KALINGA UNIVERSITY

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SCHEME & SYLLABUS FOR

Bachelor of Vocational Studies (B.Voc.) Glass and Ceramic Technology

NAAC GRADE B+ Accredited University

nirf RANKING 2024 Ranked in Top 151-200 Universities

Kalinga University, Naya Raipur, Chhattisgarh

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B.VOC IN GLASS AND CERAMIC TECHNOLOGY

Semester - I								
Course Code	**Course Title**	**Credits**	**L**	**T**	**P**	**Internal Marks**	**End Semester Exam Marks**	**Total**
BVGCT101	Communication Skills	3	3	0	0	30	70	100
BVGCT102	Fundamentals of Information Technology	3	3	0	0	30	70	100
BVGCT103	Introduction to Glass and Ceramic Engineering	3	3	0	0	30	70	100
BVGCT104	Elementary of Electrical, Mechanical and Civil Engineering	3	3	0	0	30	70	100
BVGCT105P	**Industrial Training/On Job Training/Workshop**	18	0	0	36	50	150	200
Total		**30**	**12**	**0**	**36**	**170**	**430**	**600**

Semester - II								
Course Code	**Course Title**	**Credits**	**L**	**T**	**P**	**Internal Marks**	**End Semester Exam Marks**	**Total**
BVGCT201	Industrial Operation	3	3	0	0	30	70	100
BVGCT202	Environmental Studies	3	3	0	0	30	70	100
BVGCT203	Industrial Calculation	3	3	0	0	30	70	100
BVGCT204	Pottery and Refractory	3	3	0	0	30	70	100
BVGCT205P	**Industrial Training/On Job Training/Workshop**	18	0	0	36	50	150	200
Total		**30**	**12**	**0**	**36**	**170**	**430**	**600**

Semester - III								
Course Code	**Course Title**	**Credits**	**L**	**T**	**P**	**Internal Marks**	**End Semester Exam Marks**	**Total**
BVGCT301	Fuel, Furnace and Pyrometers	3	3	0	0	30	70	100
BVGCT302	Glass, Enamel and Ceramic Coating	3	3	0	0	30	70	100
BVGCT303	Elementary Geology and Mineralogy	3	3	0	0	30	70	100
BVGCT304	Modern Ceramic and its Application	3	3	0	0	30	70	100
BVGCT305P	**Industrial Training/On Job Training/Workshop**	18	0	0	36	50	150	200
Total		**30**	**12**	**0**	**36**	**170**	**430**	**600**

Semester - IV								
Course Code	**Course Title**	**Credits**	**L**	**T**	**P**	**Internal Marks**	**End Semester Exam Marks**	**Total**
BVGCT401	Lime and Cement Technology	3	3	0	0	30	70	100
BVGCT402	Ceramic Machinery and Furnace Expose	3	3	0	0	30	70	100
BVGCT403	Ceramic Raw Materials	3	3	0	0	30	70	100
BVGCT404	Mechanical Behavior of Ceramics	3	3	0	0	30	70	100
BVGCT405P	**Industrial Training/On Job Training/Workshop**	18	0	0	36	50	150	200
Total		**30**	**12**	**0**	**36**	**170**	**430**	**600**

Semester - V								
Course Code	**Course Title**	**Credits**	**L**	**T**	**P**	**Internal Marks**	**End Semester Exam Marks**	**Total**
BVGCT501	Industrial Management and Entrepreneurship Development	3	3	0	0	30	70	100
BVGCT502	Pottery and Porcelain-I	3	3	0	0	30	70	100
BVGCT503	Glass Technology-I	3	3	0	0	30	70	100
BVGCT504	Processing of Ceramic Raw Materials	3	3	0	0	30	70	100
BVGCT505P	**Industrial Training/On Job Training/Workshop**	18	0	0	36	50	150	200
Total		**30**	**12**	**0**	**36**	**170**	**430**	**600**

Semester - VI								
Course Code	**Course Title**	**Credits**	**L**	**T**	**P**	**Internal Marks**	**End Semester Exam Marks**	**Total**
BVGCT601	Traditional Ceramics	3	3	0	0	30	70	100
BVGCT602	Pottery and Porcelain-II	3	3	0	0	30	70	100
BVGCT603	Glass Technology-II	3	3	0	0	30	70	100
BVGCT604	Ceramic Characterization	3	3	0	0	30	70	100
BVGCT605P	**Industrial Training/On Job Training/Workshop**	18	0	0	36	50	150	200
Total		**30**	**12**	**0**	**36**	**170**	**430**	**600**

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SEMESTER-01

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COMMUNICATION SKILLS
BVGCT101

Course Objective:

- The purpose of this course is to introduce students to the theory, fundamentals and tools of communication and to develop in them vital communication skills which should be integral to personal, social and professional interactions. One of the critical links among human beings and an important thread that binds society together is the ability to share thoughts, emotions and ideas through various means of communication: both verbal and non-verbal. In the context of rapid globalization and increasing recognition of social and cultural pluralities, the significance of clear and effective communication has substantially enhanced.

Course outcomes:

- The purpose of this course is to introduce students to the theory, fundamentals and tools of communication
- To develop vital communication skills which should be integral to personal, social and professional interactions.
- One of the critical links between human beings.
- An important thread that binds society together is the ability to share thoughts, emotions and ideas through various means of communication: both verbal and non-verbal.
- In the context of rapid globalization and increasing recognition of social and cultural pluralities, the significance of clear and effective communication has substantially enhanced.

Unit 1: **06**

- **Introduction:** Theory of communication, types and modes of communication, mediums and channels of communication, barriers to communication, English as a global language, the lingua franca, social influences on English

Unit 2: **06**

- **Language of Communication:** Verbal and non-verbal (spoken and written) personal, social and business barriers and strategies intra-personal, inter-personal and group communication, varieties of English, language, accent, dialect, colloquialism, historical influences on English

Unit 3: **06**

- **Speaking Skills:** Monologue dialogue group discussion effective communication/mis-communication interview public speech, regional influences on English, convergence and divergence, linguistic imperialism

Unit 4: **06**

- **Reading and Understanding** Close reading, reading analysis of a text - audience and purpose, content and theme, tone and mood, stylistic devices, structure comprehension- analysis and interpretation translation(from Indian language to English and vice-versa) literary/knowledge texts

Unit 5: **06**

- **Writing Skills**: Documenting report writing making notes letter writing, writing tabloids, diary entry, open letters, essays, newsletter and magazine articles, skits, short stories, impersonating characters it will enhance language of communication, various speaking skills such as personal communication, social interactions and communication in professional situations such as interviews, group discussions and office environments, important reading skills as well as writing skills such as report writing, note taking etc. while, to an extent, the art of communication is natural to all living beings, in today's world of complexities, it has also acquired some elements of science. it is hoped that after studying this course, students will find a difference in their personal and professional interactions.

References:

1. Fluency in English - Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr. Ranjana Kaul, Dr. Brati Biswas

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BVGCT102
FUNDAMENTALS OF INFORMATION TECHNOLOGY

Course objective:

- This is a basic course for commerce students to familiarize with computer and it's applications in the relevant fields and exposes them to other related courses of IT.

Course Outcomes:

- Gain a foundational understanding of key IT concepts, including hardware, software, and networks.
- Develop proficiency in using common computer applications, such as word processing and spreadsheet software.
- Explore the ethical and security considerations in IT, emphasizing responsible digital behavior.
- Acquire problem-solving skills by applying IT knowledge to real world scenarios.
- Prepare for further studies in IT or related fields by establishing a strong IT knowledge base.

Unit-1: **06**

- **Computer characteristics:** Speed, storage, accuracy, diligence; digital signals, binary system, ASCII; historic evolution of computers;
- **Classification of computers:** microcomputer, minicomputer, mainframes, supercomputers;
- **Personal computers:** desktop, laptops, palmtop, tablet; hardware & software; von Neumann model.

Unit-2: **06**

- **Hardware:** CPU, memory, input devices, output devices.
- **Memory units:** RAM (SDRAM, DDR RAM, RDRAM etc. feature wise comparison only); ROM-different types: Flash memory;
- **Auxiliary storage:** Magnetic devices, optical devices; floppy, hard disk, memory stick, CD, DVD, CD/DVD-Writer**;**
- **Input devices -** keyboard, mouse, scanner, speech input devices, digital camera, touch screen voice input, joystick, optical readers, bar code reader;
- **Output devices:** Display device, size and resolution; CRT, LCD, LED;
- **Printers:** Dot-matrix, inkjet, laser; plotters, sound cards & speaker.

Unit-3: **06**

- **Software:** System software, application software; concepts of files and folders, introduction to operating systems, different types of operating systems: single user, multitasking, time-sharing multi-user; booting, POST;
- **Basic features of two GUI operating systems:** Windows & Linux (Basic desk top management); Programming Languages, Compiler, Interpreter, Databases;
- **Application software:** Generic features of word processors, spread sheets and presentation software; generic introduction to latex for scientific typesetting; utilities and their use; computer viruses & protection, free software, open source.

Unit-4: **06**

- **Computer Networks and Internet:** Connecting computers, requirements for a network: server, workstation, switch, router, network operating systems; internet: brief history, world wide web, websites, URL, browsers, search engines, search tips; internet connections: isp, dial-up, cable modem, well, dsl, leased line wireless and Wi-Fi connectivity ; email, email software features (send receive, filter, attach, forward, copy, blind copy); characteristics of web-based systems, web pages, web programming languages.

