Syllabus of

UNDERGRADUATE DEGREE COURSE

Ceramic Engineering

Rajasthan Technical University, Kota

Effective from session: 2018 – 2019

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

II Year-IV Semester: B. Tech. (Ceramic Engineering)

4CR2-01: Advanced Engineering Mathematics-II

Credit 2 **Max. Marks: 100(IA:20, ETE:80)**
2L+0T+0P **End Term Exam: 2 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Complex Analysis:** Differentiability and Analytic functions, Cauchy-Riemann equations (Cartesian and Polar form), Harmonic functions. Conformal mapping. Complex Line integral, M-L inequality, Cauchy theorem, Morera's theorem, Cauchy integral formulae, Taylor series and Laurent series. Singularities and Zeros, residues at poles and infinity, residues at isolated essential singular point, Cauchy residue theorem, evaluation of real definite integrals and improper integrals.	13
3	**Special Functions:** Legendre's function, Rodrigues formula, generating function, Simple recurrence relations, orthogonal property. Bessel's functions of first and second kind, generating functions, simple recurrence relations, orthogonal property.	12
	Total	26

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Syllabus

II Year-IV Semester: B. Tech. (Ceramic Engineering)

4CR1-02/3CR1-03 : Managerial Economics and Financial Accounting

Credit: 2 **Max. Marks: 100(IA:20, ETE:80)**

2L+0T+0P **End Term Exam: 2 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Basic economic concepts-** Meaning, nature and scope of economics, deductive vs inductive methods, static and dynamics, Economic problems: scarcity and choice, circular flow of economic activity, national income-concepts and measurement.	3
3	**Demand and Supply analysis-** Demand-types of demand, determinants of demand, demand function, elasticity of demand, demand forecasting –purpose, determinants and methods, Supply-determinants of supply, supply function, elasticity of supply.	5
4	**Production and Cost analysis-** Theory of production- production function, law of variable proportions, laws of returns to scale, production optimization, least cost combination of inputs, isoquants. Cost concepts-explicit and implicit cost, fixed and variable cost, opportunity cost, sunk costs, cost function, cost curves, cost and output decisions, cost estimation.	5
5	**Market structure and pricing theory**- Perfect competition, Monopoly, Monopolistic competition, Oligopoly.	4
6	**Financial statement analysis-** Balance sheet and related concepts, profit and loss statement and related concepts, financial ratio analysis, cash-flow analysis, funds-flow analysis, comparative financial statement, analysis and interpretation of financial statements, capital budgeting techniques.	8
	Total	26

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Syllabus

II Year-IV Semester: B. Tech. (Ceramic Engineering)

4CR1-03/3CR1-02 : Technical Communication

Credit: 2 **Max. Marks: 100(IA:20, ETE:80)**

2L+0T+0P **End Term Exam: 2 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Introduction to Technical Communication-** Definition of technical communication, Aspects of technical communication, forms of technical communication, importance of technical communication, technical communication skills (Listening, speaking, writing, reading writing), linguistic ability, style in technical communication.	3
3	**Comprehension of Technical Materials/Texts and Information Design & development-** Reading of technical texts, Readingand comprehending instructions and technical manuals, Interpreting and summarizing technical texts, Note-making. Introduction of different kinds of technical documents, Information collection, factors affecting information and document design, Strategies for organization, Information design and writing for print and online media.	6
4	**Technical Writing, Grammar and Editing**- Technical writing process, forms of technical discourse, Writing, drafts and revising, Basics of grammar, common error in writing and speaking, Study of advanced grammar, Editing strategies to achieve appropriate technical style, Introduction to advanced technical communication. Planning, drafting and writing Official Notes, Letters, E-mail, Resume, Job Application, Minutes of Meetings.	8
5	**Advanced Technical Writing**- Technical Reports, types of technical reports, Characteristics and formats and structure of technical reports. Technical Project Proposals, types of technical proposals, Characteristics and formats and structure of technical proposals. Technical Articles, types of technical articles, Writing strategies, structure and formats of technical articles.	8
	Total	26

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4CR3-04: Theory of Solid Mechanics

