3.1 MATERIAL SCIENCE

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RATIONALE

This course has been intended to introduce the diploma holders to the properties related to the structure and the characteristics of various types of materials used in the ceramic industries. New materials are being developed & it is possible change the properties of materials to suit the requirements. This course aims at developing knowledge on various types of materials.

DETAILED CONTENTS

Atomic structure and electronic configuration, types of bonds Space lattice and unit cell crystal system and indices, structure of ceramic material, X-ray, Bragg's law and use of X-ray for determination of cell structure. Point, line and Surface defects. Edge and Screw dislocation. (20hrs.)

Solid solution, Intermediate phases and intermetallic compounds, Gibbs phase rule. Uniary, Binary and Ternary phase diagrams, Lever rule. Phase transformation, nucleation and growth. Martensitic tranformation. Examples: Water system , Al_2O_3-SiO_2, Iron carbon diagram. (14 hrs.)

Hardening, Recrystallisation and Grain growth, Glass transition, Elastic behaviour of materials. Strengthening, Ductile and Brittle fracture. Creep and Fatigue. Thermal properties of materials, Electrical, Electronic and dielectric behaviour of materials (Conductance, resistance, permanence, insulation, dielectric constant impedance). Magnetic behaviour, Hard and soft magnetic properties, magnetic flux, flux density magnetizing force, permeability, coercive force, retentivity, remanence, refractive index. (30 hrs.)

REFERENCE BOOKS:

1. Material Science and Engineering by V Raghavan, Prentice Hall of India Publishing
2. Material Science by Narula and Gupta
3. Engineering Materials by B.K. Agarwal
4. Material Science by R.K. Rajput; SK Kataria and Sons, Ludhiana
5. Introduction to Matrial Science for Engineers by J.F. Shackelford, Maxwell Macmillan International Edition
6. The Science and Engineering of Materials by Donald R. Askeland, PWS-Kent Publishing Company
7. Elements of Material Science and Engineering by Lawrence H. Vanvlack, Addison Wesley Publication

3.2 UNIT OPERATIONS IN CERAMICS

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RATIONALE

A thorough knowledge of unit operations is essential for the study of ceramic engineering. This course acquaints the students with the basic principles of stochiometry, fluid mechanics, mechanical operations, heat transfer and mass transfer.

DETAILED CONTENTS

1. Introduction to unit operations and unit processes and their brief description, fundamental concepts (4 hrs)

2. Fluid Mechanics (10 hrs)

   - Properties of fluids
   - Different types of flow (Laminar and Turbulent)
   - Viscosity
   - Relative motion between fluids and solids
   - Dimensional analysis
   - Measurement of flow of fluids (Manometer, venturimeter, rotameter, orificemeter, pitot tube)

3. Heat Transfer (15 hrs)

   - Concept of heat transfer
   - Modes of heat transfer – conduction, convection and radiation

   Conduction
   - Conduction through composite walls
   - Fourier's law, thermal conductivity, heat transfer coefficient

   Convection
   - Free and forced convection
   - Calculation of heat transfer coefficient, local and average heat transfer coefficient, heat temperature difference, fouling factor

   Radiation
   - Black body radiation, geometrical factor, grey body, Stefan – Boltzman law
   - Radiation from non-luminous gases
   - Radiation from luminous flames

4. Mass Transfer (20 hrs)

   - The rate equation, driving force, fugacity and concentration, mass transfer by diffusion, diffusivity, mass transfer in turbulent flow.
   - Evaporation; Horizontal tube evaportor; vertical tube evaporator

- Crystallization; Rate of crystallization, yield of a given operation, purity of product, size of crystals

- Agitation; objectives and requirements, types of agitation equipments

5. Mechanical Operations (15 hrs)

Size reduction; objectives, stages of reduction – coarse size reduction, intermediate size reduction, fine size reduction. Screening; Industrial screening equipments, sieve analysis, determining particle size. Sedimentation: batch and continuous equipments, equipments like thickners, filter press, cyclone separators, dryers