Unit-5: **06**

- **Information Technology and Society:** Indian IT Act, intellectual property rights, issues. application of information technology in railways, airlines, banking, insurance, inventory control, financial systems, hotel management, education, video games, telephone exchanges, mobile phones, information kiosks, special effects in movies.
- **Programming Concepts & Techniques:** Program concept, characteristics of programme, stages in program development, tips for program designing, programming aids, algorithms, pseudo code, notations, design, flowcharts, symbols, rules, compiler & interpreter. introduction to programming techniques, top-down & bottom-up approach, unstructured, & modular programming, cohesion, coupling, debugging, syntax & logical errors, linking and loading, testing and debugging, documentation.

References:

1. Programming in C, R.S. Salaria, Khanna Publishing House
2. Computer Concepts and Programming in C, R.S. Salaria, Khanna Publishing House
3. Handbook of Computer Fundamentals, N.S. Gill, Khanna Publishing House

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BVGCT103
INTRODUCTION TO GLASS AND CERAMIC ENGINEERING

Course Outcomes:
After undergoing this course, the students will be able to:

- Basic idea about Glass & Its raw material
- How makes the Glass
- How many types of Glasses
- Basic idea about Enamel & Its raw material
- Basic idea about Pottery & Its raw material
- Basic idea about Refractory & Its raw material
- Basic idea about Special/Modern Ceramic

Unit 1: **08**
Glass:

- History of Glass
- Elementary knowledge of raw materials
- Manufacturing process of glass by flow chart
- **Types of glass -** container glass, sheet glass, plate glass, bulb glass, laboratory ware glass,
- Decoration of Glass, types/method of decoration

Unit 2: **08**
Enamel:

- History of Enamel, Definition of Enamel
- Elementary knowledge of Enamel's raw materials
- Manufacturing process of Enamel Slip
- Making of enamel frits by quenching process
- Classification of Enamels and their applications
- Application methods of enamels

Unit 3: **07**
Pottery:

- History of pottery, Definition of pottery
- Elementary knowledge of raw materials .
- Manufacturing methods of pottery wares with flow chart
- **Types of pottery wares-** White wares as Earthen ware, stone ware, sanitary wares, Porcelain, and terracotta
- Uses of pottery wares

Unit 4: **07**

Refractory:

- History of refractory, Definition of refractory materials
- Elementary knowledge of raw materials considered as refractories ,
- types of refractory acid refractory ,basic refractory , neutral refractory.
- Manufacturing method of refractory
- Properties of refractory bricks
- Applications of refractory bricks

Cements:

- History of cements, Definition of cements
- Elementary idea of cements , raw materials, Types of cements
- Manufacturing methods of cements by different methods
- Application of Cement

Composites:

- Introduction to Ceramic Composites, Classification of composites, Properties & application, Define Cermet, application

Electronic Ceramics:

- Ceramic Capacitor, transistor, Piezo Electric Ceramic

Non Oxide Ceramic

- Define & classify with example

References:

1. Elementary of Ceramic Engineering by B.L. Yadav
2. Elements of Ceramics by F.H.Norton
3. Introduction to Glass Science Technology by James E. Shelby
4. Enamels by Andrewl & Andrewl
5. Technology of Enamels by V.I Vargin

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BVGCT104
ELEMENTARY OF ELECTRICAL, MECHANICAL AND CIVIL ENGINEERING

Course Outcomes:
After undergoing this course, the students will be able to:

- Understand the construction and function D.C. machine & A.C. machine
- Understand the principle of single phase Transformer
- Understand the types of bearing, use of bearing, types & Use of lubricant
- Understand the control systems as mechanical, hydraulic, Pneumatic & Electrical
- Understand how to improve the bearing capacity of soil, how to make the foundation for the Furnace & Kilns

Unit 1: **10**

Electrical Engineering:

- **D.C. Machines -** Working, Principle, types and applications, Write the Ohm/s law & Kirchhoff's laws
- Fundamentals of A.C.- Definition of Alternating current: Instantaneous value, maximum value, time periods, frequency, R.M.S. value, average value, phase and phase difference, leading and lagging power factor. Concept of 3-phase system: KVA, KVAr, KW, calculation of power consumed in single phase and three phase circuits. Star and delta connection (Line voltage, Line current, phase voltage and phase current only).
- **Transformers -** Working principle of a signal phase transformer and its applications.
- **A.C. Machines:** Motors: Brief idea about construction, starting methods and applications (excluding winding details of single phase induction motors), three phase induction motors (squirrel cage & slip ring type).
- **Electrical Measuring Instruments:** Ammeter, voltmeter, wattmeter and induction type energy meters (single phase only), meggars, multimeters. Temperature measuring thermocouple, Resistance, thermometer, Furnace Electrification.

Unit 2: **10**

Mechanical Engineering:

- **Internal combustion engines, classification of I.C. engines, mechanism of I.C. engine. Classification of control systems:** mechanical, hydraulic, pneumatic and electrical, working and uses of simple machines- loaders and lift trucks, conveyors, Excavators , mixing and placing equipments. Combustion table in MM and Inch.
- **Bearing & Lubricants:** Types of Bearings, lubrication of Machines, types of lubricants, basic rules of lubrication. Properties of a good lubricant.
- **Safety and Accident Prevention:** Safety organization, prevention of accidents due to mechanical causes, safety in operation of electrical equipments, fire precaution of storage of lubricants.

Unit 3: **10**

Civil Engineering:

- Selection of site for location of a factory, orientation of a factory building, nature of soils and bearing capacity, Improving bearing capacities,
- Types of various foundations and their salient features, suitability of various foundations for heavy, light and vibrating machines.
- Foundation materials for the construction of furnaces and kilns. Construction of kilns and furnace walls. Arches and domes etc.
- Concrete- Various ingredients of concrete, different grades of concrete, water cement ratio, workability, physical/field testing of concrete, mixing of concrete, placing and curing of concrete.
- RCC- Basics of reinforced cement concrete and its use (elementary knowledge), introduction to various structural elements of a building.

References:

1. Textbook of Concrete Technology 2nd Edition, by Kulkarni, PD Ghosh TK and hull, YR; New Age International(P) Ltd, Publishers, New Delhi
2. Materials of Construction by Ghosh; Tata McGraw Hill Publishing Co. Ltd., New Delhi
3. Civil Engineering Materials by TTTI, Chandigarh; Tata McGraw Hill Publishing Co. Ltd., New Delhi
4. Concrete Technology by J.Jha and Sinha; Khanna Publishers, Delhi
5. Building Construction by Jha and Sinha; Khanna Publishers, Delhi
6. Building Construction by Vairani and Chandola; Khanna Publishers, Delhi
7. Civil Engineering Materials by SV Deodhar and Singhai; Khanna Publishers, New Delhi
8. Soil Mechanics and Foundation Engineering by SK Garg; Khanna Publishers, New
9. Basic Electronics by VK Mehta; S Chand and Co., New Delhi
10. Basic Electrical Engineering by JB Gupta, S Kataria and Sons, Delhi

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BVCS105P
INDUSTRIAL TRAINING/ON JOB TRAINING/ WORKSHOP

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SEMESTER-02

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BVGCT201
INDUSTRIAL OPERATION

Course Outcomes:
After undergoing this course, the students will be able to:

- Understand the theory of crushing and grinding machines/mills
- Understand the principle/function of screening, Conveying, pugging, pressing, equipments
- Understand the types filtrations and for its equipment.
- Understand the function as mechanical, hydraulic, Pneumatic & Electrical power press
- Understand the type of mixing equipments
- Understand the type of conveyers

Unit 1: **08**
Introduction:

- Concept and rule of unit operation in process industries and House Keeping.
- Properties of Fluids
- Types of Flow: Laminar & Turbulent, Newtonian and Non-Newtonian fluids
- Concept of Bernoulli equation and its application

Unit 2: **08**
Size reduction:

- Theory of crushing Rittinger's law and Kicks law, Cclassification and their general description of crushing and grinding machines as –
  a) Crusher - Jaw crushers, , gyratory crushers, roll crushers, hammer mills,
  b) Grinder - ball mills, tube mills, vibrating mills, Raymond mill
- Maintenance of open circuit and closed circuit operations in ceramic machinery
- To decide optimum speed of ball mill for best grinding and mill discharges.
- Introduction & Construction of ball mill as Ball mill size, types of Lining
- Determination of Ball size & ratio of Ball
- Determination surface area of materials

Unit 3: **07**
Handling of Solids & Slurries:

- Screening and grinding of solid particles. Standard screening equipments and standard sieves. Conveying equipments, classification, their general construction, industrial application and operation, belt conveyors, chain conveyors, screw conveyors, bucket conveyors, pneumatic conveying system, pumping and transportation of slurry and their flow control.