Credit 2 **Max. Marks: 100(IA:20, ETE:80)**

2L+0T+0P **End Term Exam: 2 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Stress-strain:** Tensile, compressive, shear stress and strain, stress-strain diagram. Stress-strain Relationships: Hooke's law, Poisson's ratio, elastic constants and their relationships for isotropic homogeneous material, thermal stresses.	5
3	Composites bars, simple elastic, plastic and visco-elastic behavior of common materials in tension and compression test, concept of factor of safety and permissible stress.Mohr's circle of stress and strain, a brief theory of elastic failures.	6
4	Types of load, types of beams, Introduction to bending moment and shear force diagrams. bending stress and shear stress distributions in various sections viz. circular, hollow, T etc.Torsional shear stress in solid, hollow and stepped circular shafts; concept of equivalent bending and equivalent twisting moment.	5
5	**Vibration:** Degree of freedom for dynamic analysis, single degree of freedom system, force-displacement relation: linearly elastic system and inelastic system, damping force. Equation of motion: external force, application of Newton's second law of motion, dynamic equilibrium stiffness, damping and mass components, mass-spring damper systems. Free Vibration: Un-damped, viscously damped free vibration: types of motion, under-damped systems, decay of motion, free vibration tests.	6
6	**Friction:** Laws of static, dynamic and rolling friction, dry & viscous friction, inclined plane and screw jack, friction axis, bearing and theory of film lubrication, Clutches. Introduction to thin and thick walled cylinders, energy methods (Castigliano's Theorems).	5
	Total	28

4CR4-05: Ceramic Analysis and Instrumentation

Credit 3 **Max. Marks: 150(IA:30, ETE:120)**
3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Crystallography:** Continuous and characteristic emission of X-rays, absorption filters, diffraction, Bragg's Law powder and single crystal X-ray diffractometer, atomic scattering factor,geometrical structure factor. Indexing of diffraction patterns, determination of structure and lattice parameters. Applications of XRD & XRF: Applications of X-ray diffraction in ceramic systems, X-ray fluorescence (XRF).	7
3	**Spectroscopic Analysis:** Introduction, absorption and reflection techniques, atomic techniques: emission, absorption and fluorescence, Photo acoustic spectroscopy, Microwave spectroscopy and mass spectrometers. Atomic Absorption spectrometer, IR, FTIR and Raman– Basic principle, instrumentation and analysis of data.	8
4	**Gas and Liquid Analysis:** Infrared and ultraviolet absorption analyzers, Paramagnetic oxygen analyzers, Thermal conductivity analyzers, Chemical luminescence analyzers and flame photometer and its uses in analysis. PH meters, conductivity meter, analyzers for measurement of ammonia, silica, sodium and dissolved oxygen.	7
5	**Electron Microscopy**: Principle, construction and operation of scanning electron microscope (SEM), Principle construction and working of transmission electron microscope (TEM), electron diffraction, bright field and dark field images, SAD, sample preparation of ceramic materials for SEM, TEM and EPMA.	8
6	**Particle Size:** Light scattering, Coulter counter, sieving, X-ray line broadening and sedimentation method for particle size measurements, surface area and porosity measurements, BET surface area measurements, gas adsorption, Mercury porosimetry and pycnometry for porosity of powders.	9
	Total	40

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

II Year-IV Semester: B. Tech. (Ceramic Engineering)

