

Approved
Course Structure for UG Engineering Degree in Ceramic Technology
under Autonomy

Semester – III

Sl. No.	Course Code	Course Title	L	T	P	Contact hrs/wk	Credits
1.	HS 302	Law for Engineers	3	0	0	3	3
2.	BS 306	Mathematics III	3	0	0	3	3
3.	BS 307	Geology	3	0	0	3	3
4.	ES 306	Unit Operation I	3	1	0	4	3
5.	CT 301	Ceramic Raw Materials	3	1	0	4	3
6.	CT-302	Energy Resources & Furnaces	3	1	0	4	3
7.	BS 317	Geology Lab.	0	0	3	3	2
8.	ES 316	Unit operation Lab	0	0	3	3	2
9.	CT 311	Chemical Analysis Lab	0	0	3	3	2
		TOTAL	18	3	09	30	24
10.	MC 303	Value Education, human Rights and Legislative Procedures	3	0	0	3	3

Semester – IV

Sl. No.	Course Code	Course Title	L	T	P	Contact hrs/wk	Credits
1.	BS 408	Numerical Methods	2	1	0	3	2
2.	ES 407	Unit operation II	3	1	0	4	3
3.	BS 409	Fundamentals of Biology	3	0	0	3	3
4.	CT 403	Thermodynamics & Kinetics of Solids states Reactions	3	1	0	4	3
5.	CT 404	Process Ceramics.	3	1	0	4	3
6.	BS 418	Numerical Methods Lab.	0	0	3	3	2
7.	CT 411	Fuel Testing Lab	0	0	3	3	2
8.	CT 412	Powder Preparation & Characterization Lab	0	0	3	3	2
9.	CT 413	Physical Testing of Raw Materials	0	0	3	3	2
		TOTAL	14	4	12	30	22

Semester – V

Sl. No.	Course Code	Course Title	L	T	P	Contact hrs/wk	Credits
1.	CT 505	Refractories	3	1	0	4	3
2.	CT 506	Glass Science & Technology	3	1	0	4	3
3.	CT 507	Whitewares	3	1	0	4	3
4.	CT 508	Cement & Concrete	3	1	0	4	3
5.	OE 501	DBMS/Object Oriented Programming/Operation Research	2/2/2	1	0	3/3/3	3
6.	CT 515	Refractories Lab	0	0	3	3	2
7.	CT 516	Glass Lab	0	0	3	3	2
8.	CT 517	Whitewares Lab	0	0	3	3	2
9.	CT 518	Cement & Concrete Lab	0	0	3	3	2
10.	OE 511	DBMS Lab/ Object Oriented Programming Lab /Operation Research Lab	0	0	3	3	2
		TOTAL	14	5	15	34	25

Semester – VI

Sl. No.	Course Code	Course Title	L	T	P	Contact hrs/wk	Credits
1.	HS 603	Economics (Gr A) & Statistics (Gr B)	3	1	0	4	4
2.	CT 609	Monolithic Refractories	3	1	0	4	3
3.	ES 608	Engineering Materials Science	3	1	0	4	3
4.	CT 610	Metallurgy	3	1	0	4	3
5.	CT 611	Ceramic Coatings (Gr. A) & Process Calculations (Gr. B).	3	1	0	4	3
6.	OE-602	Instrumentation/Process Control	3/3	1	0	4/4	3
7.	CT 618	Instrumental Analysis Lab.	0	0	3	3	2
8.	CT 619	Ceramic Coating Lab	0	0	3	3	2
9.	HS 614	Seminar	0	0	4	4	2
		TOTAL	18	6	10	34	25
10.	MC 604	Technical Communication & Soft Skills	3	0	0	3	3

Semester – VII

Sl. No.	Course Code	Course Title	L	T	P	Contact hrs/wk	Credits
1.	CT 712	Advanced Ceramics	3	0	0	3	3
2.	CT 713	Physical Ceramics	3	0	0	3	3
3.	CT E 714	Steel Plant Refractories/Bioceramics	3/3	0	0	3/3	3
4.	CT E 715	Nano Technology/Composites	3/3	0	0	3/3	3
5.	OE 703	Quality Management	3	0	0	3	3
6.	HS 715	Group Discussion	0	0	2	2	2
7.	CT 720	Plant Design	0	0	4	4	2
8.	CT 721	Industrial Training	0	0	0	0	2
9.	CT 722	Project Part I	0	0	6	6	3
		TOTAL	15	0	12	27	24