Unit 4: **07**

Mechanical Operation:

- Screen analysis, Tyler standard screen series, screen effectiveness, Types of screening equipment i.e. gyrating screens, stationary screens and vibrating screens, Screen efficiency, Screen capacity, Type of filtration apparatus their general construction, application and operation of filter press and rotary, filters, filter aids centrifugal filtration. Types of mixing equipment used in ceramic industry. Introduction for modernization of ceramic machineries

Heat Transfer & Thermodynamics:

- Modes of heat transfer – conduction, convection and radiation
- First law of thermodynamics: calculation of internal energy, enthalpy, heat and work
- Second law of thermodynamics and its applications
- Third law of thermodynamics and its applications

References:

- Mechanical Operations by Swain Palra, G.K. Roy, Tata McGraw Hill Publication
- Mechanical Operations by Kiran D. Patil, Nirali Publication
- Chemical Engineering, Vol. I and II by Coulson and Richardson, Pergamon Press Publication
- Unit Operation of Chemical Engineering by McCabe and Smith; McGraw Hill Publication
- Introduction to Chemical Technology by Badger and Banchero, McGraw Hill Publication
- Unit Operations Vol. I & II by Chatterjii, Khanna Publishers,
- Engineering Thermodynamics by P.K.Nag

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BVGCT202
ENVIRONMENTAL STUDIES

Course Outcomes:

- Master core concepts and methods from ecological and physical sciences and their application in environmental problem solving.
- Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
- Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.
- Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
- Master core concepts and methods from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.

Unit 1: **06**

Introduction to Environmental Studies:

- Multidisciplinary nature of environmental studies, Scope and importance; concept of sustainability and sustainable development.

Ecosystems:

- What is an ecosystem? Structure and function of the ecosystem;
- **Energy flow in an ecosystem:** food chains, food webs and ecological succession.
- **Case studies of the following ecosystems**: Forest ecosystem, grassland ecosystem, desert ecosystem, aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Unit-2: **06**

Natural Resources:

- **Renewable and Non--renewable Resources:** Land resources and land use change; Land degradation, soil erosion and desertification.
- **Deforestation:** Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- **Water:** Use and over--exploitation of surface and ground water, floods, droughts, conflicts over water (international & inter--state).
- **Energy resources:** Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit-3: **06**

Biodiversity and Conservation:

- **Levels of biological diversity:** genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots, India as a mega--biodiversity nation; Endangered and endemic species of India
- **Threats to biodiversity:** Habitat loss, poaching of wildlife, man--wildlife conflicts, biological invasions;
- **Conservation of biodiversity:** In--situ and Ex--situ conservation of biodiversity.
- **Ecosystem and biodiversity services:** Ecological, economic, social, ethical, aesthetic and Informational value.

Unit-4: **06**

Environmental Pollution:

- Types, causes, effects and controls; Air, water, soil and noise pollution, Nuclear hazards and human health risks
- **Solid waste management:** Control measures of urban and industrial waste. Pollution case studies.

Environmental Policies & Practices:

- Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture
- **Environment Laws:** Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).
- Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Unit-5: **06**

Human Communities and the Environment:

- **Human population growth:** Impacts on environment, human health and welfare. Resettlement and rehabilitation of project affected persons; case studies.
- **Disaster management:** floods, earthquake, cyclones and landslides.
- **Environmental movements:** Chipko, Silent valley, Bishnois of Rajasthan.
- **Environmental ethics:** Role of Indian and other religions and cultures in environmental conservation. Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

References:

- Carson, R. 2002. *Silent Spring*. Houghton Mifflin Harcourt.
- Gadgil, M., & Guha, R.1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
- Gleeson, B. and Low, N. (eds.) 1999.Global Ethics and Environment, London, Routledge.
- Gleick, P. H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
- Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll.Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.
- Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36--37.
- McCully, P. 1996. Rivers no more: the environmental effects of dams(pp. 29--64). Zed Books.
- McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
- Odum, E.P., Odum, H.T. & Andrews, J. 1971.Fundamentals of Ecology. Philadelphia: Saunders.
- Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
- Rao, M.N. & Datta, A.K. 1987. Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd.
- Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012.Environment. 8th edition. John Wiley & Sons.
- Rosencranz, A., Divan, S., & Noble, M. L. 2001. Environmental law and policy in India. Tripathi 1992.
- Sengupta, R. 2003. Ecology and economics: An approach to sustainable development. OUP.
- Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
- Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. Conservation Biology: Voices from the Tropics. John Wiley & Sons.
- Thapar, V. 1998. Land of the Tiger: A Natural History of the Indian Subcontinent.
- Warren, C. E. 1971. Biology and Water Pollution Control. WB Saunders.
- Wilson, E. O. 2006.The Creation: An appeal to save life on earth. New York: Norton.
- World Commission on Environment and Development. 1987.Our Common Future. Oxford University Press.

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BVGCT203
INDUSTRIAL CALCULATION

Course Outcomes:
After undergoing this course, the students will be able to:

- Have understanding of scope of material and balance in chemical industries.
- Carry out conversions of units and equations.
- Have knowledge of the solution concentrations, specific gravity, density, molarity, normality, molality in the chemical industries.
- Find the contents and properties of given analyzed gas.
- Find out quantity of material input and outputs of various unit operations.
- Calculate material input and outputs of chemical reactions to identify excess and limiting reactants.
- Calculate the enthalpy associated with a reaction.
- Calculate the quantities of utility required.
- Carry out combustion calculations, proximate analysis and ultimate analysis

Unit 1: **08**

Introduction & Scope:

- Introduction & Scope of material and Energy Balances in Ceramic Industry

Unit Conversion:

- Unit conversion of units, and their conversion factors, S.I Units, MKS System, CGS System, FPS

Unit 2: **08**

Stoichiometric and composition relationships:

- Conservation of mass, mass and volume relationships in chemical reactions, concept of gram-mole and gram-atom, mass and volume relationship for gaseous substance, use of molal units, choice of basis of calculation.

Gases and Gas Mixture:

- Ideal gas law, Boyle's law, Charles's law, value of universal gas constant, Behaviour of ideal gases - P & T relationship, standard condition, gauge pressure, Dalton and Amagat's laws, average molecular weight of a gaseous mixture.

Unit 3: **07**

Humidity and Saturation:

- Simple problem using Chart

Material Balance:

- Drying and firing problems. Solving problems on various unit operations like drying, evaporation, crystallization, distillation, mixing, blending, absorption, extraction.

Unit 4: **07**

Combustion processes:

- Analysis of the products of combustion: proximate and ultimate analysis.
- Problems of fuel analysis, air fuel ratio, and theoretical oxygen/air required.
- Problems of fuel analysis Oxidation of sulphur and its compounds

Environment & Pollution:

- Ceramic industry and its influence on the environment. How to make it environment friendly. Major pollutants and their remedies. Industrial waste disposal .Waste minimization and recycling. Reduction of GHS (Green House Gases), Control of combustion by improved process (Reduction in fuel consumption)

References:

- Stoichiometry by B. I. Bhatt &S. M. Vora; McGraw Hill Publication
- Material Science by Narula and Gupta
- Engineering Materials by B.K. Agarwal
- Material Science by R.K. Rajput; SK Kataria and Sons, Ludhiana
- Introduction to Matrial Science for Engineers by J.F. Shackelford,
- Chemical Process Principles Part-1 by O.A. Hougen and K.M. Watson.
- Chemical Process Principles Part-1 by R.A. Rastogi
- Solved Examples in Chemical Engineering by G.K. Ray

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BVGCT204
POTTERY AND REFRACTORY

Course Outcomes:
After undergoing this course, the students will be able to:

- Know various raw materials used in white ware and heavy clay wares
- Know the process of manufacturing of various white ware & heavy clay wares
- Understand various composition and body formulation of various types of white ware& heavy clay wares their manufacturing process and the characteristic
- Understand various qualities and process of testing of various ceramic products
- Know the general idea about the specification as per the BIS for white ware and heavy clay wares

POTTERY:

Unit 1: **08**

- **Introduction:** Ancient pottery, Definition of pottery, Classification of Pottery ware
- **Raw Materials:** Origin of clay, Principle of formation and classification. Primary and secondary clays, washing methods of clays. Winning and mining of clays. Behavior, functions and physical properties of the important pottery raw materials -china clay, ball clay, fire clay, Red burning clay, quartz, feldspar, nepheline syenite, whitening ,talc, pyrophyllite, sillimanite group minerals and bone ash, places of occurrence of important raw materials in India.
- **Body Preparation & Shaping:** Raw material unloading and storage, batch calculations, ball milling, batching, blunging, screening, dewatering clay slips, casting slip, plastic forming, dry press bodies. Jiggering, i.e. Jolly and rotary Table type Jigger, extrusion, dry pressing different types of dry pressing, finishing, drying.
- **The casting process, different types of casting-**
  - Ordinary or Notch casting
  - Bench/Batch casting
  - Battery casting
  - Capillary casting,

Unit 2: **08**

- **Drying:** Removal of water, factors affecting drying, types of driers-batch & continuous, hot flow, steams pipes, chamber driers & tunnel driers etc., defects in drying.
- **Firing:** Describe the different Firing stages for pottery wares, kiln furnitures and placing of wares in kiln, Effect of heat on clay & other materials
- **Mould Materials:** Mould materials and their properties. (Different Types of dies and Mould), Process of mould making using POP. Rubber Mould,

REFRACTORY

Unit 3: **07**

- **Raw Materials:** Classification of refractory materials, clay minerals, alumina silica, magnesite, dolomite, chromite, and other refractory oxides. Synthetic raw materials - Fused alumina, sintered alumina.
- **Making of Refractory Bricks:** Moulding methods, drying, effect of heat on clay, Manufactrure and properties of silica and semi-silica refractories, fire clay and other alumino silicate refractories, application of phase diagrams related to the manufacture of above refractories.

Unit 4: **07**

- **Manufacturing of Crucibles & Saggers:** A detailed study of the manufacture of crucibles, furnace blocks, refractory block for furnace, saggars and muffles used in different industries.

