ANNA UNIVERSITY : : CHENNAI 600 025

UNIVERSITY DEPARTMENTS

R – 2008

B.TECH. CERAMIC TECHNOLOGY

III TO VIII SEMESTERS CURRICULUM AND SYLLABI

SEMESTER III

CODE	COURSE TITLE	L	T	P	C
THEORY					
MA 9211	Mathematics – III	3	1	0	4
CT 9201	Materials Science for Ceramics	3	0	0	3
CT 9202	Unit Operations	3	0	0	3
CY 9213	Instrumental Methods of Analysis	3	0	0	3
EE 9213	Electrical Drives and Controls	3	0	0	3
CH 9204	Basic Mechanical Engineering	3	0	0	3
CE 9215	Mechanics of Solids	3	0	0	3
PRACTICALS					
CT 9207	Ceramic Science Lab	0	0	2	1
EE 9214	Electrical Engineering Lab	0	0	4	2
CH 9257	Mechanical Engineering Lab	0	0	4	2
	TOTAL	**21**	**1**	**10**	**27**

SEMESTER IV

CODE	COURSE TITLE	L	T	P	C
THEORY					
MA 9267	Statistics and Linear Programming	3	1	0	4
CT 9251	Metallurgy	3	0	0	3
CT 9252	Ceramic Raw Materials	3	0	0	3
CT 9253	Processing of Ceramic Raw Materials	3	0	0	3
CT 9254	White ware & Heavy Clayware	3	0	0	3
	Elective – I	3	0	0	3
	Elective – II	3	0	0	3
PRACTICALS					
CT 9257	Ceramic Powder Processing Lab	0	0	2	1
CT 9258	White ware & Heavy Clayware Lab	0	0	2	1
	TOTAL	**21**	**1**	**4**	**24**

SEMESTER V

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
CT 9301	Thermodynamics for Ceramics	3	0	0	3
CT 9302	Fuels & Energy Engineering	3	0	0	3
CT 9303	Ceramic Fabrication Processes	3	0	0	3
CT 9304	Glass Engineering – I	3	0	0	3
CT 9305	Refractories – I	3	0	0	3
	Elective – III	3	0	0	3
	Elective – IV	3	0	0	3
PRACTICALS					
CT 9307	Refractories Lab	0	0	2	1
CT 9308	Chemical Analysis of Ceramic Raw Materials Lab	0	0	2	1
CT 9306	Technical Seminar	0	0	2	1
CT 9309	Industrial Training*	-	-	-	1
	TOTAL	**21**	**0**	**6**	**25**

*** Industrial Training for four weeks during the 4th Semester vacation**

SEMESTER VI

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
CT 9351	Kilns, Furnaces & Pyrometry	3	0	0	3
CT 9352	Glaze Technology	3	0	0	3
CT 9353	Phase Equilibria in Ceramics	3	0	0	3
CT 9354	Glass Engineering – II	3	0	0	3
CT 9355	Refractories – II	3	0	0	3
	Elective – V	3	0	0	3
	Elective – VI	3	0	0	3
PRACTICALS					
CT 9357	Glaze Lab	0	0	2	1
CT 9358	Glass Lab	0	0	2	1
GE 9371	Communication Skills and Soft Skills Lab	0	0	2	1
	TOTAL	**21**	**0**	**6**	**24**

SEMESTER VII

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
CT 9401	Advanced Structural Ceramic Materials	3	0	0	3
CT 9402	Advanced Ceramic Processing	3	0	0	3
CT 9403	Calculations in Ceramics	3	0	0	3
CT 9404	Electronic Ceramics	3	0	0	3
CT 9405	Cement & Concrete	3	0	0	3
	Elective – VII	3	0	0	3
	Elective – VIII	3	0	0	3
PRACTICALS					
CT 9407	Advanced Instrumental Methods of Analysis Lab	0	0	2	1
CT 9408	Advanced Ceramic Processing Lab	0	0	2	1
		21	**0**	**4**	**23**

SEMESTER VIII

CODE NO	COURSE TITLE	L	T	P	C
THEORY					
	Elective – IX	3	0	0	3
	Elective – X	3	0	0	3
PRACTICALS					
CT 9451	Project Work	0	0	12	6
		6	**0**	**12**	**12**

TOTAL CREDITS: 190

LIST OF ELECTIVES FOR B.TECH. CERAMIC TECHNOLOGY

CODE NO	COURSE TITLE	L	T	P	C
CT 9021	Properties of Ceramics	3	0	0	3
CT 9022	Ceramic Testing & Quality Control	3	0	0	3
CT 9023	Adhesive	3	0	0	3
CT 9024	Process Automation	3	0	0	3
CT 9025	Materials Management	3	0	0	3
CT 9026	Monolithics & Castables	3	0	0	3
CT 9027	Heat Recovery Systems	3	0	0	3
CT 9028	Quality Control in Ceramic Industries	3	0	0	3
CT 9029	Abrasives	3	0	0	3
CT 9030	Bioceramics	3	0	0	3
CT 9031	Special Glasses	3	0	0	3
CT 9032	Advanced Coating Technologies	3	0	0	3
GE 9023	Fundamentals of Nano science	3	0	0	3
CT 9033	Fibres & Composites	3	0	0	3
CT 9034	Plant Equipment & Furnace Design	3	0	0	3
CT 9035	Nanoceramics & Nanocomposites	3	0	0	3
CT 9036	Mechanical Behaviour of Ceramics	3	0	0	3
CT 9037	Non Destructive Testing	3	0	0	3
CT 9038	Microwave Processing of Ceramics	3	0	0	3
CT 9039	Nuclear & Space Ceramics	3	0	0	3
CT 9040	Entrepreneurship Development	3	0	0	3
CT 9041	Computer Aided Design	3	0	0	3
GE 9021	Professional Ethics in Engineering	3	0	0	3
GE 9022	Total Quality Management	3	0	0	3
GE 9261	Environmental Science & Engineering	3	0	0	3
IB 9309	Process Economics & Industrial Management	3	0	0	3

MA9211 MATHEMATICS III L T P C

(common to all branches of B.E. / B.Tech programmes) 3 1 0 4

AIM

To facilitate the understanding of the principles and to cultivate the art of formulating physical problems in the language of mathematics.

OBJECTIVES

- To introduce Fourier series analysis which is central to many applications in engineering apart from its use in solving boundary value problems
- To acquaint the student with Fourier transform techniques used in wide variety of situations in which the functions used are not periodic
- To introduce the effective mathematical tools for the solutions of partial differential equations that model physical processes
- To develop Z- transform techniques which will perform the same task for discrete time systems as Laplace Transform, a valuable aid in analysis of continuous time systems

UNIT I FOURIER SERIES 9+3

Dirichlet's conditions – General Fourier series – Odd and even functions – Half-range Sine and Cosine series – Complex form of Fourier series – Parseval's identity – Harmonic Analysis.

UNIT II FOURIER TRANSFORM 9+3

Fourier integral theorem – Fourier transform pair-Sine and Cosine transforms – Properties – Transform of elementary functions – Convolution theorem – Parseval's identity.

UNIT III PARTIAL DIFFERENTIAL EQUATIONS 9+3

Formation – Solutions of first order equations – Standard types and Equations reducible to standard types – Singular solutions – Lagrange's Linear equation – Integral surface passing through a given curve – Solution of linear equations of higher order with constant coefficients.

UNIT IV APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 9+3

Method of separation of Variables – Solutions of one dimensional wave equation and one-dimensional heat equation – Steady state solution of two-dimensional heat equation – Fourier series solutions in Cartesian coordinates.

UNIT V Z – TRANSFORM AND DIFFERENCE EQUATIONS 9+3

Z-transform – Elementary properties – Inverse Z-transform – Convolution theorem – Initial and Final value theorems – Formation of difference equation – Solution of difference equation using Z-transform.

L: 45, T: 15, TOTAL: 60 PERIODS

TEXT BOOK

1. Grewal, B.S. "Higher Engineering Mathematics", Khanna Publications (2007)

REFERENCES

1. Glyn James, "Advanced Modern Engineering Mathematics, Pearson Education (2007)
2. Ramana, B.V. "Higher Engineering Mathematics" Tata McGraw Hill (2007).
3. Bali, N.P. and Manish Goyal, "A Text Book of Engineering 7th Edition (2007) Lakshmi Publications (P) Limited, New Delhi.

CT9201 MATERIALS SCIENCE FOR CERAMICS L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about crystal systems, microstructure and dependence on various properties.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt about the atomic structure and bonding.
- Have studied about the structure of solids and various imperfections.
- Have learnt the basics about phase diagrams and phase transformations.
- Have learnt the basic concepts of diffusion in solids.
- Have studied the general properties of the solids.

UNIT I CHARACTERIZATION OF CERAMIC SOLIDS 10

Classification of engineering materials – structure-property relationships – atomic structure – bonding – bond energy, bond type, bond length, ionic, metallic, covalent, vanderwaals, secondary, variation in bonding character and properties – polymorphic transformations – structure of ceramics – metallic and ceramic structures – binary, ternary, silicate structures.

UNIT II STRUCTURE OF SOLIDS AND IMPERFECTIONS 9

Crystalline and non crystalline states – inorganic solids – covalent, metals and alloys, ionic, polymers – classification – structure – crystallinity. Imperfections – point – vacancy, Schottky, Frenkel- Line – dislocations – edge, screw, properties of dislocations – surface - grain boundary, interface boundary, twin and twist boundary, stacking faults – volume imperfections.

UNIT III PHASE DIAGRAMS AND PHASE TRANSFORMATIONS 9

Phase rule – single component system – binary phase diagrams – micro structural changes during cooling – lever rule – applications of phase diagrams – phase transformations – time scale for phase changes – nucleation & growth – applications.

UNIT IV DIFFUSION 8

Fick's laws of Diffusion – Solution to Fick's second law – applications based on the second law solution. Relationship between diffusibility and atomic mobility. Atomistic mechanisms of Diffusion – vacancy , interstitial, substitutional, interstitialcy, ring mechanism. Different types of diffusivities and their interdependence – tracer diffusivity, chemical diffusivity etc. Temperature dependence of diffusivity and activation energy. Kirkendall effect and Matano interface. Surface and Volume diffusivity.

UNIT V PROPERTIES 9

Physical properties – density, specific gravity, melting behavior. Thermal Properties – heat capacity, thermal conductivity, thermal expansion. Dielectric properties – polarization, dielectric constant, dielectric strength, dielectric loss, capacitance.

TOTAL: 45 PERIODS

TEXT BOOKS

1. V.Ragavan, Materials Science & Engineering, Prentice Hall of India, New Delhi, 2004.
2. W.D.Kingery, H.K.Bowen and D.R.Uhlmann, Introduction to Ceramics, John Wiley & Sons,2nd Edn, 2004.

REFERENCES

1. David W Richerdson, Modern Ceramic Engineering, Marcel Dekker Inc, New York,3rd Edn, 2006.
2. Michael W Barsoum, Fundamentals of Ceramics, McGraw Hill Co, New York.2000.
3. Dr.M.Arumugam, Materials Science, Anuradha Agencies, 2002.
4. Upadyaya G.S and Anish Upadhyaya, Materials Science and Engineering, Viva Books Pvt. Ltd., 2006.

CT9202 **UNIT OPERATIONS** **L T P C**
3 0 0 3

AIM

The course is aimed to enable the students to have a better understanding on the principles of unit operations like fluid mechanics, heat transfer and mass transfer.

OBJECTIVES

On completion of the course the students are expected to

- Have a thorough knowledge on the fluid statics and the fluid flow phenomena.
- Have studied the different equations involved in fluid flow and the changes that occur in a fluid flowing past immersed solids.
- Have understood the concepts involved in transfer of heat by conduction and convection.
- Have a clear idea on principle of heat transfer by radiation and radiative heattransfer between different surfaces.
- Have studied the basic mass transfer operations commonly come across in ceramic technology, like diffusion, humidification, drying of solids and crystallization.

UNIT I FLUID STATICS AND FLUID FLOW PHENOMENA 8

Fluid statics – hydrostatic equilibrium, applications of fluid statics – manometer, gravity & centrifugal decanter. Fluid flow phenomena – laminar flow, rheological properties of fluids, turbulence, boundary layers.

UNIT II FLUID FLOW EQUATIONS AND FLOW PAST IMMERSED SOLIDS 9

Fluid flow equation – Mass balance in a flowing fluid, mechanical energy equation for flowing fluid, Hagen-Poiseulle equation, Fanning equation. Flow past immersed solids – drag and drag coefficient, flow through a bed of solids, motion of particles through fluids.

UNIT III CONDUCTIVE AND CONVECTIVE HEAT TRANSFER 10

Conductive heat transfer – basic laws of conduction, steady state conduction, unsteady state conduction. Convective heat transfer – typical heat transfer equipments, energy balance, heat flux and heat transfer coefficient, heat transfer by forced convection in laminar flow, turbulent flow and transition region between laminar and turbulent flow, natural convection.

UNIT IV RADIATIVE HEAT TRANSFER 7

Emission of radiation, absorption of radiation by opaque bodies, radiation between surface, radiations to semi transparent materials, combined heat transfer by conduction, convection and radiation.

UNIT V BASICS OF MASS TRANSFER OPERATIONS 11

Diffusion – theory of diffusion, prediction of diffusivities, transient diffusion, mass transfer theories. Humidification operation – definition, humidity chart, wet bulb temperature. Drying of solids – classification of dryers, solids handling in dryer, principles of drying, cross circulation drying, through circulation drying, freeze drying, drying equipments for solids, pastes, solutions and slurries. Crystallization – crystal geometry, super saturation, mechanism of crystallization, material and heat balance in crystallization, classification of crystallization equipments. Basic problems on material balance.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Warren L.McCabe, Julian C.Smith and Peter Harriott, Unit Operations of Chemical Engineering, 7th Edn., McGraw Hill International Edition, 2005.
2. Salil K.Ghosal, Shyamal K.Sanyal and Siddhartha Datta, Introduction to Chemical Engineering, Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2003.

REFERENCES

1. Perry R.H and Green D (eds), Perry's Chemical Engineers' Handbook, 6th Edn.,McGraw-Hill, New York, 1984.
2. Walas S.M, Chemical Process Equipment, Butterworths, Stoneham, MA, 1988.
3. Treybal R.E, Mass Transfer Operations, 3rd Edn., McGraw-Hill, New York, 1980.

CY9213 **INSTRUMENTAL METHODS OF ANALYSIS** **L T P C**

(Common to Chemical, Textile, Leather, Ceramic and Petroleum Refining & Petrochemicals) **3 0 0 3**

AIM

To know the principle and importance of various analytical instruments used for the characterization of various materials

OBJECTIVES

- To have thorough understanding of theory, instrumentation and applications of analytical equipments used in industries for testing quality of raw materials, intermediates and finished products
- To know the importance of analytical instrumentation during the purification, compounding and formulating the finished product

UNIT I INTRODUCTION TO SPECTROSCOPICAL METHODS OF ANALYSIS 12

ELECTROMAGNETIC RADIATION: Various ranges, Dual properties, Various energy levels, Interaction of photons with matter, absorbance & transmittance and their relationship, Permitted energy levels for the electrons of an atom and simple molecules, Classification of instrumental methods based on physical properties

QUANTITATIVE SPECTROSCOPY: Beer -Lambert's law, Limitations, Deviations (Real, Chemical, Instrumental), Estimation of inorganic ions such as Fe, Ni and estimation of Nitrite using Beer -Lambert's Law

UNIT II UV AND VISIBLE SPECTRSCOPY 12

Various electronic transitions in organic and inorganic compounds effected by UV, and Visible radiations, Various energy level diagrams of saturated, unsaturated and carbonyl compounds, excitation by UV and Visible radiations, Choice of solvents, cut off wavelengths for solvents, Lamda max and epsilon max rules, Woodward -Fieser rules for the calculation of absorption maxima (Lamda max) for dienes and carbonyl compounds, Effects of auxochromes and efffects of conjugation on the absorption maxima, Different shifts of absorption peaks(Batho chromic, hypsochromic, hypochromic), Multicomponent analysis (no overlap, single way overlap and two way overlap), Instrumentation for UV and VISIBLE spectrophotometers (source, optical parts and detectors), Photometric titration (Experimental set -up and various types of titrations and their corresponding curves), Applications of UV and VISIBLE spectroscopies

UNIT III IR, RAMAN AND ATOMIC SPECTROSCOPY 10

Theory of IR spectroscopy, Various stretching and vibration modes for diatomic and triatomic molecules (both linear and nonlinear), various ranges of IR (Near, Mid, Finger print and Far) and their usefulness, Instrumentation (Only the sources and detectors used in different regions), sample preparation techniques, Applications.Raman spectroscopy: Theory, Differences between IR and Raman. Atomic absorption spectrophotometry: Principle, Instrumentation (Types of burners, Types of fuels, Hollow cathode lamp, Chopper only) and Applications, Various interferences observed in AAS (Chemical, radiation and excitation) Flame photometry: Principle, Instrumentation, quantitative analysis (Standard addition method and internal standard method) and applications

Differences between AAS and FES.

UNIT IV THERMAL METHODS 5

Thermogravimetry: Theory and Instrumentation, factors affecting the shapes of thermograms (Sample Characteristics and instrumental characteristics), thermograms of some important compounds (CuSO4. $5H_2O$, CaC_2O_4. $2H_2O$, MgC2O4, Ag_2CrO_4, Hg_2CrO_4, $AgNO_3$ etc), applications. Differential thermal analysis: Principle, Instrumentation and applications, differences between DSC and DTA. Applications of DSC (Inorganic and Polymer samples)

UNIT V CHROMATOGRAPHIC METHODS 6

Classification of chromatographic methods, Column, Thin layer, Paper, Gas, High Performance Liquid Chromatographical methods (Principle, mode of separation and Technique). Separation of organic compounds by column and Thin layer, mixture of Cu, Co and Ni by Paper, separation of amino acids by paper, estimation of organic compounds by GC and HPLC

TOTAL: 45 PERIODS

REFERENCES

1. Willard, H.H., Merritt.l.l., Dean J.a., and Settle,F.A., Instrumental methods of analysis, Sixth edition, CBS publishers,1986
2. Skoog D.A and West D.M, Fundamentals of Analytical Chemistry, Saunders -college Publishing, 1982.
3. Banwell, G.C., Fundamentals of molecular spectroscopy, TMH,1992.
4. A.I. Vogel's Quantitative Inorganic analysis . V Edition
5. Day R.A Underwood A.L Qualitative Inorganic analysis (A. I. Vogel). V Edition, Prentice-Hall of India (P) Ltd, NewDelhi
6. Sharma, B.K., Instrumental Methods of Analysis, Goel publishing House,1995
7. Kalsi .P.S. Spectroscopy of organic compounds, 6th Edition, New Age International Publishers,2006
8. William Kemp, Organic Spectroscopy, 3rd Edition, Palgrave publishers, 2007
9. Sathya Narayana. D. N. Vibrational Spectroscopy, First Edition 2004 and Reprint 2005, New Age International publishers.