Semester – VIII

Sl. No.	Course Code	Course Title	L	T	P	Contact hrs/wk	Credits
1.	HS 804	Industrial Management	3	1	0	4	3
2.	CT E 816-	Electrical & Electronic Ceramics/Optical Ceramics/Bio Ceramics	3/3	1	0	4/4	3
3.	OE 804	Artificial Intelligence & Robotics/Engineering System Modeling & Simulation/Bioinformatics	3/3	1	0	4/4	3
4.	CT 821	Comprehensive Viva Voce	0	0	0	0	2
5.	CT 822	Project Part II	0	0	16	16	6
		TOTAL	9	3	16	28	17

DETAILED SYLLABI OF 3rd SEMESTER UNDER AUTONOMY;B.Tech, C.T

(approved in A.C. meeting held in Dec,13 & May,14)

HS 302: Law for Engineers

Credits: 3

The objective of the course is to familiarize students (Prospective engineers) with elementary knowledge of laws that would be of utility in their profession. The syllabus covers Constitution of India and new areas of law like IPR, ADR, Human Rights, Right to Information, Corporate law, Law relating Elections and Gender Studies. To be supplemented by the historical development of laws wherever required.

Module 1A: Constitutional Law covering the Preamble; Fundamental Rights, Judicial Activism including Equality and Social Justice, Life and Personal Liberty and Secularism and Religious freedoms; Directive principles of State policy; Fundamental Duties; Emergency provisions – kinds, legal requirements and legal effects; (5 Lectures)

Module 1B: Human Rights and Public International Law covering Human Rights in International Law-Theoretical foundation, human rights and international law; Historical development of human rights; Human Rights in Indian tradition and Western tradition; Covenant on Civil & Political Rights 1966 including Optional Protocol – I (Individual Complaint Mechanism) & Optional Protocol – II (Abolition of Death Penalty); Covenant on Economic, Social and Cultural Rights 1966 including Optional Protocol – I (2002); UN Mechanism and specialized agencies, (UNICEF, UNESCO, WHO, ILO, FAO, etc.); International NGOs – Amnesty International, Human Rights Watch, Greenpeace Foundation; Enforcement of Human Rights in India including Supreme Court, High Courts, Statutory Commissions – NHRC, NCW, NCM, NC-SCST etc. Public International Law, covering Introduction, Customs, Treaties, State territories including Recognition of States and governments, Law & Practice of Treaties and Law of Sea; (5 Lectures)

Module 2A: General Principles of Contract under Indian Contract Act, 1872 covering General principles of contract – Sec. 1 to 75 of Indian Contract Act and including Government. as contracting party, Kinds of government contracts and dispute settlement, Standard form contracts; nature, advantages, unilateral character, principles of protection against possibility of exploitation, judicial approach to such contracts, exemption clauses, clash between two standard form contracts; (4 Lectures)

Module 3A: Law relating to Intellectual property covering Introduction – meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; Other new forms such as plant varieties and geographical indications; International instruments on IP – Berne convention, Rome convention, TRIPS, Paris convention and international organizations relating IPRs, WIPO, WTO etc; Law relating to Copyright in India including Historical evolution of Copy Rights Act, 1957, Meaning of copyright – literary, dramatics and musical works, sound records and cinematographic films, computer programs, Ownership of copyrights and assignment, Criteria of infringement, Piracy in Internet – Remedies and procedures in India; Law relating to Trademarks under Trademark Act, 1999 including Rationale of protection of trademarks as Commercial aspect and Consumer rights, Trademarks, registration, procedures, Distinction between trademark and property mark, Doctrine of deceptive similarity, Passing off an infringement and remedies; Law relating to Patents under Patents Act, 1970 including Concept and historical perspective of patents law in India, Patentable inventions with special reference to biotechnology products, Patent protection for computer programs, Process of obtaining patent – application, examination, opposition and sealing of patents, Patent cooperation treaty and grounds for

opposition, Rights and obligations of patentee, Duration of patents – law and policy considerations, Infringement and related remedies; (8 Lectures)

