Syllabus of

UNDERGRADUATE DEGREE COURSE

Ceramic Engineering

Rajasthan Technical University, Kota

Effective from session: 2018 – 2019

RAJASTHAN TECHNICAL UNIVERSITY, KOTA

Syllabus

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

3CR2-01: Advanced Engineering Mathematics-I

Credit: 3 **Max. Marks: 150(IA:30, ETE:120)**

3L+0T+0P **End Term Exam: 3 Hours**

SN	Contents	Hours
1	**Numerical Methods–1:** Finite differences, Relation between operators, Interpolation using Newton's forward and backward difference formulae. Gauss's forward and backward interpolation formulae. Stirling's Formulae. Interpolation with unequal intervals: Newton's divided difference and Lagrange'sformulae. Numerical Differentiation, Numerical integration: Trapezoidal rule and Simpson's 1/3rd and 3/8 rules.	**10**
2	**Numerical Methods–2:** Numerical solution of ordinary differential equations: Taylor's series, Euler and modified Euler's methods. Runge- Kutta method of fourth order for solving first and second order equations. Milne's and Adam's predicator-corrector methods. Solution of polynomial and transcendental equations-Bisection method, Newton-Raphson method and Regula-Falsi method.	**08**
3	**Laplace Transform:** Definition and existence of Laplace transform, Properties of Laplace Transform and formulae, Unit Step function, Dirac Delta function, Heaviside function, Laplace transform of periodic functions. Finding inverse Laplace transform by different methods, convolution theorem. Evaluation of integrals by Laplace transform, solving ODEs by Laplace transforms method.	**10**
4	**Fourier Transform:** Fourier Complex, Sine and Cosine transform, properties and formulae, inverse Fourier transforms, Convolution theorem, application of Fourier transforms to partial ordinary differential equation (One dimensional heat and wave equations only).	**7**
5	**Z-Transform:** Definition, properties and formulae, Convolution theorem, inverse Z-transform, application of Z-transform to difference equation.	**5**
	Total	**40**

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

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

SN	Contents	Hours
1	**Introduction 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.	4
2	**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
3	**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
4	**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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3CR1-03/ 4CR1-03: 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	**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.	4
2	**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
3	**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
4	**Market structure and pricing theory**- Perfect competition, Monopoly, Monopolistic competition, Oligopoly.	4
5	**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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3CR3-04 Electronic Measurement & Instrumentation

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

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

SN	Contents	Hours
1	**Theory of errors:** Accuracy & precision, repeatability, limits of errors, systematic & random errors modeling of errors, probable error & standard deviation, Gaussian error analysis, combination of errors.	6
2	**Electronic Instruments for measuring basic parameters:** Electronic voltmeter, electronic multimeters, digital voltmeter, component measuring instruments, Q meter, vector impedance meter, RF power & voltage measurements, measurement of frequency. Introduction to shielding & grounding.	6
3	**Oscilloscopes:** CRT construction, basic CRO circuits, CRO probes, oscilloscope techniques of measurement of frequency, phase angle and time delay, Types of Oscilloscopes: Multibeam, multi trace, storage & sampling, oscilloscopes, curve tracers.	6
4	**Signal generation:** Sine wave generators, frequency synthesized signal generators, sweep frequency generators. Signal Analysis: Measurement technique, wave analyzers, frequency – selective wave analyser, heterodyne wave analyser, harmonic distortion analyser, spectrum analyser.	5
5	**Transducers:** Introduction, classification, selection criteria, characteristics, construction, working principles, Application of Transducers- RTD, thermocouples, thermistors, LVDT, RVDT, strain gauges, bourdon tubes, bellows, diaphragms, seismic accelerometers, tachogenerators, load cell, piezoelectric transducers, ultrasonic flow meters.	5
	Total	**28**

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3CR4-05: Introduction to Ceramics