EE9213 ELECTRICAL DRIVES AND CONTROLS L T P C
3 0 0 3

UNIT I INTRODUCTION 9

Fundamentals of Electrical Drives, advantages of Electrical Drives. Choice of an Electric Drive – characteristics of loads. Components of an Electric Drive: Electrical Motors – power converters (AC to DC, DC to DC, DC to AC, AC to AC) – Control units (Fuses, Switches, Circuit breakers, contactors and relays). Equations governing motor load dynamics – equilibrium operating point and its steady state stability.

UNIT II HEATING AND POWER RATING OF MOTOR DRIVE 9

Load diagram, heating and cooling of motors – classes of motor duty. Determination of rating for continuous, intermittent and short time duty cycles.

UNIT III POWER CONVERTERS 9

Control rectifiers – single phase and three phase circuits – choppers – step up and step down choppers – A.C. Voltage controllers. Single phase and three phase A.C. Voltage controllers, Inverters: Voltage source and current source inverters (Elementary Treatment only).

UNIT IV D.C. MOTOR DRIVE 9

D.C. Motor: Types, speed – torque characteristics. Starting – braking – speed control: Armature voltage – field current control – Ward Leonard methods – Four-quadrant operation. Converter fed separately excited D.C. motor drive – chopper fed D.C. motor drive (Continuous current operation only).

UNIT V A.C. DRIVES 9

Principle of operation of 3 phase induction motor – equivalent circuit – Slip – torque characteristic – starting methods: star – Delta starter, Auto transformer starter, Rotor resistance starter, Speed control: Stator voltage control, frequency control, rotor resistance control, slip-power recovery scheme. Inverter fed 3-phase induction motor drive: v/f control, Rotor resistance control, slip-power recovery controls.

TOTAL: 45 PERIODS

TEXT BOOKS

1. G.K. Dubey, Power Semi Conductor Controller Drives. Prentice Hall of India 1989.
2. S.K.Pillai, A First Course on Electrical Drives. Wiley Eastern Ltd., 1993.

REFERENCES

1. P.C. Sen – Principles of Electric Machines and Power Electronics. John – Willey and Sons – 1997.
2. S.K. Bhattacharya and Brijinder Singh, Control of Electrical Machines, New Age International Publishers.

CH9204 BASIC MECHANICAL ENGINEERING L T P C
3 0 0 3

AIM

To impart knowledge on thermodynamics and thermal engineering power generating units such as engines and theory of machines

OBJECTIVE

- Students should learn thermodynamics and thermal engineering to understand the principles behind the operation of thermal equipments like IC engines and turbines etc., Students should be able to appreciate the theory behind operation of machinery and be able to design simple mechanisms

UNIT I LAWS OF THERMODYNAMICS 10

Basic concepts and hints; Zeroth law; First Law of Thermodynamics - Statement and application; Steady flow energy equation-problems- Second law of Thermodynamics – Kelvin - Plank statement and Clausius statement- problems; Limitations; Heat Engine, Refrigerator and Heat Pump, Available energy, Equivalence entropy; Reversibility: Entropy charts; Third law of Thermodynamics - Statement.

UNIT II HEATING AND EXPANSION OF GASES 6

Expressions for work done, Internal energy and heat transfer for Constant Pressure, Constant Volume, Isothermal, Adiabatic and Polytropic processes-Derivations and problems; Free expansion and Throttling process.

UNIT III AIR STANDARD CYCLES 6

Carnot cycle; Stirlings cycle; Joule cycle; Otto cycle; Diesel cycle; Dual combustion Cycle-Derivations and problems.

UNIT IV I.C. ENGINES, STEAM AND ITS PROPERTIES AND STEAMTURBINES12

Engine nomenclature and classification; SI Engine; CI Engine; Four Stroke cycle, Two stroke cycle; Performance of I.C.Engine; Brake thermal efficiency; Indicated Thermal Efficiency, Specific fuel consumption.

Steam - Properties of steam; Dryness fraction; latent heat; Total heat of wet steam; Dry steam; Superheated steam. Use of steam tables; volume of wet steam, volume of superheated steam; External work of evaporation; Internal energy; Entropy of vapour, Expansion of vapour, Rankine cycle.

Steam turbines – Impulse and Reaction types - Principles of operation.

UNIT V SIMPLE MECHANISM, FLY WHEEL, DRIVES AND BALANCING 11

Definition of Kinematic Links, Pairs and Kinematic Chains; Working principle of Slider Crank mechanism and inversions; Double slider crank mechanism and inversions. Flywheel-Turning moment Diagram; Fluctuation of Energy. Belt and rope drives; Velocity ratio; slip; Creep; Ratio of tensions; Length of belt; Power Transmitted; gear trains-types. Balancing of rotating masses in same plane; Balancing of masses rotating in different planes.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Nag, P.K., " Engineering Thermodynamics ", II Edition, Tata McGraw Hill Publishing Co., Ltd., 1995.
2. Rajput, R .K, “Thermal Engineering”, Laxmi publications (P) Ltd, 2001.
3. Khurmi R.S., and Gupta J.K, “Theory of Machines”, Eurasia Publishing House (P) Ltd., 2004.

REFERENCES

1. Smith, " Chemical Thermodynamics ", Reinhold Publishing Co., 1977.
2. Bhaskaran, K.A., and Venkatesh, A., " Engineering Thermodynamics ", Tata McGraw Hill, 1973.
3. Pandya A. and Shah, " Theory of Machines ", Charatakar Publishers, 1975.
4. Khurmi R.S., and Gupta J.K, “Thermal Engineering”, S.Chand & Company (P) Ltd.,2001.
5. Kothandaraman and Dhomkundwar,”: A course in Thermal Engineering (SI Units)”, Dhanpat Rai and Sons, Delhi (2001)

CE9215 MECHANICS OF SOLIDS L T P C
3 0 0 3

AIM

To given them knowledge on structural, Mechanical properties of Beams, columns.

OBJECTIVES

- The students will be able to design the support column, beams, pipelines, storage tanks and reaction columns and tanks after undergoing this course. This is precursor for the study on process equipment design and drawing.

UNIT I STRESS, STRAIN AND DEFORMATION OF SOLIDS 9

Rigid bodies and deformable solids – forces on solids and supports – equilibrium and stability – strength and stiffness – tension, compression and shear stresses – Hooke’s law and simple problems – compound bars – thermal stresses – elastic constants and Poisson’s ratio – welded joints – design.

UNIT II TRANSVERSE LOADING ON BEAMS 9

Beams – support conditions – types of Beams – transverse loading on beams – shear force and bending moment in beams – analysis of cantilevers, simply – supported beams and over hanging beams – relationships between loading, S.F. and B.M. In beams and their applications – S.F.& B.M. diagrams.

UNIT III DEFLECTIONS OF BEAMS AND STRESSES IN BEAMS 9

Double integration method – Macaulay’s method – Area – moment theorems for computation of slopes and deflections in beams – conjugate beam method. Theory of simple bending – assumptions and derivation of bending equation (M/I = F/Y = E/R) – analysis of stresses in beams – loads carrying capacity of beams – proportioning beam sections – leaf springs – flitched beams – shear stress distribution in beams – determination of shear stress in flanged beams.

UNIT IV TORSION **9**

Torsion of circular shafts – derivation of torsion equation (T/J = C/R = G0/L) – stress and deformation in circular and hollow shafts – stresses and deformation in circular and hollow shafts – stepped shafts – shafts fixed at both ends – stresses in helical springs – deflection of springs – spring constant

UNIT V COLUMNS **9**

Axially loaded short columns – columns of unsymmetrical sections – Euler's theory of long columns – critical loads for prismatic columns with different end conditions – effect of eccentricity.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Junarkar, S.B., Mechanics of Structure Vol. 1, 21st Edition, Character Publishing House, Anand, Indian, (1995)
2. William A.Nash, Theory and Problems of Strength of Materials, Schaum's Outline Series. McGraw Hill International Editions, Third Edition, 1994.

REFERENCE

1. Elangovan, A., Thinma Visai Iyal (Mechanics of Solids in Tamil), Anna University, Madras, 1995.

CT9207 **CERAMIC SCIENCE LAB** **L T P C**

[Minimum of 10 experiments] **0 0 2 1**

PART - A

1. Determination of Thermal Conductivity
2. Determination of Thermal Expansion
3. Determination of Dielectric Constant and Dielectric Loss
4. Determination of Dielectric Breakdown
5. Determination of Electrical Conductivity of Insulating Materials

PART – B

1. Physical Properties of Ceramic Raw Materials
   - Determination of Moisture Content
   - Determination of Loss on Ignition
2. Physical Properties of Ceramic Body
   - Pressing of Ceramic Raw Material
   - Determination of Shrinkage of Ceramic Body – Dry & Fired, Volume & Linear
   - Determination of Density - True & Bulk
   - Determination of Porosity
   - Determination of Water Absorption

Equipments Required:

1. Hot Air Oven
2. Hot Plate
3. LCR Meter
4. Dilatometer

TOTAL: 30 PERIODS

EE9214 ELECTRICAL ENGINEERING LABORATORY L T P C
0 0 4 2

AIM

To provide the practical knowledge and control methods of electrical machines

OBJECTIVE

To impart practical knowledge on

I. Characteristic of different machines
II. Method of speed control of machines
III. Measurement of various electrical parameters

1. Study of DC & AC Starters
2. Study of Transducers
3. Wheatstone Bridge and Schering Bridge
4. ADC and DAC Converters
5. Speed Control of DC Shunt Motor
6. Load Test on DC Shunt Motor
7. OCC & Load Characteristics of DC Shunt Generator
8. Load Test on Single-Phase Transformer
9. Load Test on Three-Phase Induction Motor
10. Load Test on Single-Phase Induction Motor.

TOTAL: 60 PERIODS

CH9257 MECHANICAL ENGINEERING LAB L T P C
0 0 4 2

AIM:

To impart practical knowledge in operating IC engines and conduct experiments. To understand test procedures in testing material for engineering applications

OBJECTIVES:

Students will be able to understand Power-generating units such as engines and operate IC engines and conduct tests. They will be able to appreciate the theory behind the functioning of engines. Material properties, their behavior under different kinds of loading and testing can be visualized.

LIST OF EXPERIMENTS *

1. Port timing diagram
2. Valve timing diagram
3. Study of 2,4 stroke I C Engines
4. Load test on 4-stroke petrol engine
5. Performance test on 4-stroke single cylinder diesel engine
6. Performance test on 4-stroke twin cylinder diesel engine
7. Heat balance test on diesel engines
8. Tension test
9. Compression test
10. Deflection test
11. Hardness test (Rockwell and Brinell)
12. Spring test
13. Torsion test
14. Impact test

* Minimum 10 experiments shall be offered

TOTAL: 60 PERIODS

MA9267 STATISTICS AND LINEAR PROGRAMMING L T P C
3 1 0 4

AIM

This course aims at providing the required skill to apply the statistical and Linear Programming tools for engineering problems.

OBJECTIVES

- The students will have a fundamental knowledge of the concepts of statistical inference
- Have the knowledge of applying Linear programming tools in management problems.

UNIT I TESTING OF HYPOTHESIS 9 + 3

Sampling distributions - Tests for single mean , proportion and difference of means (large and small samples) – Tests for single variance and equality of variances – χ^2-test for goodness of fit – Independence of attributes – Non-parametric tests: Test for Randomness and Rank-sum test (Wilcoxon test).

UNIT II DESIGN OF EXPERIMENTS 9 + 3

Completely randomized design – Randomized block design – Latin square design - 2^2 - factorial design.

UNIT III STATISTICAL QUALITY CONTROL 9 + 3

Control charts for measurements ($\overline{X}$ and R charts) – Control charts for attributes (p, c and np charts) – Tolerance limits - Acceptance sampling

UNIT IV LINEAR PROGRAMMING 9 + 3

Formulation – Graphical solution – Simplex method – Big-M method - Transportation and Assignment models

UNIT V ADVANCED LINEAR PROGRAMMING 9 + 3

Duality – Dual simplex method – Integer programming – Cutting-plane method.

L: 45, T: 15, TOTAL: 60 PERIODS

TEXT BOOKS

1. Johnson, R.A. and Gupta, C.B., "Miller and Freund's Probability and Statistics for Engineers", Pearson Education, Asia, 7th edition, (2007).
2. Taha, H.A., "Operations Research", Pearson Education, Asia, 8th edition, (2007).

REFERENCES

1. Walpole, R.E., Myers, R.H., Myers, S.L. and Ye, K., "Probability and Statistics for Engineers and Scientists", Pearson Education, Asia, 8th edition, (2007).
2. Devore, J.L., "Probability and Statistics for Engineering and the Sciences", Thomson Brooks/Cole, International Student Edition, 7th edition, (2008).
3. Winston, W.L.,"Operations Research – Applications and Algorithms",Thomson, 1st Indian Reprint, 4th edition, (2007).

CT9251 **METALLURGY** **L T P C**
3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about the basics of metallurgy, the various operations in the metallurgical process and in specific about steel making.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the basics about metals, ores and its extraction.
- Have learnt the various metallurgical processes that take place during the high temperature operation.
- Have learnt to measure and estimate the physical properties of metals.
- Have an immense knowledge about steelmaking.
- Have a basic knowledge about powder metallurgy.

UNIT I BASICS OF METALLURGY 10

Introduction – classification – metals, metallic ores, sampling, identification, extraction – copper, aluminum, lead, iron & steel – iron carbon diagram – heat treatment process – annealing, normalizing, hardening, tempering, surface hardening process – carburizing, nitriding, cyaniding, carbonitriding, flame hardening, metallography – sampling, grinding, polishing, microscope – metallurgical, electron, testing – hardness, impact, creep, non destructive testing.

UNIT II HIGH TEMPERATURE METALLURGICAL PROCESS 9

Introduction – reactions involving solids & gases – reduction of metal oxides, oxidation, coking, chemical vapour synthesis- reactions involving liquid phases smelting, slag refining, vaccum degassing, zone refining, casting process – thermo-mechanical process.

UNIT III MEASUREMENT & ESTIMATION OF PHYSICAL PROPERTIES 9

Introduction – factors affecting physical properties and their measurements –microstructure, thermal expansion coefficient, electrical resistivity, diffusion coefficient, yield strength, fracture toughness and hardness.

UNIT IV STEEL MAKING 9

Introduction – process design – thermodynamics & mass balance – kinetics of mass transfer & heat transfer – optimization of interfacial reactions – micro modelling –improving steel making – process and properties with reference to market, energy and environment, process for controlling inclusions, integrated optimization, future trends.

UNIT V POWDER METALLURGY 8

Introduction – production process of powders – mechanical routes, atomization routes, physical routes, chemical routes, plasma forming process- powder consolidation, compaction and sintering – advantages – disadvantages – limitations- applications.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Seshadri Seetharaman, Fundamentals of Metallurgy, 1st Edn, Wood head Publishing Limited, 2005.
2. O.P.Khanna, Introduction to Material Science & Metallurgy, Dhanpat Rai Publications Pvt. Ltd, 2003.

REFERENCES

1. K.H.Prabhdev, Handbook of Heat Treatment of Steels, Tata McGraw Hill Publishing Company Ltd, 1998.
2. R.A.Higgins, Engineering Metallurgy, Part 2, Metallurgical Process Technology, 2nd Edn, ELBS,1974.
3. S.H.Anver, Introduction to Physical Metallurgy, 15th Edn, McGraw Hill Book Company, 1997.

CT9252 CERAMIC RAW MATERIALS L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a complete knowledge on the basics of geology, mineralogy and different raw materials used commonly in ceramic industries.

OBJECTIVES

On completion of the course the students are expected to

- Have studied the basics of rock formation, its types, and mineral formation and its physical and optical properties.
- Have learnt about clay formation, clay minerals and types of clays.
- Have studied the different types of fluxes and their characteristics.
- Have learnt the types of silicate minerals, their properties and uses.
- Have an understanding on other ceramic raw materials, their properties and uses.

UNIT I GENERAL GEOLOGY AND MINEROLOGY 9

Rocks – formation, characteristics, classification into igneous, sedimentary and metamorphic. Minerals – formation, relation of mineral deposit to igneous activity, chemical and physical properties like composition, colour, streak, luster, fracture, cleavage, hardness, density and tenacity, elements of optical mineralogy.

UNIT II PLASTIC MATERIALS 10

Clay minerals. Clay structures – kaolinite and montmorillonite groups. Geology of clay deposits. Classification of clays – china clay, ball clay, fire clay, building clay etc. Beneficiation of clays. Clay properties – charged nature, cation exchange capacity, flow behaviour, plasticity, effect of heating. Mica, talc, pyrophyllite and wollastonite group – physical and chemical properties.

UNIT III FLUXES 7

Occurrence, properties and uses of natural fluxes – feldspar group, nepheline syenite, Cornish stone, lithium containing minerals. Bone ash – preparation, properties and uses.

UNIT IV SILICA AND SILICATE MATERIALS 9

Silica – occurrence, structure, polymorphic transformation, physical and chemical properties. Silicate minerals – quartz, sillimanite, kyanite, andalusite – properties and uses.

UNIT V OTHER RAW MATERIALS 10

Bauxite, magnesite, dolomite, chromite, limestone, rutile, zircon, beryllia minerals, alumina, slag and ashes, cullet – occurrence, properties and uses.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Parbin Singh, Engineering and General Geology, S.K.Kataria and Sons, New Delhi, 2001.
2. Worrall W.E, Ceramic Raw Materials, Pergamon Press, NY, 1992.