References:

- Industrial Ceramic by Singer & Singer
- White ware by W. Ryan & Redford
- Pottery Industry by H.N.Bose
- Modern pottery Manufacture by H.N.Bose
- White wares by S.Sen
- White ware by F.H.Norton

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BVGCT205P
INDUSTRIAL TRAINING/ON JOB TRAINING/ WORKSHOP

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SEMESTER-03

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BVGCT301
FUEL, FURNACE AND PYROMETERS

Course Outcomes:
After undergoing the subject, the students will be able to:

- Understand types of fuels required for ceramic industry
- Know in detail of various solid, Liquid & Gaseous fuels base kilns
- Know the construction & operation of various type Ceramic Kilns
- Know regarding various types of metallurgical furnaces and their Construction & Operation
- Know the conservation of energy in the of ceramic Kilns
- Understand general idea on Pyrometer, Pyroscope, Thermocouple

FUEL:

Unit 1: **08**

Introduction to Fuel & Combustion:

- State & Explain introduction to solid, Liquid and Gaseous fuels
- Explain Non-conventional source of energy for burning ceramic Kiln
- State and explain combustion of fuels
- Combustion calculation
- Spontaneous combustion, its causes and remedy.
- Terms & Definition relating to Fuel testing

Solid Fuels:

- State various types of solid fuels
- Classify solid fuels
- Describe the methods/ theories of formation of Coal
- State & explain the properties/nature of Coal and occurrence,
- Describe impurities in coal, grading of coal, reason for washing of coal,
- Describe hardness and grind ability of coal, agglomeration and swathing of coal, calorific value of coal, coal ash and clinkering.
- Describe in detail how coke is prepared in coke oven and state properties of coke

Liquid Fuels:

- State various types of liquid fuels
- Classify liquid fuels, Nature of oil, its origin and composition
- Describe the process of refining for the crude petroleum product- petrol, kerosene, Diesel
- Describe the procedure for storage and handling practices of liquid fuels in industry.
- State the advantages of liquid fuels over solid fuels.
- Testing of liquid fuels such as flash point, fire point, pour point, smoke point, dew point

Gaseous Fuels:

- Classify gaseous fuel
- Design and description of producer gas plant, chemical reactions, composition and calorific value in relation to operating conditions and quality of coal.
- Describe the manufacturing method of Bio Gas
- Describe Water Gas, Carbureted water gas. Coke oven Gas, Blast furnace Gas, Coal Gas, Oil Gas, BOF Gas, Refinery Gases, low and high temperature carbonization,
- Describe the Natural Gas-Composition and calorific value.
- Explain the advantages of gaseous fuel over liquid and solid fuel
- Describe the Rocket Fuels and Nuclear Fuels

Unit 2: **08**

Ceramic Kilns:

- Define the Kiln, Furnace and Oven
- Classify ceramic kiln/Furnace in details – as per used fuel, Shape, working method(Periodic, Continuous kiln)
- List the advantage of continuous kiln over periodic kiln
- Describe various type of kiln furniture used in ceramic kilns
- Describe the construction & operation of the following kilns with sketch in detail:-
  a) Scobs /woodfibre kiln
  b) Down Draft Kiln
  c) Up Draft Kiln
  d) Chamber kiln
  e) Muffle kiln - Modern muffle kilns for enamel industries.
  f) Shaft kiln
  g) g) Tunnel kiln - advantages of muffle type tunnel kiln.
  h) Rotary kiln
  i) Roller hearth kiln

FURNACE

Unit 3: **07**

- Classification of Furnaces
- Furnace used in Glass plant & their classification
- Furnace & Fuel used in Steel plant & their classification
- Sketch the following furnaces showing various section
  a) Glass Melting Tank Furnace
  b) Glass Melting Pot Furnace (Day tank furnace)
  c) Blast Furnace
  d) Muffle Furnace-
  e) Cupola
  f) Open Hearth Furnace
  g) Basic Oxygen Furnace (BOF)
  h) Electric Arc Furnace

- **Continuous Kilns:** Fundamentals of continuous kilns- construction, working and firing circuits Methods of setting in continuous kilns.
- **Importance of Chimney for Kiln & Furnaces:** chimney construction, draught pressure and chimney draught.
- **Burner & Blower Equipments:** Design and operation of Burners, Burner efficiency, blowers And measurement of air flow meater, regenerator, recuperator etc.

PYROMETER

Unit 4: **07**

- Definition pyroscope & pyrometer, classification of pyrometers,
- seger cones - classification of cones, Behaviour of cones etc.
- Thermo electric pyrometers - general principle, Material used for thermal junction - chromel-Alomel, Platinum -Rhodiun etc.,
- Indicators, recorders, Advantage of thermo electric method of measuring
- Optical pyrometers: General Prinicple, Lien's law of Ferry's optical pyrometer, Le – Chateleir's optical pyrometer, colour extinction pyrometer.
- Resistance Pyrometers, Radiation Pyrometers: Ferry's mirror pyrometer, Ferry's spiral radiation pyrometer, indicators for radiation pyrometers.

References:

- Fuels and Combustion by S.Sarkar
- Fuels Solid, liquid & Gaseous by J.S.S.Brame & King
- Furnace by Trink
- Industrial Ceramic by singer and singer
- Fuels Furnace Refractory by O.P.Gupta

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BVGCT302
GLASS, ENAMEL AND CERAMIC COATING

Course Outcomes:
After undergoing the subject, the students will be able to:

- Understand about the Raw materials of Glass, Enamel & Its Batch Calculation
- Understand about the Melting of Glass, Enamel & Refining of Molten Glass
- Understand about How to Quality control of Glass, Enamel & Coating
- About different types of coatings applied over metals & other materials
- We get an idea about metallurgy industries where maximum tonnage of ceramic materials are used
- Students get a knowledge about Enameling on Different Metal & How to Melt the Enamel
- Students get an idea about Stenciling on Enameling surface then Cover coat enamel applied and Firing in furnace
- Students get an idea about Enamel's Defect & Its remedies.

GLASS

Unit 1: **08**

- **Raw Materials:** Chemical and Physical Characteristics of principal glass making batch materials, their storage, mixing and conveying , minor ingredients and their function, factor influencing choice of batch materials..
- **Batch Calculation:** Calculation of glass batch oxide composition to raw material and raw material composition to oxide composition.

Unit 2: **08**

- **Typical Commercial Glasses:** Types of glass and their chemical composition, container glass, sheet and plate glass, scientific laboratory glass.
- **Melting and Refining:** Essential requirements of glass melting, mechanization of melting, thermal currents, production of homogeneous liquid, refining, shaping and moulding.
- **Quality Control & Test:** Quality control/methods of testing of glass

ENAMEL

Unit 3: **07**

- History of enameling, Definition of Enamel, Classification of Enamels, Types of enamels, raw materials for enamels, Base metal preparation by smelting & Pickling,
- Preparation & Application:- Batch composition, Frit making, Preparation of Enamel slip, milling additives. Methods of enameling by dipping, spraying, Brushing, and screen printing
- Defects in Enamel: control firing, Under fired, rolling, scaling, chipping, pinholes, crazing, & their causes and remedies.
- Quality Control and Testing Enamel

CERAMIC COATING

Unit 4: **07**

- **Introduction of Glaze:** Definition of Glaze, Similarities & Dissimilarities between glaze and glasses. Classification of glazes, Definition and explanation of Raw glaze, Fritted glaze, Lead glaze, Leadless glaze, Vapour glaze, Opaque glaze, Matt glaze & Crystalline glaze
- **Preparation of glaze:** Selection of raw materials, composition, batch preparation, mixing, grinding. Definition of frit, preparation of frit & importance of fritting Application Methods of glaze: Dipping, brushing, pouring & Spraying
- **Firing of glazed ware:** Drying, placing precautions of glazed ware before firing. Glaze defects & remedies : Crazing, Crawling, Peeling, Pin hole discuss their causes and remedies
- **Decorations:** Under glaze, in glaze & on glaze decorations, Decoration methods like painting, stamping, stenciling, screen printing, & chromolithography

References:

- Porcelain Enamels by Andrew
- Industrial ceramics by Singer F and Singer SS
- Modern pottery by HN Boss
- Hand Book of ceramics
- White ware by W. Rayan
- Fine ceramics by FH Norton

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BVGCT303
ELEMENTARY GEOLOGY AND MINERALOGY

Course Outcomes:
After undergoing the subject, the students will be able to:

- Understand importance of Geology in the field of ceramic engineering.
- Know the formation of rocks, minerals and Clay.
- Know the classification of rocks in details.
- Understand Physical properties of minerals.
- Understand types of clay and other important raw materials, their properties, Sources and application in ceramic industries.
- Understand the process of beneficiation of ceramic raw materials.

Unit 1: **08**

Elementary Geology:

- Various Branches of Geology
- Origin of earth and earth's crust
- Geological ages
- Elementary and general idea of rocks and minerals
- Utility of geology especially for ceramic industries.
- Occurrence of ceramic raw materials in India.

Physical Geology & Petrology:

- Define Petrology
- Discuss the types of weathering
- Discuss various types of weathering agencies
- Discuss the process of weathering

Unit 2: **08**

Petrology:

- Formation of rocks, classification of rocks
- Geological characters of rocks
- General characters of rocks
- Engg. Properties of rocks/ Lab Test of rocks
- **Rocks a construction material**
  a) For Building
  b) For Roads
- Define & Describe stratigraphy, Principal of stereography.