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

SN	Contents	Hours
1	**Introduction to Ceramics:** Definition, classification and scope of ceramics, ceramics versus metals and organics, historical perspective on the development of ceramics and ceramic industries. advanced ceramics versus traditional ceramics.Refractories, whitewares, cement, etc. Elementary ideas of their manufacture and applications. Basic glass processing, container glass, fibre glass, speciality glass products, glassceramics, glass microspheres, laminated glass, photochrome and photo sensitive glass modern / high tech ceramics, high tech functions and functional ceramics, structural ceramics, electrical and electronic ceramics, chemical and nuclear ceramics, bio-ceramics, ceramic membranes, artificial gems and ceramics, aerospace and other strategic application.	8
2	**Forming of ceramics and powder consolidation method**: Introduction, characteristics of solid particles, particle shapes, size, equivalent particle diameter, surface area, average particle size & size distribution.	5
3	**Binders & Additives:** Packing of particles, additives in forming processes, selection of additives; solvent, binder, plasticizers, deflocculants and lubricant.	5
4	**Dry and semidry pressing methods:** Dry and semidry pressing methods, die compaction and isostaticcompaction,Casting methods: slip casting, pressure casting and tape casting.Plastic forming method: extrusion and injection molding.	5
5	**Drying &Calcination:** Drying of cast or extruded articles, binder removal, calcinations & affecting factors.Sintering: Introduction to sintering of ceramics, hot and iso-static processing of ceramics.	5
	Total	28

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3CR4-06: Ceramic Raw Materials and Characterization

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

SN	Contents	Hours
1	**Rocks Types:** Various types of rocks; igneous, sedimentary and metamorphic, Structures rocks: Textures, Structures and classification of above rocks, Origin of igneous, sedimentary and metamorphic rocks,Geology and its utility in ceramic industry.	6
2	**Ceramic Minerals:** Description and classification of various minerals based on their chemical compositions, Physical properties and occurrence.Brief idea on processing of synthetic raw materials: Bayer process, Calcined Alumina, Tabular Alumina, Fused Alumina, Sea-water Magnesia, Zircon and Zirconia, Titania, Magnesio-Aluminate Spinel, Fumed Silica etc. Application& limitations: The application areas and limitations of synthetic raw materials.	5
3	**Ceramic Raw materials:**Importance, use and limitations of natural raw materials in refractories, whitewares, cement, potteries, and glass ceramic Industries; Bauxite, Limestone, Chromite, Magnesite, Dolomite, Fluorite, Graphite, Gypsum, Haematite, Kaolinite, Fireclay, Ball clay, Montmorillonite, Magnetite, NephelineSyenite, Microcline, Feldspars (soda, potash, lime), Pyrophyllite, Quartz, Quartzite, Sillimanite, Kyanite, Andalusite, Talc, Wollastonite, Zircon, Beryl, Mica, Vermicullite, Silica sand etc.	5
4	**Optical Properties:**Optical activity, Polarizing microscope, Isotropic and anisotropic minerals, Bi-referingence,Pleo-chroism, Propagation of light through uni-axial and bi-axial minerals, Extinction, Cleavage and interference figures, Beck's effect. Optical microscope: Systematic description of minerals under polarizing microscope.	6
5	**Chromatography:** Introduction, Paper and thin layer chromatography, Liquid chromatography, Types of liquid chromatography, Column and detection systems. Effect of heat on different raw materials: Differential thermal analysis (DTA), thermo gravimetric analysis (TGA), thermal analysis, Differential Scanning Calorimetry (DSC), Factors affecting the phase transformations with suitable examples, Dilatometry–basic principles, instrumentations and case study in ceramic applications.	6
	Total	**28**

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3CR4-07: Thermodynamics and Phase Equilibria