4CR4-06: Electric Properties of Materials

Credit 2 **Max. Marks: 100(IA:20, ETE:80)**

2L+0T+0P **End Term Exam: 2 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Band Theory & Solids:** Conductivity of metals, Mattheisen's rule, Sommer field model, Band theory of solids, Kronig-Penny model, origin of energy gap, Brillouin zones, distinction between metals, insulators and semiconductors, direct experimental evidence for band structure. Semiconductivity, temperature dependence of carrier concentration, factor that affect carrier mobility, Hall effect.	6
3	**Magnetic Materials:** Classification of magnetic materials, ferromagnetism, diamagnetism and paramagnetism, origin of ferromagnetism and hysteresis loop, domain and magnetic anisotropy, magnetostriction, ferrimagnetic compounds, spinel, garnet.Properties: High temperature susceptibilities, Specific heat and thermal conductivity. Soft and hard magnetic materials and their applications.	6
4	**Polarization & Dielectric Materials In Static Fields:** Introduction. Polar and non-polar dielectrics, polarization of dielectric, Clausius-Mossoti equation, Measurement of dielectric constant.	4
5	**Dielectric Material In Dynamic Fields:** Polarisabiltiy, frequency and temperature dependence of polarisability, dielectric relaxation. Dielectric losses and Breakdown of dielectrics, Electrets. Losses atmicrowave, IR & Optical frequencies.	4
6	**Piezoelectric:** Piezoelectric effect: Introduction, theory and application of piezoelectric crystals. Ferroelectric effect: Introduction, ferroelectric crystals, change in crystal structure during polarization, theory of ferro-electricity, ferroelectric domain, difference between ferroelectric and ferromagnetic domain, use of ferroelectric materials.	7
	Total	28

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

II Year-IV Semester: B. Tech. (Ceramic Engineering)

4CR4-07: Heat and Mass Transfer

Credit 2 **Max. Marks: 100(IA:20, ETE:80)**

2L+0T+0P **End Term Exam: 2 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Conduction:** Heat transfer by conduction. Fourier's law, thermal resistances in series, conduction through infinites slab, thick walled cylinder and thick sphere, variation of conductivity with temperature. Convection: Heat transfer through liquid. Newton's law, film coefficient, natural and forced, overall heat transfer coefficient, heat transfer coefficient based on inside and outside areas, dirt and foul factors, elementary concepts of dimensionless numbers, their use in predicting film coefficient, heat transfer to liquid under laminar and turbulent flows, forced convection outside tubes. Radiation and furnace: Stefan-Boltzmann law, emissivity and absorbability, black and grey bodies, view factors, gas radiation, radiant heat transfer in glass melting.	6
3	**Furnaces:** solid, liquid and gaseous fuels, their feeding devices, primary and secondary air for combustion, complete and partial combustion, calculation of radiant heat transfer in furnaces. Fuel gas: analysis and its utility, purpose of furnace linings and higher chimneys, application to steam boilers.	5
4	**Heat Exchanger:** Shell and tube heat exchangers, baffles, design of heat exchanger and their relative advantages, multi pass heat exchangers. LMTD: Mean temperature difference in co-current and countercurrent flows, LMTD correction factor for multi pass heat exchanger, plate heat exchanger, current, counter current and cross-flow heat exchangers.	5
5	**Diffusion and Diffusivity:** Fick's law, mass and molar rates of flow, different velocities and fluxes under static and moving co-ordinate system, concentration gradients in dimensional concurrentand counter current flows, two film theory, analogy between mass momentum and heat transfer. Mass transfer co-efficients: Mass transfer co-efficients, their experimental determination, use of dimensionless numbers, Sherwood, Lewis, Schmidt numbers. Absorption: absorption and desorption in packed beds and in plate columns, relative advantages.	6
6	**Drying:** Internal flow of moisture within the solids surface evaporation drying shrinkage estimation of drying rates and achievement of maximum drying rate.Dryers: Detail study of the various driers used in ceramic industries; tray driers, tunnel driers drum driers vacuum driers and spray driers.	5
	Total	28

4CR4-08: Fuels, Furnaces and Pyrometers

Credit 2 **Max. Marks: 100(IA:20, ETE:80)**
2L+0T+0P **End Term Exam: 2 Hours**

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**History of kilns:** Traditional & energy efficient kilns.	4
3	**Fuel:** Characteristics & classification of solid, liquid & gaseous fuels, solid fuels-wood& charcoals, coal, liquid -petroleum fuels, gaseous fuels –coal gas, water gas, producer gas, natural gas, LPG. Electrical Heating**:** nichrome & kanthal, super kanthal, silicon carbide, molybdenum silicide. Selection of fuels: selection of fuels in ceramic Industries.	6
4	**Combustion & Heat saving devices:** Chemistry of combustion, types of combustion, combustion of solids, liquid and gaseous fuels, fuels-flame characteristics, fluidized bed, combustion devices. regenerators, recuperators.	5
5	**Firing:** Firing of ceramic wares, ideal firing curves, setting of wares in kilns, operation & trouble shooting in ceramic kilns. Temperature measuring devices i.e. thermocouple, radiation and optical pyrometer.	5
6	**Kilns:** Classification, design and description of different types of furnaces used in ceramic Industries as downdraft kiln, Shuttle kiln, chamber furnace, tunnel kiln, Roller kilns, glass tank furnace, rotary kiln, energy auditing & management in oil & gas fired kilns. Heat balance in shuttle & tunnel kilns.	7
	Total	28