Module 3B: Right to Information Act, 2005 covering, Evolution and concept; Practice and procedures; Official Secret Act, 1923; Indian Evidence Act, 1872; Information Technology – legislation and procedures, Cyber crimes – issues and investigations; (3 Lectures)

Module 4A: Labour Laws, covering Industrial Disputes Act, 1947; Collective bargaining; Industrial Employment (Standing Orders) Act, 1946; Workmen’s Compensation Act, 1923; (3 Lectures)

Module 4B: Corporate Law, covering Meaning of corporation; Law relating to companies, public and private (Companies Act, 1956) general provisions; Law and multinational companies – International norms for control, FEMA 1999, collaboration agreements for technology transfer; Corporate liability, civil and criminal; (4 Lectures)

Module 4C: Election provisions under Indian Constitution (Art.324–329), covering Representation of Peoples Act and Prevention of Corruption Act, 1988; Superintendence, directions and control of elections to be vested in Election Commission; Prohibition as to ineligibility for inclusion in electoral roll on ground of religion, race, caste or sex; Election to the house of people and to the legislative assemblies of States to be on the basis of adult suffrage; Power of parliament to make provisions with respect to elections to legislatures; Power of legislature of State to make provisions with respect to elections to such legislature; Bar to interference by courts in electoral matters; Offences relating to elections under IPC 1860 (Sec.171-A to 171-I), Definition – candidate electoral rights, Bribery, undue influence and impersonation at elections and punishments, False statement in connection with election, Illegal payment in connection with election, Failure to keep election accounts; (4 Lectures)

Module 5: Gender Studies, covering Meaning of gender, international perspective and national perspective; Laws relating women in India; Judicial approach and responses 24 Vishaka V/s State of Rajasthan 1997 SC; Rights enforcement mechanism in India; Landmark judicial decisions of Supreme Court relating to women; (4 Lectures)

Text/Reference Books:

1. D.D. Basu (1996), *Shorter Constitution of India*, Prentice Hall of India
2. M.P. Jain (2005), *Indian Constitutional Law*, Wadhwa & Co.
3. M.P. Singh (1998), *Constitutional Law of India*, Eastern Book Co.
4. P.M. Bakshi (2003), *Constitution of India*, Universal Law Publishing Co.
5. H.M. Seervai (1993), *Constitutional Law of India*, Tripathi Publications
6. Agarwal H.O.(2008), *International Law and Human Rights*, Central Law Publications
8. S.K. Awasthi & R.P. Kataria(2006), *Law relating to Protection of Human Rights*, Orient Publishing
9. S.K. Kapur(2001), *Human Rights under International Law and Indian Law*, Central Law Agency
10. Meena Rao (2006), *Fundamental concepts in Law of Contract*, 3rd Edn. Professional Offset
11. Neelima Chandiramani (2000),*The Law of Contract: An Outline*, 2nd Edn. Avinash Publications Mum
12. Avtarsingh(2002), *Law of Contract*, Eastern Book Co.
13. Dutt(1994), *Indian Contract Act*, Eastern Law House
14. Anson W.R.(1979), *Law of Contract*, Oxford University Press
15. Kwatra G.K.(2005), *The Arbitration & Conciliation of Law in India with case law on UNCITRAL Model Law on Arbitration*, Indian Council of Arbitration