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

SN	Contents	Hours
1	**Introduction:** Basic Terminology and concepts, Brief introduction to laws of thermodynamics, concept of states of matter, intensive and extensive properties of systems, thermal and statistical entropy.Auxiliary Functions: Thermodynamic functions, Maxwell's equations and their applications in solution of problems, thermodynamics cycles.	6
2	**Phase Equilibria:** Component, Solubility limit, phases, microstructure, phase equilibria, binary isomorphous systems, interpretation of phase diagrams, lever rule, development of microstructure on isomorphous alloys, mechanical properties of isomorphous alloys, binary eutectic systems	5
3	Thermodynamic stability of Materials. Equilibrium diagrams having Intermediate phases &compound, eutectoid and peritectic reactions, congruent phase transformation, ternary phase diagrams.Ellingham diagram and its importance, application of electrochemical series in ceramics.	6
4	**Behavior of gases:** Equation of state of gas, internal energy of real gas, Ideal gases, experimental determination of heat capacities, quasi adiabatic process, Ruchhardts method of measuring gama, velocity of longitudinal waves, kinetic theory of ideal gas.	5
5	**Chemical equilibrium:** Daltons law, semi permeable membrane, Gibbs theorem, Gibbs Helmoltz equation entropy of a mixture of inert ideal gases, Gibbs function of a mixture of inert ideal gases, chemical equilibrium, condition for mechanical stability. Thermodynamics equations for a phase: Thermodynamics equations for a phase, chemical potentials, degree of reactions, equation of reaction equilibrium.	6
	Total	**28**

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3CR4-08: Particle and Fluid Mechanics

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

SN	Contents	Hours
1	**Particle Mechanics:** Theory of crushing and grinding crushers grinders and ultra fine grinders. Close and open circuit grinding, selection of equipment and power requirement. Screening & Separation: Sieve analysis, cumulative and differential plots. Industrial screening equipment's, Separation based on size, shape, density and surface properties.	6
2	**Separators and Filters:** Law of motion of single particle sedimentation, free and hindered settling. Thickener and settling chambers, Flotation, rotary fluids, centrifuge, cyclone, electrostatic and magnetic separators, Pneumatic and hydraulic transportation of solids, Jansen's equation, conveyors, bins, silos and hoppers, different equipment for mixing of fluids and solids, mixing index. Filtration: Flow through filter cake and medium, plate and frame filters, centrifugal filters, filter media, filter aids, washing of filtercakes, selection of filtration equipment's.	6
3	**Basic Definitions and Fluid Properties :** Definition of fluid, incompressible and compressible fluids, fluid as a continuum, mass, density, specific weight, relative density, specific volume, bulk modulus, velocity of sound ideal fluid viscosity, Newtonian and Non-Newtonian fluid, Kinematic viscosity. Effect of temperature and pressure on viscosity, surface tension capillarity, vapour pressure and cavitation's, fluid states; general differential equation, hydrostatics manometry, fluid forces on submerged surfaces, curved surfaces, aerostatics, Isothermal atmosphere, polytropic atmosphere.	6
4	**Kinematics and Conservation of Mass:** Flow classifications, fluid velocity and acceleration, streamlines and the stream function, path lines and rotational flow, flownet, Laplace equation. Conservation of mass and the continuity equation for three dimensions, equation of motion, Euler's equation of motion, Bernoulli's equation, applications of Bernoulli's Pitot tube,	5
5	**The Boundary Layer:** Description of the boundary layer, boundary layer thickness boundary layer separation and control, The Prandtl boundary layer equation, flow round a body, drag skin friction drag, pressure drag, combined skin friction & pressure drag (Profile drag) wave drag, lift induced drag, variation of drug co- efficient with Reynolds's number.	5
	Total	28