LIST OF PRACTICALS

1. To study the sieve analysis of the product obtained from ball mill, crusher and grinder
2. Measurement of viscosity from viscometer
3. To study the sedimentation behaviour of slurry
4. Study of filtration efficiency through filter press
5. To measure the thermal conductivity of insulating materials
6. To measure diffusivity of solids in liquid or gas

RECOMMENDED BOOKS

1. Unit Operations of Chemical Engineering by Mcabe and Smith, McGraw Hill Publication
2. Unit Operations Vol. I & II by Chatterjii, Khanna Publishers, New Delhi Publication
3. Heat Transfer by DQ Kern
4. Mass Transfer Operation by Treybal
5. Chemical Engineering I & II by Coulson & Richardson, Pergamon Press Publication
6. Introduction to Chemical Engineering by Badger and Banchero, McGraw Hill Publication

3.3 PRINCIPLES OF METALLURGY

L	T	P
3	-	-

RATIONALE

Material play an important role in any industrial applications. A diploma holder must be aware of and conversant with the different types of materials available, their properties, uses, and availability to enable him to make a judicious choice for a given application. This course has been designed to cover the above aspects so that diploma holder can perform his functions confidently.

It also includes the various treatments done on metals to improve their properties.

DETAILED CONTENTS

1. Classification (8 hrs.)

   Metals and non metals ferrous & non ferrous metals and their alloys in brief.

2. Engineering Properties Of Materials (18 hrs.)

   - Physical Properties:- Density, Heat Capacity, Specific heat, Thermal Conductivity Thermal Expansion, Porosity and Denseness.

   - Mechanical Properties:- Stress and Strain (Tensilc, Compressive, Shear). Elastic limit, Yield point, Yield strength, Resilence, Plasticity, Ductility, Malleability, Brittleness, Toughnes, Impact strength, Modulus of elasticity, compliance, Tensile, Compressive and Shear strength, Fusibility, Weldability and Mechanic ability, Hardness and Hardenability, Fracture, toughness, Bending.

3. Heat Treatment Of Steel (12 hrs.)

   Definition and importance, Annealing, Normalis Hardening, Tempering. Martempering, Austempering. Developments in heat treatment process, Surface hardening process- Carburizing, Nitriding and Flame hardening.

4. Powder Metallurgy (10 hrs.)

   Powder production, Powder mixing, Compaction and Sintering, Advantages and its limitations, Application of Powder metallurgy.

RECOMMENDED BOOKS

1. Engineering Metallurgy by V.Sivraj
2. Metallurgy for Engineers by C. Ojal
3. Material Science and Metallurgy by R.B. Choudhary, Khanna Publishers, New Delhi
4. Material Science by Van Valen.

3.4 ENGINEERING THERMODYNAMICS

L	T	P
3	1	-

RATIONALE

It is a core subject of Chemical Engineering and is essential for understanding basic concepts, thermodynamic properties of fluids & performance of thermal systems used in industry.

DETAILED CONTENTS

1. Introduction & basic concepts (11 hrs)

   Systems, processes & surroundings, homogenous & heterogeneous systems, closed, open & isolated systems, intensive & extensive properties, state & path functions. Concept of internal energy, enthalpy, entropy, free energy & equilibrium. Equation of state, ideal gas law, Vander Waal's eqn., Amagat's law, Dalton's law, Henry's law, Raoult's law, Zeroth law of Thermodynamics.

2. First law of Thermodynamics for open & closed systems. (8 hrs)

   Calculation of internal energy, enthalpy, heat and work for ideal gas undergoing reversible, isometric, isothermal, isobaric, adiabatic and polytropic process

3. Second law of Thermodynamics (8 hrs)

   Entropy change and its calculations for a closed & open system, Carnot's cycle and its efficiency, thermodynamic temperature scale, reversible & irreversible process.