16. Avtarsingh (2005), *Law of Arbitration and Conciliation*, Eastern Book Co.
17. Cornish W. R. (2008), *Intellectual Property Rights, Patents, Trademarks, Copyrights & Allied Rights*, Sweet & Maxwell
18. Wadhwa (2004), *Intellectual Property Rights*, Universal Law Publishing Co.
19. P. S. Narayan (2000), *Intellectual Property Rights*, Gogia Law Agency
20. T. Ramappa (2010), *Intellectual Property Rights Law in India*, Asia Law House
21. Bare text (2005), *Right to Information Act*
22. O.P. Malhotra, *Law of Industrial Disputes*, N.M. Tripathi Publishers
23. K.M. Desai(1946), *The Industrial Employment (Standing Orders) Act*
24. Rustamji R.F., *Introduction to the Law of Industrial Disputes*, Asia Publishing House
25. Avtarsingh (2007), *Company Law*, Eastern Book Co.
26. R.R. Pennington, *Company Law*, Butterworth Publications
27. Sethna, *Indian Company Law*
28. Ratanlal & Dhirajlal,(1994), *Indian Penal Code*, Butterworth Publications
29. B.M. Gandhi, (1990), *Indian Penal Code*, Eastern Publishers
30. P.S. Achuthan Pillai(1995), *Criminal Law*, Eastern Publishers
31. K.D. Gaur(2002), *A Text book on IPC*, Deep & Deep Publications
32. Agnes Flavia(1999), *Law and Gender Inequality - The Politics of Women "s Rights in India*, OU Press
33. Shobha Saxena, *Crimes against Women and Protective Laws*, Deep & Deep Publications
34. Diwan Paras & Diwan Peeyashi(1994), *Women and Legal Protection*, Deep & Deep Publications

BS-306 (Mathematics III):

Credits: 3

Note 1: The whole syllabus has been divided into five modules.

Module I

Fourier series:

Introduction, Periodic functions, Even and odd functions, Special waveforms, Eulers formulae for Fouriers coefficients, Dirichlet's conditions and sum of the Fourier series, Half range Fourier series, Parseval's identity (Statement only).

Fourier Transform: Fourier Transform and its properties, Inverse Fourier Transform (Statement only), Fourier Transform of derivatives (Statement only), Convolution theorem (Statement only). Related problems. (8L)

Module II

Calculus of Complex variable:

Functions, Limit and Continuity, Analytic functions, Cauchy-Riemann equations

(Statement only) and related problems, Analytic continuation, Complex integration and Cauchy's theorem (Statement only), Cauchy's integral formula (Statement only), Taylors and Laurent series, Zeros of an analytic function, Poles, Essential singularities, Residue theorem (Statement only) and its application to evaluation of definite integrals (Elementary cases only), Introduction to Conformal Mapping. (12L)

Module III

Probability:

Axiomatic definition of probability, Conditional probability, Independent events, Related problems, Bayes theorem (Statement only) & its application. One dimensional random variable, Probability distributions-discrete and continuous, Expectation, Binomial, Poisson, Uniform, Exponential and Normal distribution, Problems on Binomial, Poisson and Normal distribution only. (12L)

Module IV

Partial Differential Equations:

Mathematical modeling of ceramic processes leading to PDE

Solution of one dimensional wave equation, One dimensional heat-conduction equation, Laplace equation in two dimension by the methods of

1: Separation of variables 2: Integral Transforms (Laplace and Fourier Transforms) (6L)

Module V

Series solution of Ordinary Differential equation:

Introduction, validity of series solution of an ordinary differential equation, general method to solve equation of the type: $P_0y'' + P_1y' + P_2y = 0$, related problems, Bessel's equation, properties of Bessel's function, Recurrence formula for Bessel's function of first kind, Legendre's equation, Legendre function; Recurrence formula for Legendre function ($P_n(x)$); Orthogonality relation. (10L)

References:

1. Brown J.W and Churchill R.V: Complex Variables and Applications, McGraw-Hill.
2. Das N.G.: Statistical Methods, TMH.
3. Grewal B S: Higher Engineering Mathematics, Khanna Publishers.
4. James G.: Advanced Modern Engineering Mathematics, Pearson Education.
5. Lipschutz S., and Lipson M.L.: Probability (Schaum's Outline Series), TMH.