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

II Year-IV Semester: B. Tech. (Ceramic Engineering)

4CR4-09: Cement Technology

Credit 2
2L+0T+0P

Max. Marks: 100(IA:20, ETE:80)
End Term Exam: 2 Hours

SN	Contents	Hours
1	**Introduction:** Objective, scope and outcome of the course.	1
2	**Introduction:** Origin and development of cement and cementatious materials. Batch preparation**:** Raw materials and their classification, selection of raw materials, crushing of lime stone and other calcareous materials, proportioning of raw materials, grinding of raw materials and preparation of raw meal, blending & beneficiations of raw materials.	5
3	**Lime:** Different classes of building lime and their properties. Processing: Burning of raw mix, reactions occurring in cement making at different temperature, preheater and pre-calcinators in cement industry, heat recovery devices and waste heat utilization, Firingsystem and kiln residence time. Working of rotary kiln and clinkering reactions, clinker coolers. Clinker and their storage, cement grinding mills, cement storage and silos, conveying, packing and dispatch of cement, cement packing machines. Dust and dust collection in cement industries.	6
4	**Concrete & Testing:** Introduction, classification, properties of concrete, grades of concrete, advantages and disadvantages of concrete, concept of quality control, concrete industry, challengesfaced by concrete industries. Testing of cement.	5
5	**Types of cements**: Different types of cement:- Quick setting cement, low heat cement, blast furnace slag cement, trief cement , sorrel cement, white and colored cement, Iron ore cement, oil well cement, hydrophobic cement, water proof cement. Masonry cement, expanding and self stressingcement, sulphate resisting cement, super sulphate cement, high alumina and other refractory cements, refractorycastables, pozzolana and pozzolanic cements.	7
6	**Gypsum:** Gypsum, plaster of paris (POP), its properties and uses, manufacture of plaster of paris, setting and hardening of plaster of paris.	4
	Total	**28**

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Syllabus

II Year-IV Semester: B. Tech. (Ceramic Engineering)

4CR4-21: Ceramic Analysis and Instrumentation Lab

Credit 1.5 **Max. Marks: 75(IA:45, ETE:30)**
0L+0T+3P

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

4CR4-22: Electric Properties of Materials Lab

Credit 1.5 **Max. Marks: 75(IA:45, ETE:30)**
0L+0T+3P

1. Study of temperature dependent conductivity of insulator/semiconductor.
2. Determination of band gap of insulator/semiconductor.
3. Determine the initial permeability of given sample.
4. Study of hysteresis behaviour of ferro/ferri magnetic material.
5. Determination of dielectric constant and loss of dielectric.
6. Study of frequency dependent dielectric behaviour of dielectric.
7. Determination of relaxation time of given dielectric material.
8. Determination of curie temperature of given ferromagnetic sample.

4CR4-23: Heat and Mass Transfer Lab

Credit 1.5 **Max. Marks: 75(IA:45, ETE:30)**

0L+0T+3P

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

4CR4-24: Cement Lab

Credit 1.5 **Max. Marks: 75(IA:45, ETE:30)**

0L+0T+3P

1. Determination of consistency of standard cement paste.
2. Determination of Initial setting time and final setting time of given mix.
3. Determination of fineness of cement by dry sieving.
4. Determination of specific gravity of cement.
5. Determination of tensile strength of cement.
6. Mixing of plaster & making of moulds for slip casting.
7. Determination of setting time of given plaster of paris
8. Determination of soundness of cement by autoclave test method.
9. Determination of compressive strength of cement.
10. Workability of concrete.
11. Chemical analysis of ordinary portland cement.

4CR8-00: Social Outreach Discipline &Extra Curricular Activities

Credit 0.5 **Max. Marks: 25**