REFERENCES

1. Norton F.H, Fine Ceramics: Technology and Applications, McGraw-Hill Co., NY, 1978.
2. Wilson M.J, Clay Mineralogy, Chapman and Hall, 1955.
3. Deer W.A, Howie R.A and Zussman J, Rock Forming Minerals, Longmans, London, 1967.
4. Ryan .W, Properties of Ceramic Raw Materials, Pergamon Press, 2nd Edn., 1978.

CT9253 PROCESSING OF CERAMIC RAW MATERIALS L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a complete knowledge on the steps involved in the processing of ceramic raw materials and the equipments used for those processes.

OBJECTIVES

On completion of the course the students are expected to

- Have a thorough knowledge on the quarrying of different plastic and non-plastic raw materials.
- Have a better understanding on the different equipments used for size reduction of raw materials and the laws involved in size reduction.
- Have a clear understanding on the mechanical separation operations like screening, filtration, sedimentary separation and magnetic separation.
- Have studied the principle and working of various equipments used for mixing, conveying and storage of ceramic raw materials.
- Have a clear knowledge on methods for characterizing the ceramic powder for its shape and size.

UNIT I QUARRYING 7

Winning of clays, quarrying of non plastic materials, transportation. Clay purification methods – wet and dry methods. Weathering of clay. Beneficiation of non plastic materials.

UNIT II SIZE REDUCTION 9

Laws of size reduction, mechanism of size reduction. Different crushers and grinders – jaw crusher, gyratory crusher, hammer mill, different types of tumbling mill, jet mill, attrition mill, vibro energy mill – principle of working. Closed circuit and open circuit grinding.

UNIT III MECHANICAL SEPARATION 10

Introduction, types. Screening – dry and wet screening, equipments, effectiveness of screen, test sieves-ASTM, BSS, BIS, IS. Filtration – theory of filtration, batch and continuous filters, principles of cake filtration. Separation based on movement through a fluid – sedimentation, cyclone separation, air classification. Magnetic separation.

UNIT IV MIXING, CONVEYING AND STORAGE OF MATERIALS 9

Mixing – mechanism of mixing, types of mixers – batch and continuous mixers – pan mixer, shaft mixer, U mixer, muller mixer and other mixers, blungers, agitators. Conveying – solid conveying-types of conveyors, criteria for selecting a conveyor; liquid conveying-condition for liquid conveying, different types of pumps. Storage methods of different ceramic powders.

UNIT V POWDER CHARACTERIZATION 10

Particle shape – definition. Powder size and size distribution – definition, representation, microscopy, sieve analysis, hydrometer method, Andreason pipette method, sedigraph, laser diffraction, X-ray light broadening, light scattering. Powder characterization – surface area measurement, porosity measurement – mercury porosimetry, gas adsorption, pycnometry.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Warren L.McCabe, Julian C.Smith and Peter Harriott, Unit Operations of Chemical Engineering, 7th Edn., McGraw Hill International Edition, 2005.
2. Charles Burroughs Gill, Materials Beneficiation, Springer Verlag, 1991.

REFERENCES

1. Ryan W and Redford C, Whitewares: Production, Testing and Quality Control, Pergamon Press, NY, 1987.
2. Vincenzini P, Fundamentals of Ceramic Engineering, Elsevier Applied Science, London,1991.
3. Paul De Garmo E, Black J.J and Ronald A.Kohser, Materials and Processes in Keishi Gotoh, Powder Technology Handbook, Marcel Dekker Inc., 1997.
4. F. Singer and S. Singer, Industrial Ceramics, Oxford and IBH Publishing Co., 1991.
5. Mohamed N.Rahaman, Ceramic Processing, Taylor & Francis, 2007.Manufacturing, 8th Edn., Prentice-Hall India Pvt. Ltd., New Delhi, 1997.

CT9254 WHITEWARE AND HEAVY CLAYWARE L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a sound knowledge about the whiteware and heavy clayware products and their manufacturing processes, their properties and quality control.

OBJECTIVES

On completion of the course the students are expected to

- Have a basic knowledge about whiteware and heavy clayware, their classification and formulation.
- Be capable of classifying the various whiteware products and know the body formulation and properties.
- Have learnt in detail about the manufacturing process of various whiteware products.
- Have a better understanding about the heavy clayware products and their applications.
- Have learnt about the properties and the various properties methods.

UNIT I INTRODUCTION 9

History – definition – whiteware – heavy clayware – classification – raw materials,batch calculation, mixing, forming, drying, firing, glazing, decoration.

UNIT II WHITEWARE BODY FORMULATIONS 9

Body composition – porcelain, earthenware, bone china, sanitary ware, hotel china, terracotta, majolica, steatite bodies, corderite bodies, rutile bodies, titanate bodies, zircon bodies, lava bodies.

UNIT III WHITEWARE PRODUCTS 9

Manufacturing process & properties – whitewares at home – tableware, kitchenware, flame resistant ware, art ware, containers, construction – floor tile, wall tiles, sanitary ware, electrical – low tension insulators, high tension insulators, high frequency low loss insulators, industrial use – abrasion resistance, chemical resistance, heat resistance.

UNIT IV HEAVY CLAYWARE PRODUCTS 9

Introduction – classification- body composition – properties and applications of heavy clayware products – face bricks, paving bricks, hollow bricks, roofing tiles, sewer pipes, stoneware pipes, floor tiles, vitrified tiles.

UNIT V PROPERTIES & TESTING 9

Strength – tensile, flexural, impact – absorption & porosity – moisture expansion – thermal expansion – thermal shock resistance – heat conductivity – abrasion resistance – chemical durability – electrical properties – dielectric strength, dielectric constant, power & loss factor, volume resistivity.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Alen Dinsdale, Pottery Science : Materials, Processes and Products, Ellsi Horwood Ltd, 1986.
2. Sudhir Sen, Ceramic Whitewares : Production, Testing and Quality Control, Pergamon Press, 1987.

REFERENCES

1. F.Singer & S.Singer, Industrial Ceramics, Oxford & IBH Publishing Co, 1991.
2. Mohamed N.Rahaman, Ceramic Processing, Taylor & Francis, 2007.
3. Rexford Newcomb Jr, Ceramic Whitewares : History, Technology and Applications, Pitman Publishing Corporation, 1947.

CT9257 **CERAMIC POWDER PROCESSING LAB** **L T P C**
[Minimum of 10 experiments] **0 0 2 1**

1. Size reduction with Jaw Crusher and calculation of efficiency.
2. Grinding with ball mill and calculation of efficiency.
3. Calculation of screen effectiveness.
4. Filtration of slurry by Filter Press.
5. Particle separation from slurry by Gravity Sedimentation.
6. Mixing of powders in tumbling mixers and testing the homogeneity with mixing time and particle size.
7. Blunging of slurries and testing the homogeneity with mixing time and viscosity.
8. Particle shape and size identification with Microscope.
9. Particle size determination by Hydrometer Method.
10. Particle size determination by Andreason Pipette Method.
11. Particle size determination by Laser Diffraction Method.

Equipments Required :

1. Jaw Crusher
2. Ball Mill
3. Sieve Shaker
4. Filter Press
5. Blunger
6. Hydrometer
7. Andreason Pipette
8. Particle Size Analyser
9. Mixers
10. Centriguge

TOTAL: 30 PERIODS

CT9258 **WHITEWARE AND HEAVY CLAYWARE LAB** **L T P C**
[Minimum of 10 experiments] **0 0 2 1**

1. Preparation of Ceramic Slip in a Pot Mill
2. Determination of Slip Specific Gravity.
3. Determination of Slip Viscosity.
4. Effect of Water on Viscosity of Slip.
5. Effect of Deflocculant on Viscosity of Slip.
6. Determination of Residue in a Slip.
7. Plaster Mould Making.
8. Forming of Solid Slip Cast Article.
9. Forming of Drain Slip Cast Article.
10. Biscuit Firing.

Equipments Required:

1. Pot Mill
2. Gibbs Viscometer
3. Hot Air Oven
4. Sieves
5. Moulds
6. Furnace

TOTAL: 30 PERIODS

CT9301 THERMODYNAMICS FOR CERAMICS L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about thermodynamics and the applications of thermodynamic laws of various systems.

OBJECTIVES

On completion of the course the students are expected to

- Have an understanding about the basic concepts of thermodynamics and the thermodynamic laws.
- Have an idea about the behavior of gases under conditions of temperature, pressure and volume.
- Have a basic knowledge about concepts of heat capacity.
- Have learnt the various applications of thermodynamics and solve some thermodynamic problems.
- Have a knowledge about solution thermodynamics.

UNIT I BASIC CONCEPTS 9

Fundamental concepts – system, process, state, properties, force, work, pressure, energy, equilibrium state, phase rule. Thermodynamic laws – zeroth law, internal energy, first law for flow process, non flow process, enthalpy, limitations, second law, entropy, Clausius inequality, third law.

UNIT II PVT BEHAVIOUR 9

PVT behavior – equation of state – concept of ideal gas – constant volume constant pressure, constant temperature, adiabatic process, isotropic process – equation of state for real gases – compressibility chart – heat effects accompanying a chemical reaction.

UNIT III CONCEPTS OF HEAT CAPACITY 9

Free energy and entropy – Gibb's equation – Helmholtz equation – equilibrium constant and heat of reaction – Clausius – Claypeyron equation – partial free energy – Gibb's phase rule and its interpretation – condensed system – one component system – polymorphic transformations – P-T diagram of silica.

UNIT IV APPLICATIONS OF THERMODYNAMICS 9

Flow process – continuity equation – energy equation – Bernoulli's equation – flow through nozzles, pipes – ejectors - throttling process – compressors – Carnot cycle – refrigeration cycle – vaporization of liquid – Rankine cycle – diesel cycle.

UNIT V SOLUTION THERMODYNAMICS 9

Classification of thermodynamics properties – relationship among thermodynamics properties – fugacity – activity – thermodynamic diagrams – partial molar properties – chemical potential – activity in solutions – property changes of mixing – heat effects of mixing process.

TOTAL: 45 PERIODS

TEXT BOOKS

1. K.V.Narayanan, A Text Book of Chemical Engineering Thermodynamics, Prentice Hall India Pvt Ltd, New Delhi, 2001.
2. J.M.Smith and H.C.Van Hess, Introduction to Chemical Engineering Thermodynamics, Kogakushai, 1976.

REFERENCES

1. Robert E Treybac, Mass Transfer Operations, McGraw Hill, 1981.
2. S.I.Sandler, Chemical Engineering Thermodynamics, John Wiley & Sons, NY, 1989.

CT9302 FUELS AND ENERGY ENGINEERING L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a thorough knowledge about different types of fuels used in industries and the mechanism involved in converting the fuel into a useful source of energy.

OBJECTIVES

On completion of the course the students are expected to

- Have a complete knowledge idea about the occurrence and characteristics of the different types of solid fuels.
- Have a better knowledge about the different types of liquid fuels and their properties.
- Have a complete understanding about the different liquid fuels and their properties.
- Have a basic knowledge about the combustion process involved in the fuels.
- Have an idea about the ways of heat transfer and the different heat recovery systems.

UNIT I SOLID FUEL 9

Wood, charcoal, coal characteristics – formation of coal, grading of coal, handling and storage of coal, coal washing, hardness and grindability of coal, calorific value, coal analysis. Manufacture of coke. Agro based solid fuels – wheat, rice, bagasse, solid oxide fuel cells.

UNIT II LIQUID FUEL 9

Origin and composition of natural oil, refining process of liquid petroleum products, synthetic liquid fuels – calorific value, storage and handling of liquid fuels. Bio fuels – importance.

UNIT III GASEOUS FUELS 9

Composition and calorific value – natural gas, liquefied petroleum gas, oil gas, coal gas, producer gas, water gas, other gaseous fuels. Non conventional fuels – importance, hydrogen fuel.

UNIT IV COMBUSTION PROCESS 9

Air requirement, combustion processes of solid, liquid, gaseous fuels, control of combustion process, combustion stoichiometry.

UNIT V HEAT TRANSFER 9

Heat transfer to charge by conduction, convection and radiation in a kiln, heat loss through kiln wall, opening, cooling etc., heat balance and thermal efficiency, heat recovery – recuperator and regenerator, co-generator – importance.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Samir Sarkar, Fuels and Combustion, 2nd Edn., Orient Longman, Bombay, 1990.
2. Om Prakash Gupta, Elements of Fuels, Furnaces and Refractories, Khanna Publishers, 1995.

REFERENCES

1. Wilfrid Francis and Martin C.Peter, Fuels and Fuel Technology, Pergamon Press, 1980.
2. J.P.Holman, Heat Transfer, McGraw – Hill, 1997.
3. J.D.Gilchrist, Fuels, Furnaces and Refractories, Pergamon Press, NY, 1977.
4. A.K.Shaha, Combusiton Engineering and Fuel Technology, Oxford & IBH Publishing Co., New Delhi, 1974.

CT9303 CERAMIC FABRICATION PROCESSES L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a thorough knowledge about the different ceramic fabrication process and the other final operations involved after the fabrication of the product.

OBJECTIVES

On completion of the course the students are expected to

- Have complete knowledge about the slip casting process.
- Have a complete knowledge about the various plastic forming process.
- Have a complete knowledge about the various dry forming process.
- Have a sound understanding on the mechanism of drying and the construction and working of the various drying equipments.
- Understand effectively the importance of firing and the mechanism and types of firing equipments.

UNIT I SLIP FORMING PROCESS 9

Introduction. Slip- selection of materials, particle size measurement, viscosity, surfactant concentration, binders, pH, zeta potential, settling, solid recovery, slip recovery, slip conditioning and storage. Plaster mould – process, preparation. Slip casting – methods, mechanisms.

UNIT II PLASTIC FORMING PROCESS 9

Plastic mass preparation – pug mill, pugging defects. Shaping methods – extrusion, jiggering, injection molding, roller machine, compression molding.

UNIT III DRY FORMING PROCESS 9

Theory of packing. Pressing- Uniaxial pressing – stress distribution on green body – defects and remedies, vibration compaction, isostatic pressing, reactive hot pressing – advantages – defects and remedies.

UNIT IV DRYING AND FINISHING 9

Mechanism of drying – transfer of heat – factors that control drying – types of dryers – intermittent and continuous dryers – process of drying – drying defects – finishing – cutting and trimming – sponging, fettling and towing – scumming.

UNIT V FIRING 9

Action of heat on ceramic bodies – physical changes, chemical changes. Firing equipments, firing schedules – fast firing, firing range. Problems, defects. Liquid phase sintering, vitrification, microstructure control.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Alan G. King, Ceramic Technology and Processing, Noyes Publication, USA, 2002.
2. James S. Reed, Principles of Ceramic Processing, John Wiley and Sons, NY, 1988.

REFERENCES

1. Norton F. H, Fine Ceramics Technology and Applications, McGraw-Hill Co., 1978.
2. Terpstra, Ceramic Processing, Chapman and Hall, 1995.
3. I.J. McColm, N.J.Clark, Forming, Shaping and Working of High Performance Ceramics, Chapman and Hall, 1998.
4. Sudhir Sen, Ceramic Whiteware, Oxford & IBH Publishing Co., New Delhi, 1992.

CT9304 GLASS ENGINEERING – I L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a complete knowledge on the principle behind glass formation, raw materials and melting of glass batch, glass properties and quality control in glass.

OBJECTIVE

On completion of the course the students are expected to

- Have understood the principle behind glass formation and structures of different glasses.
- Have studied about the raw materials for glass making and calculation of a glass batch for a given composition.
- Have learnt about the reactions involved in the conversion of solid glass batch into a liquid glass melt.
- Have studied about the thermo-dynamical, thermal, mechanical, electrical and other properties of glass.
- Have learnt the defects found in a flat ware and a hollow ware, and the quality control procedure for a coated glass.

UNIT I PRINCIPLES OF GLASS FORMATION 10

Definition. Difference between a glass and crystalline material. Glass Formation – atomistic hypothesis of glass formation, kinetic approach to glass formation. Structures of glasses – fundamental laws, elements of structural models for glasses, structural models for silicate glasses. Phase diagrams of glass forming oxide systems – $CaO\text{-}Al_2O_3\text{-}SiO_2$, $Na_2O\text{-}CaO\text{-}SiO_2$ etc.

UNIT II RAW MATERIALS AND PREPARATION OF GLASS BATCH 10

Raw materials – Glass formers, intermediates and modifiers, cullet, minor ingredients like oxidizing/reducing agents, refining agents, decolourisers, colouring oxides – description and importance. Selection of glass composition, change in properties in relation to change in composition, Glass batch calculation.

UNIT III GLASS MELTING PROCESS 10

Physiochemical reactions during glass melting – effect of particle size and pre-sintering on melting. Refining – sources of gas bubbles, identification of gases, solubility of gases in glass, growth & rise of bubbles, refining agents. Homogenization – sources of inhomogenity, rate of homogenization in relation to diffusion kinetics, conventional currents & rise of bubbles. Effect of colourants in glass melting.

UNIT IV PROPERTIES OF GLASS 8

Thermodynamic & thermal properties – density, surface tension, thermal expansion, specific heat, thermal conductivity. Mechanical properties – viscosity, elastic properties, hardness, strength. Electrical & Transport properties – electrical conductivity, dielectric property, ionic diffusion. Other properties – refractive index, dispersion, chemical durability.

UNIT V TESTING AND QUALITY CONTROL 7

Flat glass defects – origin, characteristics. Container glass defects – origin, remedies. Test procedures for normal glass and coated glass.

TOTAL: 45 PERIODS

TEXT BOOKS

1. James E.Shelby, Introduction to Glass Science & Technology, The Royal Society of Chemistry, 1997.
2. Paul, Chemistry of Glasses, 2nd Edn, Chapman & Hall, 1990.

REFERENCES
1. D.Ganguli, S.Kumar, Elements of Ceramics –Vol II, Indian Institute of Ceramics, 1984.
2. Fundamentals of Glass Manufacturing Process 1991, Proceedings of the First Conference of the European Society of Glass Science and Technology, Society of Glass Technology, 1991.
3. Tooley F.V, Handbook of Glass Manufacture, Vol I&II, Ogden Publishing Co., NY, 1960.
4. A. Charles A Harper, Handbook of Ceramic Glasses & Diamonds, McGraw Hill, 2001.
5. Glass Furnaces-Design, Construction & Operation, Wolfgang Trier, Society of Glass Technology, 2000.
6. Narottam P Banral, R.H.Doremus, Handbook of Glass Properties, Academic Press, Inc, 1986.