6. Bhamra K. S.: Partial Differential Equations: An introductory treatment with applications, PHI
7. Dutta Debashis: Textbook of Engineering Mathematics, New Age International Publishers.
8. Kreyzig E.: Advanced Engineering Mathematics, John Wiley and Sons.
9. Potter M.C, Goldberg J.L and Aboufadel E.F.: Advanced Engineering Mathematics, OUP.
10. Ramana B.V.: Higher Engineering Mathematics, TMH

BS 307: Geology

Credits: 3

1. EARTH SYSTEM AND PHYSICAL GEOLOGY

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Preliminary concept of Geology and its different branches, Evolution of earth from solar system, Parts of planet earth (Lithosphere, Hydrosphere, Atmosphere),

Interior & Exterior of earth, Earthquakes, Volcanoes, Magma.

2. INTRODUCTION TO CRYSTALLOGRAPHY & MINERALOGY

5

Elements of Crystallography – Crystal structure, Unit Cell, Symmetry, Crystal System, Twinning Definition, Classification & Composition of Minerals, Physical & Optical properties of Minerals, Physical and Optical properties of some important minerals.

3. CONCEPTS OF PETROLOGY

4

Definition, Origin, Mode of occurrence and Classification of different types of rocks viz. Igneous, Sedimentary and Metamorphic rocks (Grades & Facies of Metamorphic

Rocks - a brief idea)

4. CONCEPTS OF SILICATE STRUCTURE

4

Fundamental principles of silicate structure, Structure of Quartz, Feldspar, Talc, Alumina, Magnesia, Clay minerals, Sillimanite minerals

5. SILICA & SILICATE MINERALS

6

Polymorphic forms of Silica and their transformation, Different natural forms of Silica of Industrial Importance – their properties & uses – Quartzite,

Flint, Ganister, etc. Properties, Composition, use & availability of

Pyrophyllite, Talc, Sillimanite minerals, Zircon, etc.

6. PLASTIC RAW MATERIALS 3

Clays – Geology, Classification, Composition and Properties of Clay – Physical & Chemical properties of important clay based minerals.

7. REFRACTORY RAW MATERIALS 6

General idea, Composition, Properties, Occurrence & Uses of bauxite family, Magnesite, Dolomite, Chromite, Graphite, etc. and their relevant Geological aspects.

8. ENVIRONMENTAL GEOLOGY 3

Environmental aspects of Mining, Occurrence of Ground Water & Pollution of Ground Water, Environmental hazards due to Earthquakes, volcanic eruption and other natural calamities.

9. ECONOMIC GEOLOGY 3

Non-metallic Minerals – already covered on the above studies only Indian occurrences are to be studied. Origin, formation and occurrence of coal are also to be studied. Metallic Minerals – Origin, Mode of occurrence, Formation, Extraction and Indian occurrences of Copper, Lead, Zinc, Iron, Chromite, Manganese .

10. STRUCTURAL GEOLOGY

Introduction to orientation of lithounits- dip, strike, pitch, plunge

Primary Structures: Stratification, Current, Cross & Graded Bedding, Ripple Marks

Brief description of (a) Folds: Antiform, Synform, Anticline, Syncline, Upright,

Inclined, Isoclinal, Recumbent, plunging and non-plunging. (b) Faults: Normal, Reverse, Thrust, Net-slip, Throw and Heave; Nappe and Klippe.

Unconformity : Definition, Types and their recognition in the field.

Definition and Types of Foliation, Schistosity, Lineation and Cleavage. 4

Reference Books:

1. A Textbook of Geology (with special reference to India) - G. B. Mahapatra
2. A Textbook of Geology - P. K. Mukherjee
3. Principles of Physical Geology - A. Holmes
4. A Textbook of Mineralogy - E. S. Dana & W. E. Ford
5. Rutley's Elements of Mineralogy - H. H. Read
6. The Principles of Petrology - G. W. Tyrrel
7. The Evolution of Igneous rocks - N. L. Bowen
8. Metamorphism - A. Harker

9. Manual of Sedimentary Petrography - W. C. Krumbein & F. J. Pettijohn
10. Minerals & Microscope - H. G. Smyth
11. Mineral Resources of India - Dilip K. Banerjee
12. Earth structure: an introduction to structural geology and tectonics. By Ben A van der Pluijm Stephen Marshak. W. W. Norton & Company, Inc.
13. Environmental Geology by EDWARD A. KEL LER. Pearson Prentice Hall
14. Structural Geology: Fundamentals and modern development by S. K. Ghosh. Pergamon Press
15. Structural Geology by M. P. Billings. Prentice hall of India Pvt. Ltd.
16. An introduction to geological structure and maps by G. M. Bennison. Edward Arnold