Unit 3: **07**

Mineralogy:

- Define mineralogy
- Describe various process of formation of minerals – Rock forming minerals.
- State & explain Formula/Composition of minerals
- **Explain the following physical properties of the minerals :-**
  a) Color
  b) Streak
  c) Luster
  d) Cleavage
  e) Hardness
  f) Crystal Form
  g) Fractures
  h) Specific Gravity
  i) Texture
- Describe various process of testing of minerals

Important Ceramic Raw Materials:

- Describe the types of clays and Clay minerals
- State & Explain the physical and chemical properties of clay
- Describe availability of various ceramic raw materials in India and Special emphasis to state of Uttar Pradesh
- **Discuss the properties and uses of the following ceramic raw materials:**
  a) Silica –Quartz, Quartzite, Glass Sand
  b) Lime stone, Dolomite, Magnesite, Calcite, Gypsum
  c) Alumina Anhydrous – Bauxite, Diaspore, Pyrophilite
  d) Alumino silicate – Sillimanite, Kaynite, Andalusite
  e) Magnesium silicate – minerals – Talc, Forsterite, Steatite
  f) Flourine Minerals – Flourspar, Cryolite
  g) Boron Compound – Borax
  h) Feldspar and other fluxes, Nephline, Sodalite, Wolastonite, Bentonite
  i) Graphite, Chromite, Zircon
  j) Miscellaneous – Olivine, Asbestos, Rutile, Vermiculite, Mica, Beryal, Lithium minerals

Unit 4: **07**

- **Economic Geology With Reference To Ceramic:** Economic use of ceramic raw materials such as Clay, Silica, Felspar, Talc, Limestone, Dolomite, Gypsum, Magnesite, Chromite, Bauxite, Sellimanite, Kyanite and Andalusite, Zircon, Mica, Calcite, Pyrophilite.
- Petrological microscope, study of physical and optical properties with special reference to the following minerals-Quartz, china clay, ball clay, feldspar, mica, basalt calcite, lime stone, gypsum, corundum.

References:

- A Text book of Geology by P. Singh
- Geology by G.B.Mahapatra
- Text Book of Geology by P.K.Mukharjee
- Engineering & General Geology by Praveen Singh

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BVGCT304
MODERN CERAMIC AND ITS APPLICATION

Course Outcomes:
After undergoing the subject, the students will be able to:

- Understand about the Low & High tension Insulator Body
- Understand High temperature Ceramic & Abrasive
- Understand about Fibers & Whiskers
- Understand about the Special ceramic & Bio-Ceramic
- Know about the Capacitor & Condenser

Unit 1: **08**

- **Introduction To Low loss ceramics:** The importance of low dielectric losses in high frequency work, steatite and cordierite bodies and their composition, manufacturing methods, properties and uses.
- **Introduction to High permittivity ceramics:** Electrical condensers, advantage of ceramic condensors, rutile bodies Titenates ceramics. Ferro electric and Piezo electric ceramics

Unit 2: **08**

- **Introduction To Magnetic ceramics:** Soft spinel ferrites and hard hexagonal ferrites.
- **Special Ceramics:** High temperature ceramics, Berillia, Magnesia, alumina and zirconia.

Unit 3: **07**

- Recent developments in the field of ceramics (lectures to be delivered by eminent ceramic engineers) in kilns, materials, energy efficiency. Elementary idea of non-oxide ceramic and fuel cells.
- Ceramic raw materials, Chemical analysis and Physical Testing, Investigations of Clay firing properties, Glaze and Process control.
- **Abrasive :-** Definition, Classification, properties, Manufacturing process of abrasive grains & product, Bonded & Coated Abrasive, Ceramic Cutting tools

Unit 4: **07**

- **Fibers & Whiskers:-** Definition, types, Properties, application
- **Bio-Ceramics: -** Ceramic materials for artificial tooth and bone joints, Elementary idea about preparation, properties and manufacture of bio-ceramics and their applications.

References:

- Ceramic materials for electronics by R.C. Buchahan, McGraw Hill
- Introduction to Ceramics by W.D. Kingery, Prentice Hall of India
- Industrial Ceramic by Singer & Singer
- Ceramic Material For electronic by Heneb & West
- Special Ceramic by Popper
- Magnetic Ceramic by Richerson
- Abressive by Coes L. Jr.
- Cutting Tools by R.Edwards
- Non Oxide Technical & engg. Ceramic by S.Hampshire
- Ceramic Matrix Composites by R. Warren
- Ceramic Material for Electronics by Marcel Dekker

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SEMESTER-04

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BVGCT401
LIME AND CEMENT TECHNOLOGY

Course Outcomes:
After undergoing the subject, the students will be able to:

- Know Lime & Lime Stone, their qualities, calcinations and Cementing properties
- Understand details about Portland cement
- Understand manufacturing of various type of cement, their qualities
- Know about cement Kiln and its operation
- Know various method of testing quality of cement
- Know various types of cement concrete product and its manufacturing process
- Know details about gypsum, Plaster of Paris and plaster product

Unit 1: **08**

LIME:

- Origin of lime stones, Varieties of lime stones and chemical composition of lime stone.
- Properties of lime stone & uses, Burning of lime stone
- Explain Calcinations and Slaking of Lime stone
- Describe with sketch calcinations of lime stone in lime kilns
- Effect of the presence of magnesia and use of lime mortar.
- Preparation of hydrated lime, grinding the quick lime, mixing with water.

CEMENT

Unit 2: **08**

- Definition and Raw material of cement, Chemistry of anhydrous and hydrated cement compounds. The constitution of portland cement. Method of manufacture of port land cement, and testing. Action of acid and sulphate water on port land cement, the physical and chemical properties of port land cement, defects causes and remedies.

Unit 3: **07**

- Different types of cements, e.g. Portland cement, quick setting cement, pozzolanas and pozzolanic cement, high alumina cement, water proof cement, oil well cement, hydrophobic cement, masonry cement, white cement, coloured cement, rapid hardening cement, castable refractories, low and ultra low Cement Castables.

Unit 4: **07**

- **Additives-** accelerators, retarders, water proofers, pigments, dispersing agents.
- **Testing of Cement:** Fineness of cement, Initial and final setting time of cement, Expansion of cement, Compressive and tensile strength, Impurities in cement, Specific gravity of cement, Chemical analysis of cement

References:

- Text Book of Cement and Concrete by Lee
- Advances in Cement Technology by S.M. Ghose
- Hand book on Cement Technology by Dudda

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BVGCT402

CERAMIC MACHINERY AND FURNACE EXPOSE

Course Outcomes:

After undergoing the subject, the students will be able to:

- Understand about the Plant layout and its setup machinery
- Understand details about Size Reduction & size Separation Machine
- Understand manufacturing of various type of cement, their qualities
- Know about Mixing & Body making Machine as per Requirement
- Know about different type of Shaping machines
- Know various types furnace / Kiln used in Ceramic Industries

Unit 1: **08**

- **Plant Layout:** plant location, layout of the factory building, selection, operation and maintenance of ceramic machinery and equipment (for Pottery, Refractory, Glass, Enamel and Cement).
- **Size Reduction:** Selection of crushing & grinding equipments. Definition of closed and open circuit operations.

Unit 2: **08**

- **Size Separation:** wet classifiers, Air, Electromagnetic / magnet separators, vibrating sieve, slip lifting & Diaphragm pump, Filter press, Vacuum filter, Centrifugal Dewatering
- **Mixing and Body Making:** Simple & De-airing pug mills and pugging equipments. Extruders, kneading equipments, wet pan mill, mixers, blunger, agitator etc

Unit 3: **07**

- **Shaping Machine:** Potters wheel, Jigger & Jolly, Batting machine, Semi & fully automatic jiggers, Roller machines, Extrusion wire cutting machines,
- **Pressing Machines:** Important parameters of pressing (Die, Powder & Pressure) Toggle press, Screw press, friction press, Hydraulic press, vibratory compaction machine Isostatic press, Hot isostatic press(HIP),Injection moulding, Tape casting, Tile press and their parts.
- **Furnace Design**: study of common types of furnaces in use in ceramic industries i.e. glass melting tank furnaces including unit melters, tunnel kiln, chamber kiln and down draft kiln, rotary cement kiln, muffle kiln and annealing lehrs. Environment friendly gas fired Kiln for glass beads making

Unit 4: **07**

- Chimney and chimney calculation. Furnace capacity, Fuel efficiency and firing efficiency, Essential operations of a furnace i.e. Preheating of air, gas, fuel and oil, Flame-system, preheating of batch, firing, charging, melting and reversal etc.
- Furnace life and selection of refractories, Heating and cooling down of a furnace combustion, calculation, Solid and Liquid Fuel, gaseous Mixture.
- Elementary idea of design, construction and thermal calculation of at least one of the above mentioned furnaces

References:

- Industrial Ceramic by Singer & Singer, IBH Publisher.
- A Concise Introduction to Ceramics by George C. Phillips, Amazon Publication
- Ceramics, Mastering the Craft by Richard Zakin, American Ceramic Society Publication,

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BVGCT403
CERAMIC RAW MATERIALS

Course Objectives:
The course is aimed to
- Introduce the basics of rock formation, its types, and mineral formation and its physical and optical properties.
- Impart knowledge about various natural and synthetic ceramic raw materials.
- Explain the various testing methods of ceramic raw materials.