4. Third Law of Thermodynamics and its Applications (3 hrs)

5. Applications of the laws of thermodynamics (10 hrs)

   Refrigeration coefficient of performance, vapour compression refrigeration system, absorption refrigeration, properties & applications of refrigerants, reciprocating air compressors; single stage compressor, isothermal efficiency, volumetric efficiency, clearance & clearance volume.

6. Phase equilibria (8 hrs)

   Vapour liquid equilibria, dew point and bubble point and their calculations for two phase systems, Gibbs Duhem Equation.

RECOMMENDED BOOKS:

1. Introduction to Chemical Engineering Thermodynamics by Smith and Vanness, Mc Graw Hill.
2. Chemical Engineering thermodynamics by K.V. Narayanan, Prentice Hall India.
3. Chemical Engineering Thermodynamics by Dodge, Mc Graw Hill.
4. Chemical Engineering Thermodynamics by YVC Rao.
5. Engineering Thermodynamics by PK Nag
6. Thermal Engineering by Balleny

3.5 FUELS AND FURNACES

L	T	P
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RATIONALE

Ceramic materials are manufactured at high temperature so the knowledge of fuels and furnaces is necessary for proper processing and quality products. Moreover ceramic materials are also used for high temperature applications therefore, for their characterization knowledge of fuels and furnaces are required.

DETAILED CONTENTS

1. Theory of combustion:- combustion reactions, Actual air required for combustion. Theoretical and excess air, Calorific value and the total heat produced. (8 hrs.)

2. Types of fuels:- Solid, Liquid and Gaseous fuels. (30 hrs.)

   Solid Fuels:- Coal and Coke, Classification of coal, Properties of coal. Combustible and Non-combustible constituents, Ignition temperature, Pulverised coal, its utilisation. Coke as secondary fuel. Its properties and Uses. Testing-Proximate analysis, Ultimate analysis & Calorific value.

   Liquid fuels:- Indian resourcs, types, properties of various petrolum products, Testing of liquid fuels, Octane and Cetane number, Calorific value, flash point and fire point, Viscosity determination, Burner for liquid fuels. (atomizer, cup & cone burner, squirrel gauge)

   Gaseous fuels:- Its advantage over solid and liquid fuels, Natural gas, L.P.G., Properties, Burner of gaseous fuels.

   Testing-Calorific value determination, Orsat analysis.

3. Furnaces:- Definition, Classification, types of furnaces-Gas, Oil and Coal fired furnaces, Electrical furnaces, Regenerators and Recuperators, Annealing furnaces. (10 hrs.)

4. Kilns:-Continuous and Batch type, Downdraft, Shuttle Tunnel and Rotary Kilns, Elementary idea of temperature measurement, Pyrometers-Resistance, Electrical Gas, Thermocouples- Types and standardisation. (10 hrs.)

5. Elementary idea about kiln design. (6 hrs.)

LIST OF PRACTICALS

1. To determine the moisture content of a given fuel
2. To determine the calorific Value of coal by bomb calormeter coal .
3. To determine the flash point of a given fuel.
4. Determination of viscosity of oil Redwood viscometer or Torsion viscometer.
5. To determine the Water absorption by different raw materials (powders).
6. Elementary idea about furnace and kiln design.
7. To determine coefficient of thermal conductivity of single wall.
8. Thermocouple calibration
9. Proximate analysis of coal.
10. Determination of total Grindability of coal

RECOMMENDED BOOKS

1. Elements of Fuels, Furnaces and Refractories by O.P. Gupta.
2. Industrial Chemistry by Jain and Jain.

3.6 CERAMIC RAW MATERIALS

L	T	P
3	-	-

RATIONALE

This subject has been designed to introduce the diploma holders to the properties related to the structure and the characteristics of various types of specialized materials used in the ceramic industries. The usage of these materials in various industries is also covered in this subject.