CT9305 REFRACTORIES- I L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about the various types of refractories used in the industries.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the basics about refractories and its demand.
- Have a sound knowledge about silica refractories.
- Have learnt about properties and applications of alumino silicate refractories.
- Have learnt about the various basic refractories.
- Have a knowledge about special refractories.

UNIT I INTRODUCTION 9

Definition – production - demand & growth of refractories in India - Layout of a refractory plant - classification of refractory - fundamental properties of refractories - factors for selection and use of refractories.

UNIT II SILICA REFRACTORIES 9

Raw materials & composition - manufacturing process steps – phase transformation of quartzite - properties & uses.

UNIT III ALUMINOSILICATE REFRACTORIES 9

Al_2O_3 – SiO_2 phase diagram, - types of raw materials - different alumino silicate refractories – manufacturing steps – properties & applications.

UNIT IV BASIC REFRACTORIES 9

Manufacturing process - properties and uses of magnesite, magnesia carbon, forsterite, dolomite and chrome based refractories.

UNIT V SPECIAL REFRACTORIES 9

Carbide based & nitride based refractories - carbon based carbon refractory – zirconia – beryllia - thoria refractory - fused cast refractories – cermets – ceramic fibers.

TOTAL: 45 PERIODS

TEXT BOOKS
1. D.N.Nandi, Handbook of Refractories, Tata McGraw Hill Publishing Co, New Delhi, 1991.
2. Chesters J.H, Refractroies: Production & Properties, Iron & Steel Institute, London, 1973.

REFERENCES
1. B.M.Coope & E.M.Dickson, Raw Materials for the Refractories Industries, An Industrial Minerals Consumer Survey, 1981.
2. Shaw K, Refractories & Their Uses, App,Science Publishers, UK,1972.

CT9307 **REFRACTORIES LAB** **L T P C**
[Minimum of 10 experiments] **0 0 2 1**

1. Preparation of silica refractory of various compositions
2. Preparation of fire clay refractory of various compositions
3. Preparation of high alumina refractory of various compositions.
4. Comparison of Properties of various compositions of silica refractories
5. Comparison of Properties of various compositions of fireclay refractories
6. Comparison of Properties of various compositions of high alumina refractories
7. Permanent Linear Change of silica, fire clay and high alumina refractory.
8. Comparison of density, porosity and strength of refractory prepared by powder pressing and extrusion.
9. Comparison of density, porosity and strength of silica, fire clay and high alumina refractories.
10. Preparation of insulating refractory with different pore formers and comparison of their characteristics.
11. Comparing the characteristics of a dense and porous refractory.

Equipments Required:
1. Universal Testing Machine
2. Hot Plate
3. Extruder

TOTAL: 30 PERIODS

CT9308 **CHEMICAL ANALYSIS OF CERAMIC RAW MATERIALS LAB** **L T P C**
0 0 2 1

1. **Alumino Silicate Materials**
   - Silica
   - Alumina
   - Iron Oxide
   - Alkali Oxides
   - Alkaline Earth Oxides
2. **High Silica Materials**
   - Silica
   - Alumina
   - Iron Oxide
   - Alkali Oxides
   - Alkaline Earth Oxides
3. **Feldspathic Materials**
   - Silica
   - Alumina
   - Iron Oxide
   - Alkali Oxides
   - Alkaline Earth Oxides

TOTAL: 30 PERIODS

CT9351 KILNS, FURNACES AND PYROMETRY L T P C
3 0 0 3

AIM

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

OBJECTIVES

On completion of the course the students are expected to

- Have a thorough knowledge on the different burners used based on the fuel type and the types of flame produced from burners.
- Have studied the different types of furnaces and their operation.
- Have an understanding on the different factors involved in designing a furnace.
- Have a better knowledge on different types of kilns, their construction and working.
- Have a clear understanding on the temperature and heat measurement techniques in kilns and furnaces.

UNIT I BURNERS AND FLAMES 9

Burner – classification, atomization, low pressure burner for gaseous fuel, high pressure burner for liquid fuels, advantage & disadvantage of different burners. Flames – nature of flames, laminar & turbulent, premixed & diffusion, burning velocity.

UNIT II FURNACES 9

Introduction, definition, classification – metal heating furnaces, reheating furnace, continuous furnace, sintering furnace, crucible furnaces, electric furnace, unit melters and smelters, muffle furnace, glass tank furnace.

UNIT III FURNACE DESIGN 9

Factors for consideration, heating capacity, furnace design, heat economics, furnace atmosphere, draught establishment, chimney calculation, heat transfer, safety aspects.

UNIT IV KILNS 9

Introduction, definition, classification – draught kiln, chamber kiln, tunnel kiln, roller kiln, rotary kiln, continuous kiln, shuttle kiln, top hat kiln, muffle kiln, Hoffman's kiln – principle, materials used in foundation and construction, working.

UNIT V PYROMETRY 9

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

TOTAL: 45 PERIODS

TEXT BOOKS

1. Suryanarayana A.V.K, Fuels, Furnaces, Refractories and Pyrometry, BS Publications, 2005.
2. Robert D.Reed, Furnace Operation, Gulf Publishing Co., Paris, 1991.

REFERENCES

1. Harold E. Soisson, Instrumentation in Industry, John Wiley and Sons, NY, 1995.
2. Sarkar B.K, Thermal Engineering, Tata McGraw-Hill Publishing Co. Ltd., 1998.
3. Shaha A.K, Combustion Engineering and Fuel Technology, Oxford & IBH Publishing Co., New Delhi, 1974.
4. Daniel Rhodes, Kilns: Design, Construction and Operation, Chilton Book Co., Pennsylvania, 1974.

CT9352 GLAZE TECHNOLOGY L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a complete knowledge about the importance of glazing and the processing and application of glazes.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt he definition of glazes and classification of glazes.
- Have a thorough knowledge about the raw materials and properties of the glaze raw materials.
- Have a thorough knowledge about the various glazing techniques.
- Have learnt the properties and defects produced by glazing.
- Have complete understanding about the various methods of decorating the glazed article.

UNIT I INTRODUCTION TO GLAZE 9

Definitions – composition of glaze – classification of different types of glazes – engobe – frit preparation – frit rules – compounding of lead and leadless glazes, alkaline glazes, calcarious glazes and feldspatic glazes.

UNIT II RAW MATERIALS AND PROCESSING 9

Glaze raw materials – effect of individual materials – opacifiers – colouring agents – stains – mixed colours – metallic lustures – unit operations and processes – glaze properties – grain size – specific gravity – viscosity – glaze control – additives – glaze suitability – fired properties of glazes.

UNIT III GLAZING TECHNIQUES AND SPECIAL GLAZES 9

Glazing techniques – dipping, pouring, spraying, brushing, dusting and other techniques-special glazes – matt glazes, snake skin glazes, cracked glazes, salt glazes and other glazes.

UNIT IV PROPERTIES AND DEFECTS 9

Glaze body reactions- interface layers- thermal characteristics- glaze defects and remedies-crazing, peeling, crawling, rolling, blisters, pin holes, dunting- mechanical, optical and chemical properties of glazes.

UNIT V DECORATION 9

Classification of decoration methods- advantages- different decorating techniques- painting, spraying, stenciling, stamping, printing, lithographic transferring, silk screen printing, dusting, engobing, liquid gold decoration and decoration techniques.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Kenneth Shaw, Ceramic Glazes, Elsevier Publishing Co., NY, 1971.
2. Tailor J.R and Bull A.C, Ceramics Glaze Technology, Pergamon Press, NY, 1986.

REFERENCES

1. Emmanuel Cooper, The Potter Book of Glaze Recipes, B.T.Batsford Ltd., London, 1986.
2. Hiraoki Yanagida, The Chemistry of Ceramics, John Wiley and Sons, 1996.
3. Terpstra, Ceramic Processing, Chapmann and Hall, 1995.

CT9353 PHASE EQUILIBRIA IN CERAMICS L T P C
3 0 0 3

AIM

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

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the basics of phase equilibrium and phase diagrams.
- Have studied the thermodynamics behind phase equilibria.
- Have a better understanding on the different two component and three component phase diagrams.
- Have studied the types and theory behind phase transformations and also about nucleation and growth.
- Have gained knowledge on the different experimental methods to determine phase diagrams.

UNIT I INTRODUCTION 9

Introduction, phase, component, variable, Gibb's phase rule, single component system – H_2O, SiO_2, iron, Hume Rothery's rule; binary phase diagrams – eutectic, incongruent, solid solutions, complex diagrams.

UNIT II THERMODYNAMICS OF PHASE EQUILIBRIA 9

Introduction, criteria of phase equilibrium, criterion of stability, phase equilibria in single component system and multi component system; binary solutions – constant pressure system, constant temperature system, partially miscible system, immiscible system, liquid-liquid equilibrium diagrams, ternary equilibrium diagrams.

UNIT III PHASE DIAGRAMS 9

$Al_2O_3 – SiO_2$, $MgO – Al_2O_3$, $MgO – SiO_2$, $Al_2O_3 – ZrO_2$, $K_2O – Al_2O_3 – SiO_2$, $MgO – Al_2O_3 – SiO_2$, $Na_2O – Al_2O_3 – SiO_2$. Prediction of alkali corrosion of alumino silicate refractories using phase diagrams.

UNIT IV PHASE TRANSFORMATIONS 9

Introduction, Time Scale for phase transformations, types of transformations – spinoidal, nucleation & growth, theory of transformation kinetics; nucleation and growth – nucleation kinetics, homogeneous nucleation, heterogeneous nucleation, growth and overall transformation kinetics.

UNIT V EXPERIMENTAL METHODS 9

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

TOTAL: 45 PERIODS

TEXT BOOKS

1. Kingery W.D, Yet Ming Chiang and Dunbar P.Birnie III, Physical Ceramics – Principles for Ceramic Science and Engineering, John Wiley & Sons, 1995.
2. Floyd A.Hammel, Phase Equilibria in Ceramic Systems, Marcel Dekker, 1984.

REFERENCES

1. Kingery W.D, Bowen H.K and Uhlmann D.Rm Introduction to Ceramics, 2nd Edn., John Wiley & Sons, 2004.
2. Allen M.Alper, Phase diagrams in Advanced Ceramics, Academic Press Inc., 1995.
3. Barsoum M.W, Fundamentals of Ceramics, McGraw Hill, 1997.

CT9354 GLASS ENGINEERING – II L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a thorough knowledge on furnaces used for glass melting, fabrication of glass and the treatments to the final glass article.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the different furnaces used for glass melting, their design and operation.
- Have a better understanding on the heating process in tank furnace and the measurement and control of parameters in tank furnace.
- Have studied the fabrication methods of glass flat ware and hollow ware.
- Have a clear understanding on the purpose and process of annealing of glass products.
- Have learnt the different value adding processes done to glass.

UNIT I GLASS MELTING FURNACES 8

Construction and operation of pot furnace and day tank furnace. Tank furnace – types, design & construction, refractories used. Electric tank furnace – design & operation, electrodes used, electric boosting in tank furnace.

UNIT II OPERATION OF TANK FURNACE 10

Heating process – temperature distribution, efficiencies, heat balance, thermal insulation & cooling. Measurement and control – temperature, pressure, volume and fuel/air mixture, glass level. Reversal, heating and cooling of glass furnace, hot repairs.

UNIT III FABRICATION PROCESS 9

Forehearth & Feeder, hand operations, flatware – sheet glass, float glass, plate glass, patterned glass. Hollow ware – press & blow, blow & blow, IS machine, bulbs & tubes.

UNIT IV ANNEALING 9

Introduction, nature of generation & release of strain, temporary & permanent strain, dependence of strain on cooling rate, detection & measurement of strain, annealing equation, problems in annealing, annealing glass plate, optical glass, ideal annealing cycle.

UNIT V VALUE ADDING PROCESSES IN GLASS 9

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

TOTAL: 45 PERIODS

TEXT BOOKS

1. Glass Furnaces-Design, Construction & Operation, Wolfgang Trier, Society of Glass Technology, 2000.
2. Volf V.B, Technical Approach to Glass, Elsevier, 1990.

REFERENCES

1. Tooley F.V, Handbook of Glass Manufacture, Vol I&II, Ogden Publishing Co., NY, 1960.
2. Alexis G.Pincus, Melting Furnace Operation in the Glass Industry, Magazines for Industry Inc., NY, 1980.
3. Cummings K, The Technique for Glass Forming, B.T.Batsford Ltd., London, 1980.
4. James E.Shelby, Introduction to Glass Science & Technology, The Royal Society of Chemistry, 1997.

CT9355 REFRACTORIES- II L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a sound knowledge about the various types of refractories used in the various applications.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the basics about refractories used in iron & steel industry.
- Have a sound knowledge about refractories used in non ferrous and non metallic industries.
- Have learnt about refractories used in glass and ceramic industry.
- Have learnt about the refractories used for insulation.
- Have a knowledge about special refractories used in space and atomic/nuclear energy.

UNIT I REFRACTORIES FOR IRON & STEEL INDUSTRY 9

Refractories - coke oven, blast furnace, open hearth furnace, LD converter, THF, EAF, IF, Ladle furnace, slide plate system, nozzle, shroud, continous casting, monolithics – gunning technique, refractory slag and metal interactions.

UNIT II REFRACTORIES FOR NON FERROUS & NON METALLIC INDUSTRIES 9

Refractories in non ferrous industries – copper, aluminum, lead - Refractories in non metal industries – hydrocarbon industry, fertilizer industry, cement industry.

UNIT III REFRACTORIES FOR GLASS AND CERAMIC INDUSTRY 9

Refractories for glass industry – refractory practices in sidewall, throat, forehearth and roof of glass tank, regenerator systems, refractories for ceramic industry – kiln design – LTM concept, fast firng technology, kiln furnitures – types, properties, requirements – applications in different ceramic industry.

UNIT IV REFRACTORIES FOR INSULATION 9

Purpose of insulation – types of insulating materials and preparation of insulating refractories, ceramic fibre products – design and installation – ceramic coatings.

UNIT V REFRACTORIES FOR SPACE & NUCLEAR APPLICATIONS 9

Ceramics for space – materials used in space satellite, missiles, rockets nozzles, ceramics for nuclear reactors – types of reactors, structural ceramic materials, ceramic fuel elements, control rod elements.

TOTAL: 45 PERIODS

TEXT BOOKS

1. D.N.Nandi, Handbook of Refractories, Tata McGraw Hill Publishing Co, New Delhi, 1991
2. Shaw K, Refractories & Their Uses, App,Science Publishers, UK,1972

REFERENCE

1. Chesters J.H, Steel Plant Refractories, 2nd Edn, United Steel Company Limited, UK, 1973

CT9357 **GLAZE LAB** **L T P C**

[Minimum of 10 experiments] **0 0 2 1**

1. Preparation of Glaze Slip.
2. Fusion Studies.
3. Particle Size and Particle Size Distribution of Glaze.
4. Determination of Viscosity of Glaze Slip.
5. Determination of Flow Properties of Glaze Slip.
6. Preparation of Coloured Glazes.
7. Application of Glazes.
8. Glost Firing.
9. Decoration.
10. Measurement of Thickness of Glaze.
11. Determination of Scratch Resistance.
12. Crazing Analysis.
13. Determination of Acid Resistance by boiling acid.
14. Determination of Alkali Resistance by boiling alkali.
15. Determination of Thermal Expansion of Glaze using Dilatometer.

Equipments Required:

1. Dilatometer
2. Pot Mill
3. Particle Size Analyser
4. Hot Air Oven
5. Furnace

TOTAL: 30 PERIODS

CT9358 **GLASS LAB** **L T P C**

[Minimum of 10 experiments] **0 0 2 1**

1. Glass Raw Material Testing.
    - Borax
    - Lime
    - Quartz
    - Feldspar
2. Sieve Analysis.
3. Preparation of Soda Lime Glass
4. Preparation of Amber Glass
5. Determination of Density.
6. Determination of Specific Gravity.
7. Determination of Refractive Index.
8. Determination of Thermal Expansion.
9. Determination of Chemical Durability.
10. Glass Defects Testing.

Equipments Required

1. Sieve Shaker
2. Hot Plate
3. Hot Air Oven
4. Furnace

TOTAL : 30 PERIODS

GE9371 COMMUNICATION SKILLS AND SOFT SKILLS LAB L T P C
0 0 2 1

AIM

To enhance the overall capability of students and to equip them with the necessary Communication Skills and Soft Skills that would help them excel in their profession.

OBJECTIVES

- To equip students of engineering and technology with effective speaking and listening skills in English.
- To help them develop their soft skills and interpersonal skills, which will make the transition from college to workplace smoother and help them excel in their job.
- To enhance the performance of students at Placement Interviews, Group Discussions and other recruitment exercises.

1. PC based session

A. Career Lab (15 periods) Viewing and discussing audio-visual materials

1. **Resume / Report Preparation / Letter Writing:** (3)
   Letter writing – Job application with Resume - Project report - Email etiquette.
2. **Presentation skills:** (3)
   Elements of effective presentation – Structure of presentation - Presentation tools – Body language.
3. **Soft Skills:** (3)
   Time management – Stress management – Assertiveness – Negotiation strategies, Psychometrics - Analytical and logical reasoning.
4. **Group Discussion:** (3)
   Group discussion as part of selection process, Structure of group discussion – Strategies in group discussion – Mock group discussions.
5. **Interview Skills:** (3)
   Kinds of interviews – Interview techniques – Corporate culture – Mock interviews.

II. Class Room Session **TOTAL: 45 PERIODS**

1. **Resume / Report Preparation / Letter writing**: Students prepare their own resume and report. (9)
2. **Presentation Skills:** Students make presentations on given topics. (12)
3. **Group Discussion**: Students participate in group discussions. (12)
4. **Interview Skills**: Students participate in Mock Interviews (12)

   Note: Classroom sessions are practice sessions.