Course Outcomes:
On completion of the course, the students are expected to
- Recognize different rocks and minerals
- Describe various types of natural and synthetic ceramic minerals
- Define the properties and applications of natural and synthetic ceramic minerals
- Employ the testing methods to analyse the raw materials.

Unit 1: **08**
General Geology and Minerology:
- Minerals – formation, relation of mineral deposit to igneous activity; chemical and physical properties like composition, color, streak, luster, fracture, cleavage, hardness, density and tenacity; radioactive properties and optical properties, Rocks – formation, characteristics, classification into igneous, sedimentary and metamorphic. Some important rocks – granite, sandstone, marble - Availability, Industries and Demand.

Unit 2: **08**
Alumino Silicate Materials:
- **Occurrence, properties, industrial importance of fluxes, uses of natural fluxes –** feldspar group, nephelinesyenite, Cornish stone. Clay minerals. Clay structures – kaolinite and montmorillonite groups. Occurrence 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 behavior, plasticity, effect of heating. Mica, talc, pyrophyllite and sillimanite group – physical and chemical properties, applications - Availability, Industries and Demand.

Unit 3: **07**
Alumina and Silica:
- **Alumina –** natural raw materials. Preparation, properties and applications of synthetic alumina raw materials – calcined alumina, fused alumina, tabular alumina, reactive alumina, bubble aluminaSilica – occurrence, structure, polymorphic transformation, physical and chemical properties. Silicate minerals – quartz, quartzite – properties and uses.Availability, Industries and Demand
- **Other Raw Materials:** Occurrence, properties,industrial importance of Wollastonite, Magnesite, dolomite, chromite, limestone, rutile, zircon, beryllia, gypsum minerals, lithium containing minerals, Preparation / Occurrence, properties and uses of Silicon carbide, Tungsten carbide, Silicon nitride, Aluminium nitride, Boron nitride, Plaster of Paris, Bone ash, cullet, slag, Fly ash.

Unit 4: **07**

Testing:

- **Coning 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, sedigraph, Determination of surface area by permeametry, adsorption, Plaster of Paris setting timeand strength; Testing of clay plasticity, thixotropy, shrinkage, water absorption. Theory and procedure for chemical estimation of silica, alumina, alkali and alkaline earth oxides in a given ceramic raw material.

References:

- Parbin Singh, Engineering and General Geology, S.K.Kataria and Sons, New Delhi,2001.
- Christopher W.Sinton, Raw Materials for Glass and Ceramics: Sources, Processes and Quality Control, John Wiley and Sons, Inc., 2006
- Norton F.H, Fine Ceramics: Technology and Applications, McGraw-Hill Co., NY,1978.
- Wilson M.J, Clay Mineralogy, Chapman and Hall, 1955.
- Deer W.A, Howie R.A and ZussmanJ, Rock Forming Minerals, Longmans, London,1967.
- Ryan .W, Properties of Ceramic Raw Materials, Pergamon Press, 2nd Edn.,1978.
- Worrall W.E, Ceramic Raw Materials, Pergamon Press, NY,1992.
- Venkat Reddy D, Engineering Geology, Vikas Publishing House Pvt. Ltd., New Delhi,2010.

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BVGCT404
MECHANICAL BEHAVIOR OF CERAMICS

Course Objectives:
The course is aimed to impart basic knowledge about
- Elastic behaviour of Ceramic Materials
- Fracture behaviour , strength and creep behaviour of ceramic materials
- Toughening techniques and thermal shock behaviour of ceramic materials.

Course Outcomes:
On completion of the course the students are expected to
- Have a basic understanding about elasticity, deformation point of isotropic and crystalline materials.
- Have learnt about various fractures, fracture testing techniques, strength behaviour, thermal shock resistance and creep behaviour
- Design ceramic components for safe life and identify suitable ceramic material for intended application

Unit 1: **08**
Elastic Behaviour:
- **Elastic constants –** elastic deformation of isotropic and crystalline materials - effect of lattice constant, Grain size and Temperature- Theoretical strength – Yield criteria - stress – strain relationship - Stiffness measurement – static and dynamic methods,– Critical resolved shear stress

Unit 2: **08**
Fracture:
- **Types of fracture -** ductile and brittle fracture - Linear elastic fracture mechanics, Stress concentration, Griffith theory , stress at crack tip – Irwin theory - Critical stress intensity factor measurement – single edge notched, Chevron notched beam, indentation method, notch test – Statistical treatment.

Unit 3: **07**
Strength:
- **Strength reducing mechanisms –** subcritical crack propagation, failure under constant stress.
- **Stable crack propagation –** R curve, measurement. Fatigue of Ceramics – Testing method, Paris theory, and Life time prediction.

Unit 4: **07**
Thermal Behaviour:
- Thermal stress, Eshellbymethod .Thermal shock resistance parameters, measurement, micro cracking of ceramics, thermal tempering. Thermal conductivity - measurement, Creep of Ceramics – mechanisms, measurement types – Diffusion, dislocation, Construction of Deformation Map- safe life design.

Toughening and Mechanical Properties of Ceramics:

- **Toughening mechanisms** – crack deflection, crack bowing, crack branching, crack tip shielding by process zone and bridging effect, transformation toughening Mechanical properties of Alumina, Silicon Nitride, Silicon Carbide and Porous ceramics

References:

- Barsoum. M.W, Fundamentals of Ceramis, 1 st edition, Taylor & Francis, 2003.
- Hasselman, D.P.H and HellerR.A. (Ed), Thermal Stresses in Service Environments, Plenum Press,1989.
- Cocks A.C.F and PonterA.R.C, Mechanics of creep brittle material -1 and 2, Elsevier Applied Science, 1989.
- JahanmirSaid, Friction and Wear of Ceramics, Marcel Dekker Inc, 1993.
- 5. Roy.W.Rice, Mechanical Properties of Ceramics and Composites, Marcel Dekker Inc. , 1993.
- Parton V.Z.andBorishkovskyV.G., Dynamic Fracture Mechanics (VOl-2), Hemisphere Publishing, 1990.
- Kussmaul. K., Fracture Mechanics Verification by Large-Scale Testing, Mechanical Engg.Publication, 1991.
- BratR.C, HasselmanD.P.H., MunzD., Sakai M.andV.Ya.Shevchenko, Fracture Mechanics of Ceramics, Plenom Press Publication, 1991.
- SastriV.S and Edward Ghalai, Corrosion-preventionand protection, John Willey and Sons, 2007.
- 1. John B.Watchman, Mechanical Properties of Ceramics, John Wiley and Sons Inc., NY, 1996.
- 2. Davidge, R.W., Mechanical Behaviour of Ceramics, Ceramic Book Literature Service, London, UK, 1979.

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SEMESTER-05

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BVGCT501
INDUSTRIAL MANAGEMENT AND ENTREPRENEURSHIP DEVELOPMENT

Course Outcomes:
After undergoing this course, the students will be able to :

- Know about various schemes of assistance by entrepreneurial support agencies
- Conduct market survey
- Prepare project report
- Explain the principles of management including its functions in an organization.
- Have insight into different types of organizations and their structures.
- Inculcate leadership qualities to motivate self and others.
- Manage human resources at the shop-floor
- Maintain and be a part of healthy work culture in an organization.
- Use marketing skills for the benefit of the organization.
- Maintain books of accounts and take financial decisions.
- Undertake store management.
- Use modern concepts like TQM, JIT and CRM.

ENTREPRENEURSHIP

Unit 1: **08**

Introduction:

- Concept /Meaning and its need
- Qualities and functions of entrepreneur and barriers in entrepreneurship
- Sole proprietorship and partnership forms and other forms of business organizations
- Schemes of assistance by entrepreneurial support agencies at National, State, District level, Organisation: NSIC, NRDC, DC, MSME, SIDBI, NABARD, NIESBUD, HARDICON Ltd., Commercial Banks, SFC's TCO, KVIB, DIC, Technology Business Incubators (TBI) and Science and Technology Entrepreneur Parks

Market Survey and Opportunity Identification/Ideation:

- Scanning of the business environment
- Salient features of National and Haryana State industrial policies and resultant business opportunities
- Types and conduct of market survey
- Assessment of demand and supply in potential areas of growth
- Identifying business opportunity
- Considerations in product selection
- Converting an idea into a business opportunity

Project report Preparation

- Preliminary project report
- Detailed project report including technical, economic and market feasibility
- Common errors in project report preparations
- Exercises on preparation of project report
- Sample project report

MANAGEMENT

Unit 2: **08**

Introduction to Management:

- Definitions and importance of management
- **Functions of management:** Importance and process of planning, organising, staffing, directing and controlling
- Principles of management (Henri Fayol, F.W. Taylor)
- Concept and structure of an organisation
- Types of industrial organisations and their advantages
- Line organisation, staff organisation
- Line and staff organisation
- Functional Organisation

Unit 3: **07**

Leadership and Motivation:

- **Leadership:** Definition and Need, Qualities and functions of a leader, Manager Vs leader, Types of leadership, Case studies of great leaders
- **Motivation:** Definition and characteristics, Importance of self-motivation, Factors affecting motivation, Theories of motivation (Maslow, Herzberg, Douglas, McGregor)

Management Scope in Different Areas:

- **Human Resource Management:** Introduction and objective, Introduction to Man power planning, recruitment and selection, Introduction to performance appraisal methods
- **Material and Store Management:** Introduction functions, and objectives, ABC Analysis and EOQ
- **Marketing and sales:** Introduction, importance, and its functions, Physical distribution, Introduction to promotion mix, Sales promotion
- **Financial Management:** Introductions, importance and its functions, knowledge of income tax, sales tax, excise duty, custom duty, VAT, GST

Unit 4: **07**

Work Culture:

- Introduction and importance of Healthy Work Culture in organization
- Components of Culture
- Importance of attitude, values and behavior
- **Behavioral Science –** Individual and group behavior.
- **Professional ethics –** Concept and need of Professional Ethics and human values.