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3CR4-09: Materials Science

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

SN	Contents	Hours
1	**Crystallography:** Introduction, space lattice, Bravais lattice, basis, unit cell, lattice parameters, crystal structure, factor affecting ceramic crystal structures, Miller indices, crystal symmetry.Different crystal structures: BCC, FCC and HCP, study of AX, A_mX_p, and $A_mB_nX_p$ type ceramic crystal structures.	7
2	**Type of standard crystal structures:** Introduction, structure of silicates (orthosilicates, pyrosilicates, single chain, double chain, sheet and network silicates), structure of kaolinite clay $Al_2(OH)_4(Si_2O_5)$, talc $Mg_3(OH)_2(Si_2O_5)_2$, mica $KAl_2(OH)_2(AlSi_3O_{10})$ andzeolite. Polymers and Liquid crystals:Polymer and liquid crystals.	5
3	**Crystal imperfection:** Classification of defects in natural crystals: Point, line, plane, electronic imperfections, transient imperfection, points defects: thermodynamics of point defects, lattice vacancies, Schottky defects, Frenkel defects, extrinsic vacancies and colour centers. Dislocations: Introduction, edge and screw dislocations, Burger vector, slip systems, energy of dislocations, theory of dislocation, Interaction between dislocations.	6
4	**Mechanical Properties and Diffusion:** Mechanism of plastic deformation, strengthening mechanism, recovery recrystallization and grain growth, dislocations in crystal growth. Imperfection Techniques, Effect: Effects of crystal imperfection on electronics, optical and mechanical properties and technique for imperfect determination and controlling the crystal imperfection in crystal growth.Diffusion: Diffusion, diffusion mechanisms, steady-state diffusion, non-steady-state diffusion, factors that influence diffusion.	5
5	**Optical properties:** Interaction of electromagnetic waves with matter, absorption, reflection, transmittance and colour of materials.Photoconductivity: Introduction, photo conducting materials,electronic transition in photoconductors absorption and excitation, trapping and capture, simple model of a photoconductor. Luminescence: Introduction, model for luminescence in sulphide phosphors, thallium activated alkali halides. Electroluminescence.	5
	Total	28

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3CR4-21: Ceramic Raw Materials& Characterization Lab

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

1	Determination of sulphate and chlorides in a given sample.
2	Determination of bicarbonates in a given sample.
3	Estimation of Na2O, K2O and B2O3 present in a sample.
4	Chemical analysis of limestone for insoluble content R2O3 (R = Fe, Al etc.), CaO, MgO.
5	Chemical analysis of gypsum and dolomite for insoluble content.
6	Chemical analysis of a given sample of sand.
7	Thermo gravimetric analysis of a given sample.
8	Differential thermal analysis of given sample.
9	Determination of moisture content in a given sample using Infrared Moisture Balance.
10	Determination of thermal behavior of ceramic specimen by dilatometric method.

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3CR4-22: Mineralogy and Microscopy Lab

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

Section A: Mineralogy

1. Determination of specific gravity of mineral by Pycnometer.
2. Identification in hand specimen of important rock forming minerals.

Section B: Microscopy Laboratory

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

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3CR4-23: Mechanical Operations Lab

Credit 1 **Max. Marks: 50(IA:30, ETE:20)**
0L+0T+2P

1	To classify particles/grains based on size, shape, density and surface properties.
2	To determine the terminal velocity of Cyclone separator.
3	Size reduction using Jaw crusher and calculation of equivalent diameter of solid particle.
4	Size reduction using roller crusher and calculation of equivalent diameter of solid particle.
5	Study of size reduction using ball mill.
6	To analyze the given product for its particle size distribution using Sieve shaker (Dry Method).
7	To analyze the given product for its particle size distribution using Sieve shaker (Wet Method).
8	Study of Filter Press and preparation of filter cake.

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3CR4-24: Fluid Mechanics Lab

Credit 1 **Max. Marks: 50(IA:30, ETE:20)**
0L+0T+2P

1	To determine coefficient of viscosity of a given sample.
2	Determination of pressure using pressure gauge and other devices.
3	To verify Bernoulli's equation experimentally.
4	To determine the flow rate and coefficient of discharge using Venturimeter.
5	To determine the flow rate and coefficient of discharge using Orificemeter.
6	Calibration of orifice/notch.
7	Study of nature of flow using Heleshow's apparatus.

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3CR4-25: Ceramic Processing Lab

Credit 1 **Max. Marks: 50(IA:30, ETE:20)**
0L+0T+2P

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

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