ES- 306 UNIT OPERATION – I

Credits: 3

Units and dimensions, dimensional analysis	-2 classes
Hydrostatic Equilibrium, Manometer	-2 classes
Newtonian & non-Newtonian fluid, Laminar & turbulent flow, Reynold's stress, Boundary layers, Momentum balance and Bernoulli equation, Friction factor and friction factor charts	-8 classes
Pipe, Fittings and Valves, Pumps, Fans and Compressors, Flowmeters	-5 classes
Drag and friction in flow through bed of solids, Motion of particles through	-4 classes
Heat Transfer by conduction, Fourier's law, Compound resistance in series, Heat transfer through hollow cylinder and spheres	-3 classes
Unsteady state heat conduction, Semi infinite solid, Penetration distance	-2 classes
Principles of heat flow in fluids, Countercurrent and parallel flows and related temperature profiles, Overall heat transfer co-efficient, Logarithmic mean temperature difference,	

Individual heat transfer coefficients, Calculation of overall co-efficients , Heat transfer by forced convection, Empirical equations -7 classes

Heat exchanger equipments -3 classes

Fundamental concepts of radiation, Emissivity, Blackbody radiation, Planck's law, Wein's displacement law, Stefan-Boltzman Law, Kirchoff's law, Gray body, Angle of vision

Radiation intensity of blackbody, View factor, Radiation between two black surfaces, Heat exchange between parallel gray surfaces -7 classes

Books and references;

- 1) Unit Operations of Chemical Engineering – McCabe, Smith and Harriott
- 2) Chemical Engineering – Coulson, Richardson, Backhurst and Harker
- 3) Heat Transfer – Binay K. Dutt

CT-301 Ceramic Raw Material

Credits= 3

Gr.-A Natural

1. Silicate Minerals and Silica: Fundamental principles of silicate structure. Polymorphic forms of silica & their transformation. Different natural forms of silica of industrial importance and their properties and uses – Quartzite, Ganister, Flint, Silica sand, etc. Properties, composition, effect of heat, use and Indian availability of silica minerals. (04 Lectures)
2. Plastic Raw Materials: Definition and classification of clay minerals. Structure of clay minerals (Kaolinite, Pyrophyllite, Montmorillonite, Chlorite etc.) and its comparison to the structure of micas. Composition, properties, uses, particle size, plasticity, cation exchange capacity (CEC), effect of heat treatment of the clay minerals. General idea, occurrence, Important properties and uses of china clay, ball clay, fire clay, bentonite etc. (05 Lectures)
3. Fluxes : Feldspar, Nepheline Syenite, Bone Ash, lepidolite and Wollastonite – their compositions, properties, Indian availability and uses in ceramic industries. (03 Lectures)

4. Refractory Raw Materials: General idea, composition, properties, effect of heat, Indian availability and uses of – Silimanite group, Bauxite group of minerals, Magnesite, Dolomite, Chromite and Limestone. (03 Lectures)

GR.-B -Synthetic

Scope & Application of Synthetic Ceramic powder: 3L

Purpose /Advantage of synthetic ceramic raw materials, Idea about crystal, crystallite, grain, particle, Particle size, shape and agglomerate, Application areas of synthetic ceramic powder