DETAILED CONTENTS

THEORY

1. Plastic Raw Materials:- (6 hrs.)

   Introduction, Geology, mineralogy, classification of residual clay, transported Kaolin, Ball Clays, Stone ware Clay, fire clay, Alumina clays. Bentonite, Brief clays, loess & their properties & use in ceramic industries

2. Non-clay Plastic raw materials:- (5 hrs.)

   Tale, steatile pyrophyllite (Agalamatolith) sericite pyrophyllite & their properties, use in ceramic industries

3. Non-Plastic raw materials:- (6 hrs.)

   Silica, Quartz, Sandstone, Ganister, Quartizite, Sand, Flint, Diatomite & their prpoerties & use in ceramic industries.

   Feldspar, Cornish stone, Nepheline syenite, Pumic or Volcanic ash, Perlite, Bone ash, Apatite, Tricalcium Phosphate & their properties & use in ceramic Industry.

4. Other Alumina & Silica Containing raw materials:- (5hrs.)

   Silimanite, Kyanite, Andalusite & their properties & uses.

5. Frit Making: (8 hrs.)

   Involving smelting, Quenching, Drying & milling. Study of furnaces related to enamel firing. Batch making of ground coat, cover coat enameling.

6. Glaze:- (6 hrs,)

   Introduction, raw materials, properties of raw materials of glaze (including optical properties like reflectance, opacity etc.), batch making, mixing, milling.

7. Type of Glaze: (6 hrs.)

Raw glaze, transparent glaze, opaque glaze, coloured glaze, matt glaze, lead glaze, leadless glaze, crystalline glaze etc.

Opacifiers, colors, coloring oxide like iron oxide, cobalt oxide, copper, chromium, venedium, zircon etc.

8. Enamels: (6 hrs.)

Introduction, raw materials for enamels, its properties. Application method of Enamels & Glazes: Drying & brushing, spraying, dipping, pouring, screen printing etc. Decoration : Underglaze, onglaze, inglaze.

RECOMMENDED BOOKS

1. The Science and Engineering of Materials by Donald R. Askeland, PWS-Kent Publishing Company

2. Elements of Material Science and Engineering by Lawrence H. Vanvlack, Addison Wesley Publication

3. Material Science and Engineering by V Raghavan, Prentice Hall of India Publishing

4. Ceramics, Mastering the Craft by Richard Zakin, American Ceramic Society Publication

3.7 CEMENT TECHNOLOGY

L	T	P
3	1	4

RATIONALE

This specialized subject is taught to the diploma holders of ceramic engineering in order to widen their scope of employment so as to cover all cement manufacturing units also.

DETAILED CONTENTS

1. Definition, Classification of cements, Types of cement their properties and phases of cement. (8 hrs.)

2. Raw materials, their selection and proportionality, Calcareous and Argillacious materials, Additives, Manufacture of cement (wet and dry process). (10 hrs.)

3. Effect of raw materials and constituents on the properties of cement. Calculations of raw mix. Thermo chemistry of clinker formation, sequence of reaction, hydration of portland cement, setting and hardening of portland cement, physical and mechanical properties of portland cement. (12 hrs.)

4. Lime and other building materials, Different classes of lime, Their properties, Uses. (6 hrs.)

5. Gypsum and plaster of paris, setting and hardening of plaster of Paris, its uses. (6 hrs.)

6. Testing of cement-Initial setting time, Final setting time, fineness. (6 hrs.)

LIST OF PRACTICALS

1. Determination of fineness of cement.
2. Determination of water cement ration.
3. Determination of initial & final setting time of cement.
4. Determination of initial & final setting time of Gypsum.
5. Determination of initial & final setting time of Plaster of Paris.
6. Determination of soundness of cement by Le Chatteliers apparatus.
7. Determination of tensile strength of cement mortar cubes.
8. Determination of tensile strength of lime mortar cubes.
   Determination of compressive strength of cement mortar cubes.
9. Determination of compressive strength of lime mortar cubes.
10. Determination of chemical analysis of cement.

RECOMMENDED BOOKS

1. Text Book of Cement and Concrete by Lee
2. Advances in Cement Technology by S.M. Ghose