1. Calibration of thermocouple and determination of temperature profile of the furnaces.
2. Effect of process parameters on the response behaviour of PID controller.
3. Calibration of PID temperature Controller.
4. Study of isothermal sintering behaviour of ceramic materials.
5. Study of non-isothermal sintering behaviour of ceramic materials.
6. Study of decomposition kinetics of a material from its isothermal weight loss behaviour.
7. Study of phase transformation kinetics from differential thermal analysis.
8. Study of the heating rate on constant rate heating densification behaviour.
9. Study of binder burnt out behaviour by TGA.
10. Study of recrystallization behaviour of materials