REFERENCES:

1. Prakash P, **Verbal and Non-Verbal Reasoning**, Macmillan India Ltd., 2nd Edition, New Delhi, 2004.
2. John Seely, **The Oxford Guide to Writing and Speaking**, Oxford University Press, New Delhi 2004.
3. Paul V Anderson, **Technical Communication**, Thomson Wadsworth , 6th Edition, New Delhi, 2007.
4. Edgar Thorpe and Showick Thorpe, **Objective English**, Pearson Education, 2nd Edition, New Delhi 2007.
5. David Evans, **Decision maker**, CUP, 1997

LAB REQUIREMENT

1. Teacher console and systems for students.
2. English Language Lab Software
3. Tape recorders

CT9401 ADVANCED STRUCTURAL CERAMIC MATERIALS L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a thorough knowledge about the various ceramic materials used for structural applications.

OBJECTIVES

- On completion of the course the students are expected to have a studied the structural characteristics and properties of oxide, carbide, nitride, carbon and other ceramic materials used for structural applications.

UNIT I OXIDE CERAMICS 9

Structural characteristics, properties and applications of silica, alumina, zirconia, magnesia, titania, thoria, mullite, uranium oxide and plutonium oxide.

UNIT II CARBIDES 9

Structural characteristics, properties and applications of silicon carbide, boron carbide, tungsten carbide, titanium carbide.

UNIT III NITRIDES 9

Structural characteristics properties and applications of silicon nitride, boron nitride, titanium nitride, aluminum nitride.

UNIT IV ADVANCED CERAMICS 9

Carbon compounds, borides, silicides, Sialon and cermets, high temperature superconducting oxides.

UNIT V SINGLE CRYSTALS 9

Introduction, techniques for forming- Kyropolar technique. Czochralski method, edge defined- film fed growth method, Bridgman technique, floating zone method, flux technique, hydro-thermal growth technique, micro pulling down technique.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Mc Colm, Ceramic Science for Materials Technologists, Blackie & Sons Ltd.,Glasgow, 1983.
2. Handbook of Advanced Ceramics, Vol.I, Somiya.S et al (ed), Academic Press, 2003.

REFERENCES

1. Brook R.J (ed), Concise Encyclopedia of Advanced Ceramic Materials, Pergamon Press, 1991.
2. Noboru Ichinose, Introduction to Fine Ceramics, John Wiley and Sons, 1987.
3. Gernot Kostorz, High Tech Ceramics, Academic Press, NY, 1989.

CT9402 ADVANCED CERAMIC PROCESSING L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a thorough knowledge on the advanced processing techniques in ceramics.

OBJECTIVES

On completion of the course the students are expected to

- Have a thorough knowledge on the preparation of ceramic powder by mechanical and chemical methods.
- Have studied the additives used in ceramic forming and different ceramic forming processes in dry powder, slurry and plastic consistency.
- Have a better understanding on the mechanisms of solid state and liquid phase sintering, and crystal growth during sintering.
- Have learnt the advanced sintering processes and their mechanisms.
- Have understood the processes involved in machining and surface finishing of ceramic products.

UNIT I POWDER PROCESSING 9

Powder preparation by mechanical methods – comminution, mechano-chemical synthesis. Powder synthesis by chemical methods – solid state reaction, liquid solutions, vapour phase reactions. Synthesis of nano scale ceramic powder–liquid solution technique, vapour phase technique.

UNIT II FORMING 10

Additives in ceramic forming – solvents, dispersant, binder, plasticizer, other additives. Forming of ceramics – dry and semidry pressing - die compaction and isostatic compaction; casting methods - slip casting, pressure casting, gel casting, electrophoretic deposition; plastic forming methods - extrusion, co-extrusion, injection molding, solid freeform fabrication - particle filled polymer methods, powder methods, suspension methods- Porous ceramic forming- foaming, intrusion, organic additives.

UNIT III SINTERING MECHANISMS 10

Solid state sintering – driving force, effect of surface curvature and boundary defects, mechanism, stages of sintering. Liquid phase sintering – stages, kinetic and thermodynamic factors, phase diagram in liquid phase sintering. Grain growth – different grain growth process, control of grain growth, grain growth and pore evolution in a porous compact, interaction between pore and grain boundary.

UNIT IV ADVANCED SINTERING 7

Pressure assisted sintering – hot pressing and hot iso-static pressing. Reaction bonded sintering, microwave sintering.

UNIT V MACHINING AND SURFACE FINISHING OF CERAMICS 9

Mechanism of material removal and its effect on strength, surface grinding and mechanical polishing, non abrasive finishing, ceramic surface coating, joining of ceramics – metal ceramic joints.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Mohamed N.Rahaman, Ceramic Processing, Taylor & Francis, 2007.
2. David W. Richerson, Modern Ceramic Engineering, 3rd Edn., Taylor & Francis, 2005.

REFERENCES

1. Paul De Garmo E, Black J.J and Ronald A.Kohser, Materials and Processes in Manufacturing, 8th Edn., Prentice – Hall India Pvt. Ltd., New Delhi, 1997.
2. Reed J.S, Introduction to the Principles of Ceramic Processing, Wiley, New York, 1988.
3. John G.P.Binner (Ed), Advanced Ceramics Processing and Technology, Noyes Publications, New Jersey, 1990.
4. Burtrand Lee and Sridhar Komarnei (Eds.), Chemical Processing of Ceramics, 2nd Edn., Taylor & Francis, 2005.

CT9403 CALCULATIONS IN CERAMICS L T P C
3 0 0 3

AIM

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

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the basic methods of calculating the properties of ceramic raw materials.
- Have learnt to calculate the properties of ceramic bodies.
- Have learnt to calculate the properties of suspensions.
- Have learnt to formulate glaze batches by varying the parameters.
- Have learnt to formulate glass batches.

UNIT I ULTIMATE & RATIONAL ANALYSIS 9

Ultimate analysis, proximate analysis, rational analysis of clay, stone and feldspar -mica convention – substitution of clays in body recipes – triangular plot.

UNIT II DETERMINATION OF PHYSICAL PROPERTIES 9

Shrinkage – Drying, Firing, Total, Volume, Moisture content – relationship between percentage moisture content and volume shrinkage - loss on ignition –density - specific gravity – effect of porosity on the function of ceramic materials – pore structure density – apparent volume – true volume – apparent solid volume, porosity – apparent, true, sealed pores.

UNIT III CALCULATIONS OF BODY & SUSPENSIONS 9

Density of a slip – calculations relating to mixtures of solid particles and water –dilution problems – Brongniarts Formula – dry measurement, wet measurement –effect of specific gravity – density of the body slip – dimensions of the mixing ark –adjustments to the wet recipe – addition of body stain.

UNIT IV GLAZE CALCULATIONS 9

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

UNIT V GLASS CALCULATIONS 9

Determination of molecular formula of glass from chemical composition of the glass and from glass batch – determination of batch from molecular formula of glass – determination of batch from the given chemical composition.

TOTAL: 45 PERIODS

TEXT BOOKS

1. R.Griffiths & C.Radford, Calculations in Ceramics, Johns Hill, 1965.
2. A.I.Andrews, Ceramic Tests and Calculations, John Wiley & Sons, 1928.

REFERNCES

1. Hiraoki Yanagida, The Chemistry of Ceramics, John Wiley and Sons, 1996.
2. Terpstra, Ceramic Processing, Chapmann and Hall, 1995.
3. Tooley F.V, Handbook of Glass Manufacture, Vol I&II, Ogden Publishing Co., NY, 1960.
4. Alexis G.Pincus, Melting Furnace Operation in the Glass Industry, Magazines for Industry Inc., NY, 1980.
5. R.Charan, Handbook of Glass Technology.

CT9404 ELECTRONIC CERAMICS L T P C
3 0 0 3

AIM

The Course is aimed to enable the students to know the basic concepts of ceramic materials used for electronic applications and their applications in various fields.

OBJECTIVES

On completion of the course the students are expected to

- Have studied the use of ceramic materials as insulators and capacitors and their properties.
- Have learnt the processing, properties and various applications of ceramic materials in ferroelectric applications.
- Have learnt the manufacture, characteristics and properties of magnetic ceramics.
- Have a basic knowledge about superconductivity.
- Have a basic knowledge about the manufacture, characteristics and properties of varistors and fuel cells.

UNIT I CERAMIC INSULATORS 9

Porcelain insulators – triaxial, steatite, non feldspathethic types – composition, properties and uses – dielectric strength – dielectric breakdown mechanisms – factors affecting dielectric strength – dielectric constant and loss-polarization- different types of polarization – effect of frequency and temperature.

UNIT II CERAMIC CAPACITORS 9

Capacitance-ferroelectric behavior – barium titanate – effect of solid solutions – additives – film capacitors, single layer discrete capacitors – multilayer capacitors – basic principles and fabrication processes.

UNIT III FERROELECTRIC CERAMICS 9

Piezo-electricity – barium titanate, relaxor ferroelectrics, multiferroics, ferroelectricity, manufacture of barium titanate based ceramics – properties of ferroelectric ceramics – hysteresis loop – PZT – PLZT materials, compositional systems, processing and fabrication – mixed oxide and chemical precipitation processes.

UNIT IV MAGNETIC CERAMICS 9

Classification of magnetic materials – domain theory – Ferromagnetism – Spinel ferrites – structure, types of ferrites – manganese, zinc ferrites – hexagonal ferrites – garnets – standard ceramic processing and fabrication techniques-GMR.

UNIT V VARISTORS AND FUEL CELLS 9

Introduction- ZnO varistors – PN junction diode– electrical characteristics, fabrication of ZnO varistor behavior- microstructure – gas sensors fuel cells – types, principle, working, solid oxide fuel cells – applications- structure and operation principle of oxygen sensors, NOx sensors.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Hench L.L and J.K.West, Principles of Electronic Ceramics, John Wiley, NewYork, 1990.
2. Moulson AJ and HM Herbert, Electroceramics, Chapman and Hall, London, 1990.

REFERENCES

1. Setter N and Colla SL, Ferroelectric Ceramics, Birkhauser Ver Lag, 1993.
2. S.Somiya, F.Aldinger, N.Clausen, RM Sprigs, K.Uchino, K.Koumoto, M.Kaneno, Handbook of Advanced Ceramics : Vol.II, Processing and their applications, Academic Press, 2003.
3. Buchanan RC, Ceramic Materials for Electronics, Marcel Dekker Inc., NY, 1991.

CT9405 CEMENT AND CONCRETE L T P C
3 0 0 3

AIM

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

OBJECTIVES

On completion of the course the students are expected to

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

UNIT I CEMENT 7

Raw materials, manufacturing process. Composition of cement phases – effect of composition on burnability of clinker, influence of minor components. Hydration of cement.

UNIT II TESTING AND QUALITY CONTROL OF CEMENT 8

Tests on properties of cement – consistency of standard paste, setting time, soundness, strength of cement. Quality control – litre-weight test, microscopic and X-ray investigation of clinker materials.

UNIT III TYPES OF CEMENT 10

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

UNIT IV CONCRETES 10

Aggregates – types, characteristics. Admixtures – types, characteristics. Proportioning of concrete mixtures – consideration, procedure. Recent advances in concretes – types, significance, characteristics.

UNIT V PROPERTIES OF CONCRETE 10

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

TOTAL: 45 PERIODS

TEXT BOOKS

1. P. Kumar Mehta and Paulo J.M.Monteiro, Concrete – Microstructure, Properties and Materials, 3rd Edn., Tata McGraw Hill, 2006.
2. A.M.Neville, Properties of Concrete, 4th Edn., Pearson Education, 1995.

REFERENCES

1. A.M.Neville and J.J.Brooks, Concrete Technology, Pearson Education, 1987.
2. Peter C.Hewlett (Editor), Lea's Chemistry of Cement and Concrete, 4th Edn., Elsevier, 1998.
3. Deborah DL. Chung, Multifunctional Cement Based Materials, Marcel Dekker Inc., 2003.
4. J. Bensted and P.Barnes (Editors), Structure and Performance of Cements, 2nd Edn., Spon Press, 2002.

CT9407 ADVANCED INSTRUMENTAL METHODS OF ANALYSIS LAB L T P C
[Minimum of 10 experiments] 0 0 2 1

1. Analysis of Trace Elements using Spectrophotometer, Flame Photometer and Atomic Absorption Spectroscopy.
2. Thermal Analysis – TGA, DTA, DSC.
3. Determination of Viscosity by Brookfield Viscometer.
4. Particle Size Analysis – Laser Diffraction.
5. Microscopy – Optical, SEM.
6. Vicker's Hardness.
7. Modulus of Rupture.
8. Modulus of Elasticity.
9. Creep, Wear and Abrasion Resistance.
10. Surface Area Measurement – BET.

Equipments Required:

1. Spectrophotometer
2. Atomoc absorption Spectrometer
3. Flame Photometer
4. TGA/DTA
5. Brookfield Viscometer
6. Particle Size Analyser
7. SEM
8. Vickers Hardness Tester
9. Universal Testing Machine
10. BET

TOTAL: 30 PERIODS

CT9408 ADVANCED CERAMIC PROCESSING LAB L T P C
[Minimum of 10 experiments] 0 0 2 1

1. Powder preparation of alumina by Sol Gel Process.
2. Powder preparation of zirconia by Sol Gel Process
3. Powder preparation by Precipitation Technique.
4. Powder preparation by Spray Drying.
5. Shaping by Gel Casting.
6. Tape Casting Process.
7. Porous body making by Foaming Method.
8. Porous body making by Replication Technique.
9. Porosity & Density Measurement.
10. Microstructure study of sintered samples prepared from different processing routes.
11. Metallographic Preparation- Polish & Examine using Optical Microscope.

Equipments Required:

1. Optical Microscope
2. Spray Drying
3. Hot Plate
4. Furnace
5. Hot Air Oven

TOTAL: 30 PERIODS

CT9451 **PROJECT WORK** **L T P C**
0 0 12 6

AIM

The project work aims to train the students on systematic analysis of a problem and to enable them to bring out a solution it.

OBJECTIVE

The objective of the project is to make use of the knowledge gained by the student at various stages of the degree course.

Each student is required to submit a report on the project assigned to him/her by the department. The report should be based on the literature collected from the many sources and the actual analysis done by the student on the given project.

CT9021 **PROPERTIES OF CERAMICS** **L T P C**
3 0 0 3

AIM

The course is aimed to enable the students to have a thorough knowledge on different properties of ceramics.

OBJECTIVES

On completion of the course the students are expected to

- Have a thorough knowledge on the mechanical properties and the mechanical failure modes of ceramics.
- Have studied the thermal properties of ceramics.
- Have an understanding on the optical properties of ceramics.
- Have a better knowledge on electrical properties of ceramics.
- Have a clear understanding on the magnetic properties of ceramics.

UNIT I MECHANICAL PROPERTIES **9**

Plastic deformation of different crystals, creep in single crystal, polycrystal, refractories. Viscous flow of liquids and gases. Elastic moduli, anelasticity, brittle fracture and crack propagation, strength and fracture surface work experience, static fatigue, creep fracture, effects of microstructure.

UNIT II THERMAL PROPERTIES **10**

Heat capacity, density and thermal expansion of glasses, crystals, composite bodies. Thermal conduction – phonon conductivity of single phase crystalline ceramics and glasses, photon conductivity, conductivity of multiphase ceramics, thermal stress, temperature gradients, resistance to thermal shock and thermal spalling, thermal tempering and annealing.

UNIT III OPTICAL PROPERTIES **8**

Introduction, refractive index and dispersion, reflection and refraction, absorption, scattering, polarisability, boundary reflectance and surface gloss, opacity and translucency, absorption and colour, application.

UNIT IV ELECTRICAL PROPERTIES **9**

Electrical conduction phenomena, ionic conduction in crystals and glasses, electronic conduction in crystals and glasses, non-stoichiometry and solute controlled electronic conduction, valency controlled semiconductors, mixed conduction in poor conductors, poly crystalline ceramics, electrical phenomena, dielectric loss factor for crystals and glasses, dielectric conductivity, polycrystalline and polyphase ceramics, dielectric strength.

UNIT V MAGNETIC PROPERTIES 9

Magnetic phenomena, origin of interactions in ferromagnetic materials, spinel ferrites, rare earth garnets, ortho ferrites and illmenites, hexagonal ferrites, polycrystalline ferrites, susceptibility, permeability, flux density, types of magnetism and their origin, electronic structure and magnetic moment, exchange interaction and super exchange interaction, hysteresis loop and magnetic domain – domain structure.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Kingery W.D, Bowen H.K and Uhlmann D.R, Introduction to Ceramics, John Wiley & Sons, 1991.
2. Barsoum M.W, Fundamentals of Ceramics, McGraw-Hill, 1997.

REFERENCES

1. David W.Richerson, Modern Ceramic Engineering, 3rd Edn., Taylor and Francis, 2005.
2. Moulson A.J and Herbert H. M, Electroceramics, Chapman and Hall, London, 1990.
3. Allen Dinsdale, Pottery Science: Materials, Processes and Products, Ellis Horwood Ltd., NY, 1986.

CT9022 CERAMIC TESTING AND QUALITY CONTROL L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about the various testing methods of ceramic raw materials and samples and also the basics about quality control.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the basics about the testing methods for ceramic raw materials.
- Have learnt the various methods of testing the physical properties.
- Have learnt to test the various properties of glaze.
- Have an immense knowledge about testing of refractories.
- Have a basic knowledge about quality control.

UNIT I TESTING OF RAW MATERIALS 9

Conino and quartering of sample – sampling on delivery – measurement of moisture content by IR moisture balance – speedy moisture test – particle size analysis – sieve test, sedimentation method –Stokes, Andreasen Pipette.

UNIT II TESTING OF PHYSICAL PROPERTIES 9

Determination of surface area by permeametry – plasticity – Perferkon test, Atterberg test, contraction – wet to dry, dry to fired, wet to fired, modulus of rupture – control of casting slips – fluidity – thixotrophy and specific gravity using torsion viscometer – vitrification – density – porosity – water absorption.

UNIT III TESTING FOR GLAZE 9

Measuring coherence parameter – pick up – testing of viscosity of glazes at low temperatures and high temperatures – test for the solubility of lead frits – glaze fit –hardness testing – glaze thickness – autoclave and crazing – thermal shock measurement.