Basic of Accounting and Finance:

- **Basic of Accounting:** Meaning and definition of accounting, Double entry system of book keeping, Trading account, PLA account and balance sheet of a company
- **Objectives of Financial Management:** Profit Maximization v/s Wealth Maximization

Miscellaneous Topics:

- **Total Quality Management (TQM):** Statistical process control, Total employees Involvement, Just in time (JIT)
- **Intellectual Property Right (IPR):** Introduction, definition and its importance, Infringement related to patents, copy right, trade mark

References:

- A Handbook of Entrepreneurship, Edited by BS Rathore and Dr JS Saini; Aapga Publications, Panchkula (Haryana)
- Entrepreneurship Development and Management by J.S.Narang; Dhanpat Rai & Sons, Delhi.
- Entrepreneurship Development by CB Gupta and P Srinivasan, Sultan Chand and Sons, New Delhi
- Handbook of Small Scale Industry by PM Bhandari
- Entrepreneurship Development and Management by MK Garg
- E-books/e-tools/relevant software to be used as recommended by AICTE/UBTE/NITTTR, Chandigarh.

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BVGCT502
POTTERY AND PORCELAIN-I

Course Outcomes:
After undergoing the subject, the students will be able to:
- Know the various raw materials used in white ware Industries
- Know the process of manufacturing of various white ware
- Understand various composition and formulation of various types of white ware & their characteristic
- Understand various qualities and process of testing of various ceramic products

POTTERY

Unit 1: **08**
- A study of the various ceramic fabrication process (for manufacture of Products).
- A detailed study of the manufacture of floor and wall tiles, sanitary ware, table ware, parian art ware, semi-vitreous bone china, chemical stone ware, chemical porcelain, electrical porcelain.
- **Ceramic glazes -** Different types of glazes, their composition preparation and application.

Unit 2: **08**
- **Ceramic Stains -** Their composition, preparation, application & use. Decoration with stains.
- **Ceramic Transfer -** Their preparation, application and firing.
- **Mechanization in pottery works -** Introduction to simple hand tools, equipments & Machines.

PORCELAIN

Unit 3: **07**
- Definition of porcelain, Describe the different types of porcelain as Hard porcelain, Soft Porcelain, Chemical Porcelain, Dental Porcelain, Electrical Porcelain, Bone China etc.

High and low tension insulators:
- High voltage low frequency application Porcelain Insulator, Low voltage high frequency application, Steatite, Magnesium titanate, cordierite, Porcelain.

Lithography:
- Lithium Compounds
- Prepare and Design For making Lithograph transfer.

Unit 4: **07**

Quality Control & Testing:
- Green and dry properties of body mixes such as shrinkage, bulk density, strength.
- Fired characteristics such as fired shrinkage, fired strength (MOR and Compressive strength), water absorption, apparent porosity, bulk density, fired colour at different temperatures.
- Pressing effect on the fired and green bodies.
- Thermal expansion of body and Glage.
- **Testing- Physical testing:** thermal behaviour, MOR, Porosity, Density, Crazing, etc.

References:

- Ceramic Whitewares by Sudhir Sen
- Industrial Ceramics by Singer & Singer, Khanna Publishers, New Delhi
- Handbook of Ceramics by S. Kumar & Others, Prentice Hall of India
- Whiteware by W. Rayan

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BVGCT503
GLASS TECHNOLOGY-I

Course Outcomes:
After undergoing the subject, the students will be able to:

- Know various types of raw materials for glass making & formulating batch composition
- Understand general ideas about glass melting furnace & glass melting process
- Know knowledge about strain in glass & its elimination
- Understand idea about the various process of glass forming methods
- Understand general idea about the quality of glass
- Understand different glass defects & their remedies
- Know the decoration of glass and Special glass making
- Know idea on layout of modern glass plant

Unit 1: **08**

- **Raw Material & Batch:** Storage of raw materials, batch house, melting furnace, fabrication-machines, annealing Lehar, sorting and packaging section, ware house.
- **Glass Melting Process:** Batch calculation of raw materials for glass making, Process of glass formation, Refining of glass, refining mechanism, refining agent, factor affecting refining, Role of viscosity in glass refining, Colourising and Decolorizing- Theory and agent

Unit 2: **08**

- **Manufacturing & Formation of Glass Ware:** Various methods used for glass products making, Various machines used for glass making, Manufacturing of glass by blowing & manual process, float process, semi-automatic & Automatic process, Manufacturing of glass bottle, glass Jar glass sheet, Picture tube, thermo flask, electric bulb & tube, glass bangles, Manufacturing of fiber glass, glass wool, Optical fiber, Manufacture of sheet, plate and rolled glass, toughened glass, laminated safety glass. Optical Glass- Composition, manufacture of optical glass quality control measures.
- **Annealing & Toughening of Glass:** Describe the annealing, process of annealing, aim of annealing, determine annealing schedule for various glass products, Define the Toughening of glass, Explain tempering of glass by various methods, State & explain Chemical & mechanical toughening of glass, Relation between annealing and viscosity of glass.

Unit 3: **07**

- **Properties Of Glass:** Describe the following properties of glass – Viscosity, Density, Thermal properties, optical properties, Electrical properties, Chemical durability Viscosity, variation with temperature and composition, transformation range
- **Defects in Testing of Glass:** Describe in brief – defects of glass by visual observation as cords, Blister, Seeds, Bad colours etc, Describe their causes and remedies Origin of thermal stresses, generation and release of stresses, strain viewer. Chemical durability of glass measurement of chemical durability by A.S.T.M & I.S.I Method, Effect of glass composition and its significance in glass processes & its measurements.

Unit 4: **07**

- **Glass Decoration:** Describe the following methods of glass decoration in brief – Grinding, Polishing, Etching, Sand Blasting, Painting, Engraving, Cutting, Staining, Engobing, Lustering, Enameling
- **Special Glasses:** Define & describe the characteristics and application of the following glasses -
  a) Borosilicate glass
  b) Vycor glass
  c) Pyrex glass
  d) Heat resisting glass
  e) Coloured glass
  f) Ruby glass
  g) Glass for electrical & electronic Industries
  h) Laminated glass
  i) Glass for optical communication
  j) Alumino silicate glass, Alakali Silicate glass, Vitreous Silica glass, Lead glass

References:

- A Hand Book of Glass (Vol. I & II) by F.B. Tulley
- Modern Glass Practice by S.G. Scholse, Publisher McGraw Hill

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BVGCT504
PROCESSING OF CERAMIC RAW MATERIALS

Course Objectives:

- Introduce the methods of material recovery by quarrying
- Describe the various processes involved in making the quarried raw material into fine, fractioned powders
- Discuss the means of mixing, conveying and storage of the processed raw materials.

Course Outcomes:

On completion of the course, the students are expected to

- Know the different quarrying methods to extract materials and its purification
- Select a proper size reduction method for the given input size and for the expected final size
- Discuss different size separation methods
- Identify a suitable method of mixing and conveying for the given material
- Discern different storage methods

Unit 1: **08**

Quarrying:

- 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 2: **08**

Size Reduction:

- 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 3: **07**

Mechanical Separation:

- 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. Applications - requirements and market scenario - Industries.

Unit 4: **07**

Mixing

- **Mixing –** mechanism of mixing, types of mixers – batch and continuous mixers – pan mixer, shaft mixer, U mixer, muller mixer and other mixers, liquid mixers – mechanism, blungers, agitators.

Conveying and Storage of Materials:

- **Conveying –** solid conveying-types of conveyors, criteria for selecting a conveyor; liquid conveying-condition for liquid conveying, different types of pumps.Storage methods for different ceramic powders. Problems in bin storage

References:

- Warren L.McCabe, Julian C.Smith and Peter Harriott, Unit Operations of Chemical Engineering, 7thEdn., McGraw Hill International Edition,2013.
- Charles Burroughs Gill, Materials Beneficiation, Springer Verlag,1991.
- Ryan W and Redford C, Whitewares: Production, Testing and Quality Control, Pergamon Press, NY,1987.
- Vincenzini P, Fundamentals of Ceramic Engineering, Elsevier Applied Science,London,1991.
- Paul De Garmo E, Black J.J and Ronald A.Kohser, Materials and Processes in KeishiGotoh, Powder Technology Handbook, Marcel Dekker Inc.,1997.
- Singer F.and SingerS., Industrial Ceramics, Oxford and IBH Publishing Co.,1991.
- Mohamed N.Rahaman, Ceramic Processing, CRC Press, 2thEdn.,2017.
- Tooley F.V, Handbook of Glass Manufacture, VollandII, Ogden Publishing Co.,NY, 1960.

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BVGCT505P
INDUSTRIAL TRAINING/ON JOB TRAINING/ WORKSHOP

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SEMESTER-06

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BVGCT601
TRADITIONAL CERAMICS

Course Objectives:
The course is aimed to
- Explain the composition and types of various traditional ceramic bodies.
- introduce design body compositions and formulate bodies
- describe the testing and properties of traditional ceramic bodies

Course Outcomes:
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 and heavy clayware products and know the body formulation and properties.
- Be able to test ceramic bodies and glazes

Unit 1: **08**
Designing of Body Composition:
- History – definition – classification. Raw materials – Plastic and non-plastic. Additives- Binders, electrolytes, plasticizers. Body designing –batch calculation vs chemical analysis. Recipe preparation mixing, screening, magnetic separation, storage system of slip process.