UNIT IV TESTING FOR REFRACTORIES 9

Refractoriness – RUL – cold crushing strength – permanent linear change on reheating – spalling resistance – reversible thermal expansion – thermal conductivity – specific gravity – bulk density – slag resistance test.

UNIT V QUALITY CONTROL 9

Introduction – basic concepts – Indian standards for ceramic materials – ISO 9000 -zero defects – concept quality marking and certification scheme – total quality management in ceramic industries.

TOTAL: 45 PERIODS

TEXT BOOKS

1. W.Ryan & Radford C, Whitewares : Production, Testing and Quality Control, The Institute of Ceramics by Pergamon Press, Oxford, 1987.
2. Felix Singer & Sonja Singer, Industrial Ceramics, Oxford & IBH Publishing Ltd, New Delhi, 1992.

REFERENCES

1. D.Ganguli, S.Kumar, Elements of Ceramics –Vol II, Indian Institute of Ceramics, 1984.
2. Hiraoki Yanagida, The Chemistry of Ceramics, John Wiley and Sons, 1996.
3. Juran J.M and Gryna F.M, Quality Control Handbook, McGraw Hill Book Co.,1988.
4. Rashid Chesti.A, Refractories, Prentice Hall of India Pvt Ltd, 1986.
5. Kenneth Shaw, Ceramic Glazes, Elsevier Publishing Co, NY, 1971.
6. H.Lal, Total Quality Management – A Practical approach, Wiley Edn, 1990.

CT9023 ADHESIVES L T P C
3 0 0 3

AIM

The course aimed to enable the students to have a basic knowledge about the types, properties and applications of adhesives.

OBJECTIVES

On completion of the course the students are expected to

- Have gained knowledge on classification of adhesives and forces involved in adhesion.
- Have studied the mechanical properties, adhesion and cohesion of adhesives.
- Have understood about the types, properties and applications of thermosetting resins.
- Have learnt about the types, properties and applications of thermoplastic resins.
- Have studied about the types, properties and applications of inorganic adhesives.

UNIT I INTRODUCTION 10

Definition – adhesion, adhesives and adherents, mechanism of adhesion. Classification of adhesives and adhesive joints. Molecular forces – types of bonding, surface forces. Surface of adherends – surface roughness, adsorption, moisture, chemisorptions, fresh and clean surfaces. Adhesion of solids to liquids – wetting equilibria, strength of a liquid joint, surface morphology, influence of structure, adhesives and surface lubricants, optimum condition for adhesion and adhesion. Adhesion of solids to solids – metals to metals, metals to inorganic solids, polymer to metals.

UNIT II PROPERTIES 9

Mechanical properties – rheological models and molecular theory, glass transition and visco-elasticity, chemo-rheology, two phase systems, concepts of fracture, tough-brittle transition, rupture and tearing of rubber, nucleation and growth of cracks, controlled brittle fracture and fracture toughness, controlled cleavage of crystals, adhesive strength. Adhesion and cohesion – tack, surface treatment, wetting, spreading and shear strength, non-destructive testing, destructive testing.

UNIT III THERMOSETTING RESIN ADHESIVES 9

Introduction, types. Urea formaldehyde adhesives – preparation, curing agents, fillers and extenders used for UF resin, properties and applications. Phenol formaldehyde adhesives – preparation, resol & novolak, types of PF resin based on setting temperature, fillers, extenders and thickening agents for PF resin, properties. Properties and applications of other thermosetting resins – melamine formaldehyde, resorcinol formaldehyde, epoxy resin, polyester resin.

UNIT IV THERMOPLASTIC RESIN ADHESIVES 7

Introduction, types and properties of cellulose adhesives, polyvinyl adhesives, acrylic resin adhesives, polyamide resins and nylons, and miscellaneous thermoplastic adhesives.

UNIT V NATURAL ORGANIC ADHESIVES AND INORGANIC ADHESIVES 10

Natural organic adhesives – introduction, classification, animal glue – composition, properties and testing, vegetable adhesives – introduction, types. Glass – adhesion properties of glass, theories of glass bonding, properties and applications. Enamels – properties and applications. Ceramics – ceramic to glass and ceramic to metal bonds. Soluble silicates – introduction, composition, properties and applications. Cements – phosphate cements, hydraulic cements, high temperature cements and miscellaneous cements.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Houwink R and Salomon G, Adhesion and Adhesives, Elsevier Publishing Co., 1965.
2. William C.Wake, Adhesion and the Formulation of Adhesives, Elsevier Applied Science Publishers, 1982.

REFERENCES

1. Guttmann W.H, Concise Guide to Structural Adhesives, 1st Edn., Reinhold Book Corporation, 1961.
2. Amstock J.S, Handbook of Adhesives and Sealants in Construction, Harwood Academic, 1995.
3. Patrick R.L, Treatise on Adhesion and Adhesives, Vol.I, Joint Committee on Tall Buildings, 1st Edn., 1967.
4. Miller R.S, Adhesives and Glues, 1st Edn., Frankein Chemical Industries, 1980.
5. Shields J, Adhesives Handbook, 3rd Edn., Butter-Worths, 1984.
6. Panda H, Industrial Gums and Adhesives Technology Handbook, 1st Edn., SIRI.

CT9024 PROCESS AUTOMATION L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about the control instruments and its applications in various fields.

OBJECTIVES

On completion of the course the students are expected to

- Have studied the principle and classification of process control equipments.
- Have learnt basic concepts on process control.
- Have learnt the basics about advanced control instruments.
- Have learnt about digital control instruments.
- Have learnt the optimal control instruments.

UNIT I INTRODUCTION 9

Principles of measurement and classification of process control instruments; temperature, pressure fluid flow, liquid level, velocity, fluid density, viscosity, conductivity etc., instrument scaling; sensors; transmitters and control valves; instrumentation symbols and labels.

UNIT II PROCESS AUTOMATION 9

Basic Concepts; terminology and techniques for process control; control modes; tuning process controllers.

UNIT III ADVANCED CONTROL 9

Advanced control techniques, feed forward and ratio control; controller design; adaptive control system; statistical process control; expert system; multivariable control techniques; supervisory control.

UNIT IV DIGITAL CONTROL 9

Digital control techniques; z transforms; sampling and filtering; response of discrete time systems; sampled data control systems; design of digital controllers.

UNIT V OPTIMAL CONTROL 9

Optimization and simulation; optimization techniques; single and multivariable constrained optimization; dynamic simulation of distillation columns and reactors.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Nakara, B.C & ChoudaryK.K., Instrumentation and Analysis, Tata McGraw Hill, New Delhi, Eighth Reprint, 1993.
2. Stephanopoulos G., Chemical Process Control, Tata McGraw Hill, New Delhi, 1993.

REFERENCES

1. Karl J.Astrom & Bjorn Willermans; Computer Controlled Systems, Prentice Hall of India Pvt.Ltd. 1994.
2. Chemical Engineering Refreshers series on Process Automation, McGraw Hill Publications, New York, 1991.

CT9025 MATERIALS MANAGEMENT L T P C

3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about importance of material management and its applications in various sectors.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the basic concepts about materials management.
- Have studied about the importance of purchasing.
- Have studied the importance of management in warehouse and stores.
- Have studied the importance of management in inventory.
- Have studied the concepts of different material procurement procedures.

UNIT I INTRODUCTION 9

Introduction to material management, importance of integrated materials management, need for integrated materials management, concept, definition, scope and advantage- an overview, A-B-C analysis, codification, variety reduction, standardization.

UNIT II PURCHASE MANAGEMENT 9

Material planning and purchase, purchase system, procedures, price forecasting, purchasing of capital equipment, vendor development, account procedure, purchasing decisions, procurement policies.

UNIT III WARE HOUSING AND STORE MANAGEMENT 9

Store keeping principles-past and latest techniques, stores-general layout, cost aspect and productivity, problems and development, store system procedures incoming material control, store accounting and stock incoming material control, store accounting and stock verification, value analysis.

UNIT IV INVENTORY MANAGEMENT 9

Introduction, basic models, definition of commonly used terms, replenishment model, choice of system etc., inventory work in progress, safety stock, computerization in materials management control, information to materials management case study, spare parts .

UNIT V MATERIAL PROCUREMENT PROCEDURES 9

Arbitration act- octroi, central and local sales tax, excise duties- custom tariff, import, control policies, procurement from government agencies and international market- insurance, DGS and D tariff.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Goplakrishnan P and Sundraesan M, Materials Management, An Integrated Approach, Prentice Hall of India Private Ltd., New Delhi, 1982.
2. Peckam H.H, Effective Materials Management, Prentice Hall of India Private ltd., 1984.

REFERENCES

1. Datta A.K., Materials Management Procedure, Test and Cases, Prentice Hall of India Private Ltd., New Delhi, 1984.
2. Prichard J.W and Eagle R.H., Modern Inventory Management, NY, Wiley and Breach Science Publishers, 1972.

CT9026 MONOLITHICS AND CASTABLES L T P C
3 0 0 3

AIM

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

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the types of castables, its composition and characteristics.
- Have a better understanding on the use of plastic refractories, ramming and gunning mixes as monolithic materials.
- Have studied about the composition and characteristics of mortars, coatings and dry vibratables.
- Have a clear idea on the methods of installing different monolithic materials, the application design and the lining materials used while laying monolithics.
- Have studied the wear mechanisms that cause failure in a monolithic lining and the methods to test a monolithic.

UNIT I CASTABLES 10

Introduction, types – conventional castables, low cement castables, ultra low cement castables, cement free castables – composition, characteristics, applications. Other castables – insulating castables, pumpable castables – composition, characteristics, applications.

UNIT II PLASTIC REFRACTORIES, RAMMING AND GUNNING MIXES 10

Plastic refractories – introduction, composition, properties and applications. Ramming mix – introduction, binder systems, characteristics and applications. Gunning mix – introduction, binder systems, characteristics and applications.

UNIT III MORTARS, COATINGS AND DRY VIBRATABLES 7

Mortars – introduction, classification, characteristics. Coatings – introduction, characteristics. Dry vibratables – introduction, principle and applications.

UNIT IV MONOLITHIC INSTALLATION 10

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

UNIT V WEAR MECHANISMS AND TESTING 8

Wear mechanisms – introduction, abrasion, penetration, corrosion, spalling. Tests done on monolithics – chemical analysis, density, porosity, strength, high temperature properties, corrosion, erosion.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Subrata Banerjee, Monolithic Refractories, World Scientific Publishing Co. Pte. Ltd., 1998.
2. Taikabutsu Overseas Vol.9 No.1, Recent Progress in Castable Refractories, Techno Japan, Fuji Marketing Research Co. Ltd., Japan, 1995.

REFERENCES

1. Charles A.Schacht, Refractories Handbook, Marcel Dekker Inc, New York, 2004.
2. Norton F.H, Refractories, 4th Edn., McGraw Hill Book Co., 1968.
3. Nandi D.N, Handbook of Refractories, Tata McGraw-Hill Publishing Co., New Delhi, 1991.
4. Akira Nishikawa, Technology of Monolithic Refractories, Plibrico, Japan Co. Ltd., Tokyo, 1984.

CT9027 HEAT RECOVERY SYSTEMS L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a sound knowledge about the methods to recover the waste heat from furnaces and also methods to minimize wastage of heat.

OJECTIVES

On completion of the course the students are expected to

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

UNIT I ENERGY BALANCE IN FURNACE 9

Temperature and thermal conditions in furnace, calculation of thermal operation of furnaces – heat balance, furnace productivity.

UNIT II HEAT EXCHANGERS 9

Definition, types of exchangers – parallel & counter flow exchangers, single pass 1-1, multi pass 1-2 & 2-4. Heat transfer coefficients in heat exchangers. Boilers and calandrias, extended surface equipments – types, efficiency and calculation.

UNIT III REGENERATORS 11

Principle of operation, types of regenerators, design and construction, materials of construction and applications.

UNIT IV RECUPERATORS 8

Principle of operation, types of recuperators, design, applications, comparison over regenerator.

UNIT V ENERGY CONSERVATION DESIGNS 8

Prevention of energy loss in furnace – insulation, coatings, low thermal mass materials – importance, design and applications.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Glinkov M.A and Glinkov G.M, A General Theory of Furnaces, Mir Publishers, Moscow, 1980.
2. Perry R.H and Green D (eds), Perry's Chemical Engineers' Handbook, 6th Edn.,McGraw-Hill, New York, 1984.

REFERENCES

1. Shaw K, Refractories and their Uses, App. Science Publishers, UK, 1972.
2. Robert E.Fisher (ed), Advances in Refractory Technology, Ceramic Transaction Vol 4, American Ceramic Society, 1990.
3. Warren L.McCabe, Julian C.Smith and Peter Harriott, Unit Operations of Chemical Engineering, 7th Edn., McGraw Hill International Edition, 2005.
4. Industrial Furnaces, Vol I, 4th Edn.

CT9028 QUALITY CONTROL IN CERAMIC INDUSTRIES L T P C
3 0 0 3

AIM

To impart knowledge on various quality control aspects and issues followed in ceramic industries.

OBJECTIVES

At the end of the course the students would

- Be aware on the basic concepts of standardization.
- Have a comprehensive insight in the Indian standard specifications.
- Have a basic knowledge on the concepts of quality control in ceramic industries.
- Have learnt the statistical methods of quality control.
- Have a basic knowledge about the reliability and maintainability of quality concept.

UNIT I CONCEPTS OF STANDARDISATION 9

Historical development of standards – aims, techniques, management, formulation, implementation of company standards- economic benefits of standardization.

UNIT II INDIAN STANDARDS FOR CERAMIC MATERIALS 9

IS Specification- Specification for different raw materials- test procedures- products- tiles- sanitary ware- insulators- chemical resistant wares- structural ceramic materials- refractories.

UNIT III CONCEPTS OF QUALITY 9

Quality engineering- planning for quality and reliability- quality standards- specification of inspection methods, setting of standard quality levels- introduction to ISO 9000- design of quality experiments using statistics- analysis of variance.

UNIT IV STATISTICAL QUALITY CONTROL 9

Introduction to taguchi methods and 6 sigma concepts- objectives of statistical quality control- inspection and its importance- difference between inspection and quality control, basic statistical methods- techniques of quality control- control charts for attributed- control charts for variables.

UNIT V DECORATION 9

Definition of reliability, factors affecting reliability- MTTF- MTBF- evaluation of reliability, quality management- organizing for quality- economy of quality- techniques of ABC analysis- quality management education- zero defects concept-

TOTAL: 45 PERIODS

TEXT BOOKS

1. H.Lal, Total Quality Management- A Practical Approach, Wiley Eastern, 1990.
2. Juran J.M and Gryna F.M, Quality Control Handbook, McGraw Hill Book Co., 1988.

REFERENCES

1. Jerome D Wiest and Ferdinand K Leoy, A Management Guide to PERT/CPM.
2. Guide on Company Standardization by Institute of Standards & Engineers, 1989.
3. International Organization for Standardization, 1992, Case Postal 56, CH-1211-Geneva 20- Switzerland- ISO- 9000 Compendium – Vision 2000- ISBN92- 67- 101722.

CT9029 ABRASIVES L T P C

3 0 0 3

AIM

The course aimed to enable the students to have a basic knowledge about the types, manufacturing process, properties and applications of abrasives.

OBJECTIVES

On completion of the course the students are expected to

- Have a basic understanding on the abrasives, and different raw materials and their characteristics.
- Have studied the stages involved in the manufacture of a coated abrasive.
- Have learnt about the different types of back ups used in a coated abrasive and how they affect the grinding characteristic.
- Have a good knowledge on the manufacturing of bonded abrasive, its types and characteristics.
- Have learnt the fundamentals of grinding operation, grinding aids and about polishing.

UNIT I INTRODUCTION 6

Abrasives – definition, classification, applications. Abrasive grains – classification, characteristics like hardness, toughness etc. Backings – cloth, paper, fibre, combination backing, their characteristics. Adhesives – classification, characteristics.

UNIT II MANUFACTURE OF COATED ABRASIVES 8

Raw material selection and preliminary treatments, maker coating, abrasive coating – methods and types of coating, sizer coating, drying and humidification, flexing, conversions – slitting, belt making, sheet cutting, disc cutting. Individual disc coating process. Quality control and testing.

UNIT III BACK UPS 7

Contact wheels – cloth contact wheels, rubber contace wheels, hardness, face serrations, shape, wheel diameter, speed, belt tension, dressing and protection of contact wheels – their characteristics. Drum, rolls, pads and platens – types, characteristics, choice and uses. Working principle of coated abrasive.

UNIT IV MANUFACTURE OF BONDED ABRASIVES 12

Abrasive grain type and characteristics required for bonded abrasives. Types of bonds – vitrified, silicate, resinoid, shellac, rubber and oxychloride. Bonded wheel manufacture with different bonds and their characteristics. Shapes and sizes of wheels. Factors determining grinding action – characteristics of abrasive grain, bond type, structure. Other types of wheels – Diamond wheels, reinforced wheels, mounted wheels

UNIT V BASICS OF GRINDING AND POLISHING 12

Grinding wheel – definition, abrasives chosen, grinding chips, chemical reactions, grade selection, wheel wear, chemical grinding aids. Grinding fluids – properties, types and purpose. Types of grinding – cylindrical grinding, centre less grinding, surface grinding, internal grinding. Polishing – definition, types.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Coes L Jr., Abrasive, Springer Verlag, New York, 1971.
2. Coated Abrasives – Modern Tool of Industry, Coated Abrasive Manufacturer's Institute, Cleaveland, Ohio, 1982.

REFERENCES

1. Metzger J.L, Super Abrasive Grinding, Butterworths, UK, 1986.
2. Francis T.Farago, Abrasive Methods Engineering, Vol.2, Industrial Press Inc., NY, 1980.
3. Edwards R, Cutting tools, The Institute of Materials, Cambridge, 1993.
4. Kenneth B.Lewis, William F.Schleicher, The Grinding Wheel, The Grinding Wheel Institute, Cleaveland, Ohio, 1976.

CT9030 BIOCERAMICS L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a sound knowledge about the applications of ceramic materials in biological field.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the various applications of ceramic materials in the medical field.
- Have a complete knowledge about the various calcium phosphate based ceramic materials along with the preparation, properties and applications.
- Have studied about the different bioactive glasses and glass ceramic materials.
- Have studied about the different bioactive composites.
- Have studied about the different bioactive coatings.

UNIT I MATERIALS IN MEDICINE 9

Implant areas – dental, orthopedic. Implant materials – bio polymers, bio metals, ceramic implants – porous ceramics, surface active ceramics, resorbable ceramics. Biological performance of the materials, body reaction to implant materials – corrosion, biodegradation and biocompatibility. Invitro and invivo test methods of implant materials.

UNIT II CALCIUM PHOSPHATE CERAMICS 9

Chemistry of calcium phosphate bio ceramics – preparation, mechanical properties and biological performance of tri calcium phosphate, tetra calcium phosphate, biphasic calcium phosphate, hydroxyapatite and other phosphates. Calcium phosphate bone cements – preparation, properties, setting behavior and bio compatibility.

UNIT III BIOACTIVE GLASSES AND GLASS CERAMICS 9

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

UNIT IV BIOACTIVE COMPOSITES 9

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

UNIT V BIOACTIVE COATINGS 9

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

TOTAL: 45 PERIODS

TEXT BOOKS

1. Yamamura T, Hench L.L and Wilson J, CRC Handbook of Bioactive Ceramics, Vol I & II, CRC Press, Boca Raton, 1990.
2. Park J.B, Biomaterials: An Introduction, Plenum Press, New York, 1979.

REFERENCES

1. Bonfield V, Hastings C.H and Tanner K.E (eds.), Bioactive Ceramics, Vol4, Butterworth – Heinemann Ltd., Oxford, 1991.
2. Hans Bach, Low Thermal Expansion Glass Ceramics, Springer, 1995.
3. Hench L.L and Ethridge E.C, Biomaterials: An Interfacial Approach, Academic Press, New York, 1982.

CT9031 SPECIAL GLASSES L T P C
3 0 0 3

AIM

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

OBJECTIVES

On completion of the course the students are expected to

- Have a clear understanding on the types and properties of heat resistant and safety glasses.
- Have studied the manufacture, types and applications of optical glasses.
- Have studied the composition of glass fibres and optical fibres, and their applications.
- Have learnt the composition, preparation and properties of glass ceramics.
- Have a knowledge on the methods and types of coatings on glass, their applications and quality control.

UNIT I HEAT RESISTANT AND SAFETY GLASSES 9

Borosilicate glasses – pyrex glass and jona type, composition – fabrication of laboratory ware – vycor glass. Safety glasses – toughened glass, laminated glass.

UNIT II OPTICAL GLASSES 9

Manufacture of crown and flint glass – ophthalmic glass filters – photo chromic glass – laser glass – electro chromic glass – GRIN lenses and components – chalcogenide, chalcohallide and halide glasses – applications in optical components.

UNIT III GLASS FIBRES 9

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

UNIT IV GLASS CERAMICS 9

Glass composition, heat treatment schedule, crystal nucleation in glass, nucleating agent, microstructure and properties, applications, machinable glass ceramics.

UNIT V COATED GLASS 9

Coating methods – physical vapour deposition, chemical vapour deposition. Types of coatings, characteristics of coated glass, applications of coated glasses, quality control of coated glass.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Lewis M.H, Glasses and Glass Ceramics, Chapman and Hall, London, 1989.
2. Cable M and Parker M.J, High Performance Glasses, Chapman and Hall, NY, 1992.

REFERENCES

1. Heinz G.Plaender, Schott Guide to Glass, Chapman and Hall, 1996.
2. Hans Bach, Low Thermal Expansion Glass Ceramics, Springer, 1995.
3. Philips C.J, Glass, Its Industrial Applications, Reinhold Publishing Co., NY, 1960.

CT9032 ADVANCED COATING TECHNOLOGIES L T P C

3 0 0 3

AIM

The course is aimed to enable the students to have a complete knowledge about the advanced ceramic coating technology processes, properties and applications.

OBJECTIVES

On completion of the course the students are expected to

- Have studied the classification and raw materials used for the special coatings.
- Have learnt in detail about enamel coating.
- Have studied the concept of vapour phase coatings.
- Have studied about the various special coating techniques.
- Have studied the properties and applications of special coatings.

UNIT I COATINGS – FUNDAMENTALS 9

Definition of thin film and coatings, preparation of substrate- Role of substrate- substrate selection- nucleation and thin film growth- residual stress, thickness measurements.

UNIT II VAPOUR PHASE COATINGS 9

PVD - basic evaporation process - evaporation techniques - sputtering – ion plating- CVD process- CVD reactor- CVD kinetics- product and process route.

UNIT III SPECIAL COATINGS 9

Plasma spray- pack coating- slurry coating- sol gel coating- hot dip coating- electrophoresis- electro chemical coating- corrosion resistant coating and other coatings.

UNIT IV SURFACE ANALYTICAL METHODS 9

XRD – glancing incidence, x-ray diffraction- electron microscopy techniques- auger electron spectroscopy, secondary ion mass spectroscopy, photoelectron spectroscopy.

UNIT V PROPERTIES AND APPLICATIONS 9

Thermal, mechanical. Optical and chemical properties- hardness- wear and erosion resistance- high temperature properties- applications- defects and remedies.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Hocking M.G.Vasantasree V Sidky PS, Metallic and Ceramic coatings, Longman, 1989.
2. Boriosenko Al, HighTemperature Protective Coatings,American Publishing Co., New Delhi, 1986.

REFERENCES

1. Lisa C Klien (Ed),Sol Gel Technique for Thin Films, Fibres, Performs, Electronis and Speciality Shapes, Noyes publications, New Jersy, 1988.
2. Orlando Auciello and Rainer Waser, Science and Technology of Electro ceramic Thin film, NATO ASI series- Kluwer Academic publishers, 1995.

GE9023 FUNDAMENTALS OF NANOSCIENCE L T P C
3 0 0 3

AIM

To make the students understand the importance , relevance and potentialities of this emerging field of study.

OBJECTIVES

- Study the basic nano technology and nano science.
- Understand interdisciplinary nature of this field.
- Understand the importance role of physics, chemistry, biology.
- Recognize that the rules of nano science are fundamentally different than those we experience.
- Study the basic fabrication strategies of nano science.

UNIT I INTRODUCTION 10

Nanoscale Science and Technology- Implications for Physics, Chemistry, Biology and Engineering-Classifications of nanostructured materials- nano particles- quantum dots, nanowires-ultra-thinfilms-multilayered materials. Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic and Thermal properties. Introduction to properties and motivation for study (qualitative only).

UNIT II PREPARATION METHODS 10

Bottom-up Synthesis-Top-down Approach: Precipitation, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE.

UNIT III PATTERNING AND LITHOGRAPHY FOR NANOSCALE DEVICES 5

Introduction to optical/UV electron beam and X-ray Lithography systems and processes, Wet etching, dry (Plasma /reactive ion) etching, Etch resists-dip pen lithography

UNIT IV PREPARATION ENVIRONMENTS 10

Clean rooms: specifications and design, air and water purity, requirements for particular processes, Vibration free environments: Services and facilities required. Working practices, sample cleaning, Chemical purification, chemical and biological contamination, Safety issues, flammable and toxic hazards, biohazards.

UNIT V CHARECTERISATION TECHNIQUES 10

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation

TOTAL : 45 PERIODS

TEXT BOOKS

1. A.S. Edelstein and R.C. Cammearata, eds., "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Publishing, Bristol and Philadelphia, 1996.
2. N John Dinardo, "Nanoscale charecterisation of surfaces & Interfaces", 2nd Edition, Weinheim Cambridge, Wiley-VCH, 2000

REFERENCES

1. G Timp (Editor), "Nanotechnology", AIP press/Springer, 1999
2. Akhlesh Lakhtakia (Editor), "The Hand Book of Nano Technology,Nanometer Structure", Theory, Modeling and Simulations", Prentice-Hall of India (P) Ltd, New Delhi, 2007.

CT9033 FIBRES AND COMPOSITES L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a sound knowledge about the different types of ceramic fibres, composites, their properties and applications.

OBJECTIVES

On completion of the course the students are expected to

- Have studied the different fibre reinforcements, their manufacturing routes, properties and applications.
- Have studied the different types of matrices, its manufacturing techniques and properties.
- Have a basic knowledge about the types, manufacturing process and properties of composites.
- Have a basic knowledge about the properties of composite materials.
- Have a sound knowledge about the different types of whiskers.

UNIT I REINFORCEMENTS 9

Fibre definition, fibre flexibility; Glass fibres – types, manufacturing process, properties, glass wool forming process; Alumina fibres, mullite fibres, zirconia fibres, boron fibres, carbon fibres and graphite fibres – manufacturing techniques, properties and applications; Strength of reinforcements.

UNIT II TYPES OF MATRICES 9

Introduction, types – polymer, ceramic, metal, glass, thermosetting and thermoplastic matrices.

UNIT III COMPOSITES 9

Definition, classification – metal / polymer / ceramic matrix composites, particulate and fibre reinforcements – processing methods, microstructure. Carbon-carbon composites, nano composites**.**

UNIT IV PROPERTIES OF COMPOSITES 9

Elastic and strength properties – fracture behavior – fibre matrix load transfer – failure of a composite – criteria, damage of composites from physical and mechanisms to modeling, long term behavior of composite materials, high temperature stability – wear and friction.

UNIT V WHISKERS 9

Background of whisker growth – whisker nucleation and growth – composite processing – whisker purification, whisker / matrix poeder mixing, densification, SiC and Si_3N_4 whiskers, VLC synthesis, properties.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Anthony R.Bunsell and Marie-Helene Berger, Fine Ceramic Fibres, Marcel Dekker Inc., 1999.
2. Chawla K.K, Ceramic Matrix Composites, Chapman and Hall, 1993.

REFERENCES

1. Hull D and Clyne T.W, An Introduction to Composite Materials, 2nd Edn.,Cambridge University Press, 1996.
2. Bunsell A.R and Renard J, Fundamentals of Fine Fibre Reinforced Composite Materials, IOP Publishing Ltd., 2005.
3. Warren R, Ceramic Matrix Composites, Blackie, 1992.

CT9034 PLANT EQUIPMENT AND FURNACE DESIGN L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a sound knowledge about designing the layout of the plant and designing of furnaces.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the factors for selection of a plant layout.
- Have studied the ways of assembling the various sections in the plant for proper functioning.
- Have studied the principles of designing equipments.
- Have studied the principle and designing of furnaces.
- Have studied the construction of furnaces.

UNIT I PLANT DESIGN 9

Proper location of the plant- factors to be considered, factory buildings- layouts with necessary details.

UNIT II ASSEMBLING 9

Assembling of economics, engineering and industrial data, calculations and data necessary for the process route- electrical, piping instruments, motors, compressors etc- flow diagrams- process, design and overall technical report.

UNIT III EQUIPMENT DESIGN 9

Design principles- crushers, filter press, sieves, pugmill and different types of pug moulds- tunnel, chamber and electrical.

UNIT IV FURNACE DESIGN 9

Design of furnaces- tank furnace, tunnel kiln, chamber kiln, rotary kiln, muffle furnace, blast furnace, open hearth furnace, stack calculations- chimney foundations. Essential operations- firing, charging, melting, preheating- air, gas, fuel, flame systems, furnace high temperature measurements and temperature control instruments.

UNIT V FURNACE CONSTRUCTION 9

Furnace life and selection of proper refractories, thermal currents and atmosphere, safe firing schedule. Basic knowledge about furnace construction, capacity, fuel and firing efficiencies- design, construction and thermal calculation of one of the furnaces.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Sule D.R., Manufacturing Facilities: Location, Planning and Design, PWS- kent, Boston, 1988.
2. Karbandha O.P., Process, Plant and Equipment Costing, Savek Publishers, Bombay, 1977.

REFERENCES

1. Robert D Reed, Furnace Operation, Gulf Publishing Co., Paris, 1991.
2. Harold E Soissson, Instrumentation in Industry, John Wiley & Sons, NY, 1995.
3. Brownhell L.E. and Young E.H., Chemical Plant Design, McGraw Hill, 1950.

CT9035 NANOCERAMICS AND NANOCOMPOSITES L T P C
3 0 0 3

AIM

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

OBJECTIVES

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

UNIT I NANO SCIENCE AND TECHNOLOGY 9

General definition and size effects–important nano structured materials and nano particles-importance of nano materials- applications.

UNIT II SYNTHESIS & CONSOLIDATION 9

Precipitation methods – sol gel techniques –ball milling, CVD and PVD methods, gas phase condensation, magnetron sputtering and laser deposition methods.

UNIT III NANOCERAMICS 9

Introduction to nanoceamics- properties of nano ceramics- advanced nano ceramics- carbon nano tubes, fibres, nanosilica-nano alumina- nano titania and zinc oxide- applications.

UNIT IV NANO COMPOSITES 9

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

UNIT V CHARACTERIZATION METHODS 9

X-ray diffraction, Raman spectroscopy**-** UV- visible spectroscopy, scanning probe microscopy, atomic force microscopy, scanning electron microscopy and transmission electron microscopy techniques.

TOTAL: 45 PERIODS

TEXT BOOKS

1. R.H.J.Hannink & A.J.Hill, Nanostructure Control, Wood head Publishing Ltd.,Cambridge, 2006.
2. C.N.R.Rao, A.Muller, A.K.Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and Applications Vol. I & II, 2nd edition, 2005, Wiley VCH Verlag Gibtl & Co.

REFERENCES

1. J.Stows Hall, Nanofuture, Manas Publications, 2006.
2. Mick Wilson, Kamali Kannangara,Geoff Smith, Michelle Simmom, Burkhard Raguse, " Nano Technology: Basic Science & Engineering Technology", 2005, Overseas Press.
3. Karl.M.Kadish, Rodney S.Rnoff, " Fullereness : Chemistry, Physics and Technology", John Wiley & Son Inc. Publications, 2000.

CT9036 MECHANICAL BEHAVIOUR OF CERAMICS L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a detailed understanding about the behaviour of ceramic materials with different mechanical properties.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt in detail about the elastic property and brittle nature of ceramics.
- Have understood the fracture behaviour of ceramics.
- Have studied the behaviour of the materials in strength and engineering design.
- Have learnt the creep behaviour of ceramic materials.
- Have understood the thermal shock behaviour of the ceramic materials.

UNIT I ELASTIC BEHAVIOUR 7

Elastic constants – effect of atomic structure and microstructure. Response to stress – elastic deformation of isotropic and crystalline materials – measurement techniques.

UNIT II FRACTURE MECHANICS 8

Theoretical strength and stress concentrations, linear elastic fracture mechanics, micro structural aspects, fracture testing techniques.

UNIT III STRENGTH AND ENGINEERING DESIGN 10

Strength testing, statistical treatment to strength, time dependent strength behaviour – subcritical crack growth, stable crack propagation, cyclic fatigue – SPT diagram. Toughening of Ceramics.

UNIT IV CREEP BEHAVIOUR 10

Creep – definition, types – diffusion creep, dislocation creep, viscous creep. Microstructure dependence of creep, creep deformation maps.

UNIT V THERMAL BEHAVIOUR 10

Thermal stress, thermal shock resistance parameters, thermal stresses and cracking, testing technique, applications of thermal stress.

TOTAL: 45 PERIODS

TEXT BOOKS

1. John B.Wachtman, Mechanical Properties of Ceramics, John Wiley & Sons, New York, 1996.
2. Davidge R.W, Mechanical Behaviour of Ceramics, Ceramic Book Literature Service, London, 1979.

REFERENCES

1. Kingery W.D, Bowen H.K and Uhlmann D.R, Introduction to Ceramics, John Wiley & Sons, 1991.
2. Barsoum M.W, Fundamentals of Ceramics, McGraw-Hill, 1997.
3. Hasselman D.P.H and Heller R.A (eds.), Thermal Stresses in Severe Environments, Plenumn Press, 1989.

CT9037 NON DESTRUCTIVE TESTING L T P C
3 0 0 3

AIM

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

OBJECTIVES

On completion of the course the students are expected to

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

UNIT I SURFACE NDT METHODS 7

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

UNIT II RADIOGRAPHIC TESTING 12

Electromagnetic spectrum – sources - x-ray, gamma ray – x-ray generation, spectrum ,equipment controls, properties, attenuation and differential attenuation- interaction of radiation with matter – radiographic testing – principle and mechanism, recording medium-films and fluorescent screens- non-imaging detectors- film radiography detectors- film radiography- calculation of exposure for X-ray and gamma rays- quality factors- image quality indicators and their use in radiography.

UNIT III ULTRASONIC TESTING 11

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

UNIT IV EDDY CURRENT TESTING 8

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

UNIT V OTHER METHODS 7

Imaging- principle and applications- testing of composites- acoustic emission testing-application of AET- on-line monitoring or continuous surveillance and application in materials science- optical methods of NDT- photo elasticity- evaluation procedure- Holographic NDT procedure- Speckle phenomenon- speckle interferometry-speckle shear interferometry.

TOTAL: 45 PERIODS

TEXT BOOKS

1. B.Hull and V.John, Non Destructive Testing, McMillan Education Ltd, 1968.
2. Mc Gonnagle, W.J, Non-destructing testing methods, Mc Graw Hill Co., NY, 1961.

REFERENCES

1. Metals Handbook, Volume 2, 8th Edn, ASTM, Metals Park, Ohio.
2. Dainty, Laser Speckle & Related Phenomena, Springer – Verlag, New York, 1984.

CT9038 MICROWAVE PROCESSING OF CERAMICS L T P C
3 0 0 3

AIM

The course is aimed to enable the students to the basic concepts about processing the ceramic materials in microwave atmosphere.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the introduction about microwave processing.
- Have learnt the concepts of microwave heating circuit.
- Have learnt the applicator types of microwave.
- Have studied the industrial applications of microwave processing.
- Have studied the hazard and safety of microwave processing.

UNIT I INTRODUCTION 9

Dielectric Behavior of materials- power dissipation- propagation factor and skin depth- heat and mass transfer phenomena- temperature distribution- wall loss.

UNIT II MICROWAVE HEATING CIRCUIT 9

Power sources- klystron and magnetron- operating characteristics- protection system- high frequency breakdown phenomena- automatic control of the process- automation, tuning and machining.

UNIT III APPLICATION TYPES 9

Travelling wave applicators- multimode applications- power transfer- uniformity of heating.