Unit 2: **08**
Body Formulations:
- Body composition – porcelain, earthenware, bone china, sanitary ware, hotel china, terracotta, majolica, steatite bodies, cordierite bodies, rutile bodies, titanate bodies, zircon bodies, lava bodies - Industries - Market Scenario - Demand.

Unit 3: **07**
Whiteware Products:
- Manufacturing process and properties – whitewares at home – tableware, kitchenware, flame resistant ware, art ware, containers, whitewares in construction – floor tile, wall tiles, sanitary ware, whitewares in electrical applications – low tension insulators, high tension insulators, high frequency low loss insulators, whitewares in industrial use – abrasion resistance, chemical resistance, heat resistance - Industries - Market Scenario - Demand.

Unit 4: **07**
Heavy Clayware Products:
- 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, fireclay sanitaryware - Industries - Market Scenario - Demand.

Properties and Testing:

- Tests on unfired body –bulk density, green MOR, Shrinkage. Tests on fired body - strength, density, porosity, moisture absorption, abrasion resistance, chemical durability, thermal expansion, thermal shock resistance and electrical properties - dielectric strength, dielectric constant, power and loss factor, volume resistivity.

References:

- SingerF.andSingerS, Industrial Ceramics, Oxford and IBH Publishing Co, 1991.
- Ryan W.and RadfordC., Whitewares Production, Testing and Quality Control, Pergamon Press, NY, 1987.
- Rexford Newcomb Jr, Ceramic Whitewares : History, Technology and Applications, Pitman Publishing Corporation, 1947.
- AlenDinsdale, Pottery Science : Materials, Processes and Products, Ellis Horwood Ltd, 1986.
- SudhirSen, Ceramic Whitewares : Production, Testing and Quality Control, Pergamon Press, 1987.
- Bryan Sentance, Ceramics: A World Guide to Traditional Techniques, Thames and Hudson, 2004.

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BVGCT602
POTTERY AND PORCELAIN-II

Course Outcomes:
After undergoing the subject, the students will be able to:

- Know the various raw materials used in white ware Industries
- Know the Defects in various white ware
- Understand various composition and formulation of various types of white ware bodies & their characteristic
- Understand various qualities and process of testing of various ceramic products

Unit 1: **08**

- Raw material for white wares. Thermal effect, high temperature reactions in raw materials and their chemical change. Properties effect on ceramic whitewares, Texture and other physical properties. Influence of size and shape of particles. Particles size of ceramic materials and their determination. Changes in volume factors which influence the change.
- Defects in white ware bodies caused by thermal expansion effects. Factors which influence changes in porosity and water absorption. Factors involved in the strength of whiteware bodies.

Unit 2: **08**

- Define Calcination, sintering and vitrification. Development of the grain growth Microstructure of white wares.
- Triaxial and other white wares and compositions with their Batch calculations.
- **Mechanism of firing and control:** Modern trends in firing of whitewares.

Unit 3: **07**

- Strength of porcelain insulators. Factors effecting breakdown of high and low voltage insulators.
- **White wares bodies:** Earthen Ware, Stone ware, sanitary wares, bone china, chemical porcelain, electrical porcelain manufacturing method, properties and uses.
- Describe the Ceramic Glaze, Raw material & their influence, Preparation, classification, application(Dipping, spraying, pouring, brushing, dusting) & decoration, Properties, Defects(Crawling, pinholes, peeling, crazing, spit-out dunting, blistering, sulphering, rolling, chipping) and their remedies.

Unit 4: **07**

- Ceramic colours and decoration, Factor affecting colour.
- **Recent development and control techniques applied to the whitewares processes-** Kilns, Roller Head Jigger, Digital Printing.

References:

- Industrial Ceramics by Singer & Singer, Khanna Publishers, New Delhi
- Fine Ceramics by F.H. Norton.
- A Handbook of Ceramics, Prentice Hall of India

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BVGCT603
GLASS TECHNOLOGY-II

Course Outcomes:
After undergoing the subject, the students will be able to:

- Know various raw materials for glass ceramic
- Understand general ideas about Ornamental glass, melting furnace & glass melting process
- knowledge about colorants in glass
- Understand idea about the various process/technique of glass decoration
- Understand Float glass making process & other glass products
- Know the various process/technique decoration of glass and Special glass making
- Know idea on layout of modern glass plant

Unit 1: **08**

- **Glass Ceramics:-** Introduction on Nucleation and crystallization in glasses, Controlled heat treatment for crystallization, Ultra low thermal expansion glass ceramics, Machinable glass ceramics.
- **Ornamental Glass:** History of glass beeds making, Tools and apparatus for glass beads making. Raw materials of ornamental glass i.e. Soda Lime, Types of ornamental products i.e. Glass beads, Glass Pendants, Different techniques of glass beads making

Unit 2: **08**

- **Colourants of glass**-Titanium, oxides, Chromium oxide, manganese oxide, Iron oxide, Cobalt oxide, Nickel oxide, Copper oxide, Selenium oxides and others.
- Different techniques of decoration i.e. Silvering, Fuming, Lustering, Feathering, Dating, Banding, Dichroic, Millefiori,
- **Float Glass:** Theory of float process, construction of float tank, Control of glass ribbon thickness, application/uses of Float glass

Unit 3: **07**

- **Ophthalmic Glasses:** Refractive and dispersion in glass, Design of glass lens.
- **Glass And Refectory Technology:** Different types of refractories used in glass industry, Properties, Behaviour, Conditions in the different zones of glass. Melting furnace and selection of refractory accordingly.

Unit 4: **07**

- ASTM methods for determination of strain point, annealing point, softening point, density, co-efficient of thermal expansion, viscosity
- Manufacturing of glass bottles, hollow and pressed ware, sheet and plate glass, safety glass, optical glass, toughened glass, fiber glass, heat resistance glass, window glass

References:

- Handbook of Glass Manufacturing by F.V. Tooley, Prentice Hall of India Publication
- Modern Glass Practice by S.G. Scholse, McGraw Hill Publication

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BVGCT604
CERAMIC CHARACTERIZATION

Course Objective:

- To enable students to be thorough in different materials characterizations techniques which are dependent on their composition, phase, crystal, particulate and microstructure properties and applications.

Course Outcomes:

On completion of the course, the students are expected to

- Know the techniques to characterize a material right from raw material stage to final product stage
- Explain the principle of various characterization techniques
- Select a suitable characterization technique to analyze a property
- Be able to design a material with required properties with the aid of characterization techniques

Unit 1: **08**

- **Thermal Analysis:** Principles of Differential thermal analysis (DTA), Thermo gravimetric analysis (TGA) and Differential scanning calorimetry (DSC), Dilatometer - their applications in processing and Characterization of ceramics, glasses, and glass Ceramics.

Unit 2: **08**

- **X – Ray Diffraction:** Characteristics X – rays, Fundamental principles of X-ray diffraction (XRD); Brag's Law, Determination of Crystal Structure and particle size from XRD, Atomic Scattering and geometrical structure factors and their application in intensity calculation. Single crystal and powder diffraction.

Unit 3: **07**

- **Spectroscopy:** Basic laws of spectrophotometry and its application in elemental analysis in UV/ Visible range, Construction and working principle of spectrophotometer, Beer-Lambert's law-limitations, deviations. Additive rule of absorbance in multiple analysis of materials. General aspects of IR spectroscopy and its application in structural analysis of ceramic systems. Optical systems and operation of FTIR spectrophotometers. Raman spectroscopy.

Unit 4: **07**

- **Surface Characterizations:** Construction and operation of optical microscope; Principle of electron microscopy: electrostatic and magnetic lens systems; Generation of electron beam (Electron gun); Interaction of electron beam with material. Construction and operation of Transmission Electron Microscope and Scanning, Electron Microscope. Mechanism of image formation in SEM and its processing. Electron microprobe analysis (EDAX and WDS).Preparation of ceramic samples for TEM and SEM electron microscopic studies. Characteristics of microstructure; Quantitative microstructure and phase analysis: Study of the morphology, size and aggregation of ceramic materials. BET, Atomic force microscopy, Auger electron spectroscopy.
- **Electrical, Magnetic Characterizations:** Electrical resistivity in bulk and thin films (2-probe method and 4-probe method), Hall effect, Impedance spectroscopy, Vibrating sample magnetometer (VSM), Magnetic PE loop.

References:

- Antony R. West , Solid State Chemistry and its applications, Second edition, John Wiley and Sons, 2014.
- ZhangS, Li L.and Ashok Kumar, Materials Characterization Techniques, CRC Press, 2008.
- CullityB. D., Elements of X-ray diffraction, Second edition, Addition-Wesley publication, 2001.
- Yoshio Waseda, Kozo Shinoda, Eiichiro Matsubara, X-Ray Diffraction Crystallography: Introduction, Examples and Solved Problems, Springer, 2011.
- Characterization of materials (Materials Science and Technology: A comprehensive treatment, Vol 2A and 2B, VCH (1992)
- https://nptel.ac.in/courses/113106034/
- https://nptel.ac.in/courses/115103030/
- https://chem.libretexts.org/

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