UNIT IV INDUSTRIAL APPLICATIONS 9

Microwave drying- microwave sintering- application to laboratory models and pilot system- comparison with pilot heating.

UNIT V HAZARDS AND SAFETY 9

Exposure standards- industrial- frequency band- leakage from industrial equipment- batch system- continuous flow system- safety precautions.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Metaxas A.C and Meredith RJ, Industrial Microwave Heating, Peter Peregrinus Ltd., UK, 1983.
2. Snyder W.B, Sutton W.H, Iskander M.F and Johnson D.L (Ed), Microwave Processing of Materials, Volume I & II, MRS, Pittsburgh, 1991.

REFERENCES

1. Binner J.G.P (Ed), Advanced Ceramic Processing and Technology, Volume I, Noyes Publications, New Jersey, 1990.
2. Randall M German, Sintering Technology, Marcel Dekker, Inc, 1996.

CT9039 NUCLEAR & SPACE CERAMICS L T P C
3 0 0 3

AIM

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

OBJECTIVES

On completion of the course the students are expected to

- Have studied the basic concepts of nuclear physics.
- Have learnt about the nuclear reactors.
- Have studied in detail about the production and properties of various fuels.
- Have studied about the radiation protection.
- Have studied the basics about space ceramics.

UNIT I FUNDAMENTALS OF NUCLEAR CERAMICS 9

Atomic structure- atomic number- mass number- isotopes- nuclear energy and nuclear forces, binding energy- nuclear stability- radio activity- nuclear reactions- nuclear fission- nuclear fusion.

UNIT II NUCLEAR REACTORS 9

Types of reactors- ordinary water moderated reactors- heavy water cooled and moderated reactors- design, construction and control of nuclear reactors- moderators- coolants- reflectors and structural materials.

UNIT III FUELS 9

Methods of production and properties, uranium oxide, thorium oxide, beryllium oxides- encapsulation, nuclear fuel cycle, spent fuel characteristics, reprocessing techniques.

UNIT IV RADIATION PROTECTION 9

Types of waste- disposal- ICRP recommendations- radiation hazards and prevention- radiation dose units.

UNIT V SPACE CERAMICS 9

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

TOTAL: 45 PERIODS

TEXT BOOKS

1. Merrite L.C, Basic Principles of Nuclear Science and Reactors, Wiley Eastern, 1977.
2. Benedict M and Pigter T.A, Nuclear Chemical Engineering, McGraw Hill, 1981.

REFERENCES

1. Terpstra, Ceramic Processing, Chapman and Hall, 1995.
2. Gan-Moog, chow and Kenneth E Gonslaves, Nanotechnology, American Chemical Society, 1996.
3. Norton, F.H, Fine Ceramics, Technology and Applications, McGraw Hill, London, NY, 1970.

CT9040 ENTREPRENEURSHIP DEVELOPMENT L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about entrepreneurship and development in that area.

OBJECTIVES

On completion of the course the students are expected to

- Have studied the basic concepts of entrepreneurship and entrepreneurial environment.
- Have learnt about small business and preparation of feasibility chart.
- Have a basic knowledge about establishment of a business.
- Have learnt about how to manage a business unit.
- Have some basic concepts about promotion of entrepreneurship and practical knowledge about some case studies.

UNIT I ENTREPRENEURSHIP AND ENTREPRENEURIAL ENVIRONMENT 11

Definition of entrepreneurship, entrepreneur, entrepreneurial potentials, traits and types of entrepreneurs, differences between entrepreneur and intrapreneur, entrepreneurship as a career, business environment, roll of family/society in entrepreneur, institutional support to entrepreneurs, entrepreneur support organizations(financial and non-financial), entrepreneur training organizations, government policies about industrial and entrepreneur development, incentives and subsidies for industries.

UNIT II BUSINESS PLAN/FEASIBILITY REPORT PREPARATION 10

Small enterprises, definition, classification, characteristics, ownership structure, project history, project formulation, importance of feasibility report, format for preparation of business feasibility report, steps involved in setting up a business, sources of product identification, criteria for selection of products, selecting a good business opportunity, market survey and research, techno-economic feasibility assessment, preliminary project report, project appraisal, sources of information, classification of needs and agencies.

UNIT III ESTABLISHNMENT OF BUSINESS UNIT 9

Mobilization of sources (financial, personal and material), selection and training of human resource, purchase of project equipments and raw materials, plant location, infrastructure, building, installation of machinery, material production, marketing channel selection, commercialization of product, legal agents of business.

UNIT IV MANAGEMENT OF BUSINESS UNIT 8

Introduction to general management, financial management, management accounting, production management, human resource development, marketing management, organization development, TQM-ISO 9000 series, sickness of industries, strategies for closing business.

UNIT V PROMOTION OF ENTREPRENEURSHIP AND CASE STUDIES 7

Risk taking and decision making, role of government agencies like DIC, TIIC, SIDCO, SIPCOT, TIDCO, SISI, NSIC, IFC, ITCOT, banks, etc., case study of a successful entrepreneur, case studies on identification and selection of products, preparation of project feasibility report, establishment of business unit and sickness of business unit.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Khanka, S.S Entrepreneurial Development, S. Chand and Co., New Delhi, 1999.
2. Saravanavel,P., Entrepreneurship Development, Ess Pee Kay Publishing House, Madras, 1987.

CT9041 COMPUTER AIDED DESIGN L T P C
3 0 0 3

AIM

The course is aimed to enable the students to have a basic knowledge about designing of equipment and instruments by computers.

OBJECTIVES

On completion of the course the students are expected to

- Have learnt the concepts about computers.
- Have studied some fundamentals of finite element analysis.
- Have studied about the basic solid modeling using computers.
- Have some practical knowledge of designing equipments using computers.
- Have a basic knowledge in doing graphics.

UNIT I INTRODUCTION 9

Introduction to microprocessors- input, output and memory devices- interfacing concepts, evaluation of OS- functions and characteristics. Fundamentals of computer aided design- requirements of hardware and software- the design process steps-morphology of design.

UNIT II FINITE ELEMENT ANALYSIS 9

Fundamentals of finite element analysis- element types- nodal approximation- element matrices, vectors and equations- global connectivity-assembly-boundary conditions- solution techniques- introduction to packages.

UNIT III SOLID MODELLING 9

Geometric modeling- wireframe, surface and solid models- techniques- solid modelling packages- interface to drafting, design analysis and CNC- rapid prototyping.

UNIT IV EQUIPMENT DESIGN 9

Computer aided design of size reduction equipments, dryers, filters and centrifuges, shaping machines, furnaces.

UNIT V COMPUTER GRAPHICS 9

Analysis of design data- creating a basic graph - different display techniques- labeling the axes- plotting the data- logarithmic graphs- bar graphs.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Groover and Zimmers, CAD/CAM; Computer Aided Design and Manufacturing, Prentice Hall of India, New Delhi, 1994.
2. Radhakrishnan P and Kothandaraman C.P., Computer Graphics and Design, Dhanpatraj and Sons, New Delhi, 1991.

REFERENCES

1. Rogers D.F and Adams J.A., Mathematical Elements in Computer Graphics, McGraw Hill, NY, 1976.
2. Delchambre, CAD Method for Industrial Assembly, John Wiley & Sons, England, 1996.
3. M.V.Joshi and V.V.Mahajani, Process Equipment Design, Macmillan India Ltd., 1997.
4. Mano M., Computer System Architecture, Prentice Hall of India, New Delhi, 1994.
5. Daniel L. Ryan, Computer Aided Graphics and Design, Marcel Dekker Inc., NY, 1985.

GE9021 PROFESSIONAL ETHICS IN ENGINEERING L T P C
3 0 0 3

AIM

To sensitize the engineering students on blending both technical and ethical responsibilities.

OBJECTIVES

- Identify the core values that shape the ethical behavior of an engineer.
- Utilize opportunities to explore one's own values in ethical issues.
- Become aware of ethical concerns and conflicts.
- Enhance familiarity with codes of conduct.
- Increase the ability to recognize and resolve ethical dilemmas.

UNIT I ENGINEERING ETHICS 9

Senses of 'Engineering Ethics' – Variety of moral issues – Types of inquiry – Moral dilemmas – Moral Autonomy – Kohlberg's theory – Gilligan's theory – Consensus and Controversy – Professions and Professionalism – Professional Ideals and Virtues – Uses of Ethical Theories.

UNIT II ENGINEERING AS SOCIAL EXPERIMENTATION 9

Engineering as Experimentation – Engineers as responsible Experimenters – Research Ethics - Codes of Ethics – Industrial Standards - A Balanced Outlook on Law – The Challenger Case Study

UNIT III ENGINEER'S RESPONSIBILITY FOR SAFETY 9

Safety and Risk – Assessment of Safety and Risk – Risk Benefit Analysis – Reducing Risk – The Government Regulator's Approach to Risk - Chernobyl Case Studies and Bhopal

UNIT IV RESPONSIBILITIES AND RIGHTS 9

Collegiality and Loyalty – Respect for Authority – Collective Bargaining – Confidentiality – Conflicts of Interest – Occupational Crime – Professional Rights – Employee Rights – Intellectual Property Rights (IPR) - Discrimination

UNIT V GLOBAL ISSUES 9

Multinational Corporations – Business Ethics - Environmental Ethics – Computer Ethics - Role in Technological Development – Weapons Development – Engineers as Managers – Consulting Engineers – Engineers as Expert Witnesses and Advisors – Honesty – Moral Leadership – Sample Code of Conduct

TOTAL: 45 PERIODS

TEXT BOOKS

1. Mike Martin and Roland Schinzinger, "Ethics in Engineering", McGraw Hill, New York (2005).
2. Charles E Harris, Michael S Pritchard and Michael J Rabins, "Engineering Ethics Concepts and Cases", Thompson Learning, (2000).

REFERENCES

1. Charles D Fleddermann, "Engineering Ethics", Prentice Hall, New Mexico, (1999).
2. John R Boatright, "Ethics and the Conduct of Business", Pearson Education, (2003)
3. Edmund G Seebauer and Robert L Barry, "Fundamentals of Ethics for Scientists and Engineers", Oxford University Press, (2001)
4. Prof. (Col) P S Bajaj and Dr. Raj Agrawal, "Business Ethics – An Indian Perspective", Biztantra, New Delhi, (2004)
5. David Ermann and Michele S Shauf, "Computers, Ethics and Society", Oxford University Press, (2003)

GE9022 TOTAL QUALITY MANAGEMENT L T P C
3 0 0 3

AIM

To provide comprehensive knowledge about the principles, practices, tools and techniques of Total quality management.

OBJECTIVES

- To under the various principles, practices of TQM to achieve quality
- To learn the various statistical approaches for quality control.
- To understand the TQM tools for continuous process improvement.
- To learn the importance of ISO and Quality systems.

UNIT I INTRODUCTION 9

Introduction - Need for quality - Evolution of quality - Definition of quality - Dimensions of manufacturing and service quality - Basic concepts of TQM - Definition of TQM – TQM Framework - Contributions of Deming, Juran and Crosby – Barriers to TQM.

UNIT II TQM PRINCIPLES 9

Leadership – Strategic quality planning, Quality statements - Customer focus – Customer orientation, Customer satisfaction, Customer complaints, Customer retention - Employee involvement – Motivation, Empowerment, Team and Teamwork, Recognition and Reward, Performance appraisal - Continuous process improvement – PDSA cycle, 5s, Kaizen - Supplier partnership – Partnering, Supplier selection, Supplier Rating.

UNIT III TQM TOOLS & TECHNIQUES I 9

The seven traditional tools of quality – New management tools – Six-sigma: Concepts, methodology, applications to manufacturing, service sector including IT – Bench marking – Reason to bench mark, Bench marking process – FMEA – Stages, Types.

UNIT IV TQM TOOLS & TECHNIQUES II 9

Quality circles – Quality Function Deployment (QFD) – Taguchi quality loss function – TPM – Concepts, improvement needs – Cost of Quality – Performance measures.

UNIT V QUALITY SYSTEMS 9

Need for ISO 9000- ISO 9000-2000 Quality System – Elements, Documentation, Quality auditing- QS 9000 – ISO 14000 – Concepts, Requirements and Benefits – Case studies of TQM implementation in manufacturing and service sectors including IT.

TOTAL: 45 PERIODS

TEXT BOOK

1. Dale H.Besterfiled, et at., “Total Quality Management”, Pearson Education Asia,Third Edition, Indian Reprint (2006).

REFERENCES

1. James R. Evans and William M. Lindsay, “The Management and Control of Quality”, 6th Edition, South-Western (Thomson Learning), 2005.
2. Oakland, J.S. “TQM – Text with Cases”, Butterworth – Heinemann Ltd., Oxford, 3rd Edition, 2003.
3. Suganthi,L and Anand Samuel, “Total Quality Management”, Prentice Hall (India) Pvt. Ltd.,2006.
4. Janakiraman,B and Gopal, R.K, “Total Quality Management – Text and Cases”, Prentice Hall (India) Pvt. Ltd., 2006.

GE9261 ENVIRONMENTAL SCIENCE AND ENGINEERING
(Common to all branches) **L T P C**
3 0 0 3

AIM

The aim of this course is to create awareness in every engineering graduate about the importance of environment, the effect of technology on the environment and ecological balance and make them sensitive to the environment problems in every professional endeavour that they participate.

OBJECTIVE

- At the end of this course the student is expected to understand what constitutes the environment, what are the precious resources in the environment, how to conserve these resources, what is the role of a human being in maintaining a clean environment and useful environment for the future generations and how to maintain ecological balance and preserve bio-diversity and the role of government and non-government organization in environment managements.

UNIT I ENVIRONMENT, ECOSYSTEMS AND BIODIVERSITY 14

Definition, scope and importance of environment – need for public awareness - concept of an ecosystem – structure and function of an ecosystem – producers, consumers and decomposers – energy flow in the ecosystem – ecological succession – food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the (a) forest ecosystem (b) grassland ecosystem (c) desert ecosystem (d) aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries) – Introduction to biodiversity definition: genetic, species and ecosystem diversity – biogeographical classification of India – value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values – Biodiversity at global, national and local levels – India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts – endangered and endemic species of India – conservation of biodiversity: In-situ and ex-situ conservation of biodiversity.

Field study of common plants, insects, birds

Field study of simple ecosystems – pond, river, hill slopes, etc.

UNIT II ENVIRONMENTAL POLLUTION 8

Definition – causes, effects and control measures of: (a) Air pollution (b) Water pollution (c) Soil pollution (d) Marine pollution (e) Noise pollution (f) Thermal pollution (g) Nuclear hazards – soil waste management: causes, effects and control measures of municipal solid wastes – role of an individual in prevention of pollution – pollution case studies – disaster management: floods, earthquake, cyclone and landslides.

Field study of local polluted site – Urban / Rural / Industrial / Agricultural.

UNIT III NATURAL RESOURCES 10

Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people – Water resources: Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems – Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies – Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles.

Field study of local area to document environmental assets – river / forest / grassland / hill / mountain.

UNIT IV SOCIAL ISSUES AND THE ENVIRONMENT 7

From unsustainable to sustainable development – urban problems related to energy – water conservation, rain water harvesting, watershed management – resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products – environment production act – Air (Prevention and Control of Pollution) act – Water (Prevention and control of Pollution) act – Wildlife protection act – Forest conservation act – enforcement machinery involved in environmental legislation- central and state pollution control boards- Public awareness.

UNIT V HUMAN POPULATION AND THE ENVIRONMENT 6

Population growth, variation among nations – population explosion – family welfare programme – environment and human health – human rights – value education – HIV / AIDS – women and child welfare – role of information technology in environment and human health – Case studies.

TOTAL: 45 PERIODS

TEXT BOOKS

1. Gilbert M.Masters, 'Introduction to Environmental Engineering and Science', 2nd edition, Pearson Education (2004).
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, (2006).

REFERENCES

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice hall of India PVT LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press (2005)

IB9309 PROCESS ECONOMICS & INDUSTRIAL MANAGEMENT L T P C
3 0 0 3

AIM

To introduce process economics and industrial management principles to chemical engineers.

OBJECTIVES

- The objective of this course is to teach principles of cost estimation, feasibility analysis, management, organization and quality control that will enable the students to perform as efficient managers.

UNIT I PRINCIPLES OF PRODUCTION MANAGEMENT AND ORGANISATION 15

Planning, organization, staffing, coordination, directing, controlling, communicating, organization as a process and a structure; types of organizationsMethod study; work measurement techniques; basic procedure; motion study; motion economy; principles of time study; elements of production control; forecasting; planning; routing; scheduling; dispatching; costs and costs control, inventory and inventory control.

UNIT II ENGINEERING ECONOMICS FOR PROCESS ENGINEERS - INTEREST, INVESTMENT COSTS AND COST ESTIMATION 10

Time Value of money; capital costs and depreciation, estimation of capital cost, manufacturing costs and working capital, invested capital and profitability.

UNIT III PROFITABILITY, INVESTMENT ALTERNATIVE AND REPLACEMENT 8

Estimation of project profitability, sensitivity analysis; investment alternatives; replacement policy; forecasting sales; inflation and its impact.

UNIT IV ANNUAL REPORTS AND ANALYSIS OF PERFORMANCE 4

Principles of accounting; balance sheet; income statement; financial ratios; analysis of performance and growth.

UNIT V ECONOMIC BALANCE AND QUALITY AND QUALITY CONTROL 8

Essentials of economic balance – Economic balance approach, economic balance for insulation, evaporation, heat transfer.

Elements of quality control, role of control charts in production and quality control.

TOTAL : 45 PERIODS

TEXT BOOKS

1. Peters, M. S. and Timmerhaus, C. D., " Plant Design and Economics for Chemical Engineers ", 5th Edn., McGraw Hill, 2002.
2. Holand, F.A., Watson, F.A. and Wilkinson, J.K., " Introduction to process Economics ", 2nd Edn., John Wiley, 1983.
3. Narang, G.B.S. and Kumar, V., " Production and Costing ", Khanna Publishers, New Delhi, 1988.

REFERENCES

1. Allen, L.A., " Management and Organization", McGraw Hill.
2. Perry, R. H. and Green, D., " Chemical Engineer's Handbook ", 7th Edn., McGraw Hill.