1. Methods of Ceramic Powder preparation: 6L
Sol-Gel process (SGP), Sol-Gel-Auto combustion process, Precipitation and co-precipitation technique, Hydrothermal synthesis, Solvent vaporization technique
2. Characterization of Synthetic Ceramic powder: 3L
Particle size distribution of nano and micron range particle, Decomposition and crystallization study by DTA, TGA and DTGA, Phase analysis by XRD, Debye-Scherrer equation for crystallite size determination. SEM and TEM.
3. Alumina : 4L
Phases of Alumina and its structure, Bayer alumina and its purification, Calcined Alumina, Tabular alumina, Fused alumina, Synthesis of oxide and hydroxide Powder from solution/combustion routes & powder Characterization
4. Zirconia: 4L
Polymorphic transformation of ZrO_2 , Partially stabilized and fully stabilized zirconia (PSZ & FSZ), Synthesis of stabilized ZrO_2 powder (with Y_2O_3 , CeO_2 etc.) from solution routes & powder Characterization , Monodisperse spherical ZrO_2 powder spinel
5. Mullite, Silica Gel and Precipitated Silica: 4L
Synthesis from different precursors in solution routes & their Characterization
6. Barium Titanate and Ferrite: 4L
Temperature dependent structural stability of $BaTiO_3$, Synthesis of $BaTiO_3$ by Pechini and modified Pechini process, Normal and inverse spinel ferrites, Synthesis of Ni, Zn and Mn ferrite powder by sol-gel-auto combustion , co-precipitation techniques & powder Characterization.

Recommended Books

1. Ceramic Raw Materials (2nd Revised Edition) – W. E. Worrall (1982). Pergamon Press, Oxford. 111p.
2. Properties of Ceramic Raw Materials (2nd Edn. in SI/Metric Units) – W. Ryan (1978). Pergamon Press, Oxford. 113p.

3. Ceramic Raw Materials of India: A Directory – S.K Guha (Editor) (1982). Indian Institute of Ceramics, Kolkata. 202p.

4. Ceramic Powder preparation : A Hand Book, Dibyendu Gangully & Minati Chatterjee, Kluwer Academic Publishers

5. Sol-Gel Processing of Advanced Ceramics, Editor by F. D. Gnanam, Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi

CT-302 (Energy Resource & Furnaces):

Credits = 3

A) Energy Resource

- a) Introduction, calorific value, inflammability limits, flame temperature. 3L
- b) Origin of coal, proximate & ultimate analysis, stages of coal, coal petrography, storage of coal & spontaneous combustion. 4 L
- c) Carbonisation of coal, low temperature & high temperature carbonisation, coke making & by-product recovery, salient features of LTC&HTC. 4 L
- d) Origin of petroleum, Classification of petroleum, Products from petroleum distillation, General scheme of petroleum distillation, Cracking, Visbreaking, reforming, sweetening, viscosity index, flash point&fire point, cloud point, pour point & freezing point, carbon residue, aniline point & diesel index, octane & cetane no., coal-tar fuel. 7L
- e) Natural gas, liquefied petroleum gas, producer gas & water gas preparation. 4L

B) Elements of Furnaces

- a) Introduction. Classification of industrial furnaces. Components of a total furnace systems. Furnaces/kiln construction materials. 4L
- b) Heat/fuel economy Energy audit and its necessities. Sources of heat losses. Factors affecting fuel economy. Thermal efficiency in operation of furnace. 6L
- c) Techniques of waste heat recovery. Definition of recuperators & regenerators. Operation of different type of recuperators & regenerators. 4L
- d) Dynamics of gas in a furnace - Definition of Draught, its necessities, classification of draughts. Deduction of the equations for natural draught & chimney height along with problems. 5L
- e) Study of Different Furnaces/Kilns - Down Draft Kiln, Tunnel Kiln, Shuttle kiln, Bell type kiln, Glass Tank Furnace, Blast Furnace, BOF, EAF, Roller Hearth Kiln, Rotary Kiln, Induction Furnaces, Electrical Furnaces, SiC, MoSi₂ & Lanthanum Chromate heating Element. 5 L

References:

1. Elements of Fuels, Furnaces & Refractories – O.P. Gupta.
2. Fuels & combustions – Samir Sarkar
3. Industrial Furnaces Vol. I & II – Trincs W.
4. The science of Flames and Furnaces – M.W. Thring.
5. Principles of Blast Furnaces for iron making- A.K. Biswas.

MC 306: Value Education, Human Rights and Legislative Procedures Credits: 3

Module 1: Values and Self Development-Social values and individual attitudes, Work ethics, Indian vision of humanism, Moral and non moral valuation, Standards and principles, Value judgments. Importance of cultivation of values, Sense of duty, Devotion, Self reliance, Confidence, Concentration, Truthfulness, Cleanliness, Honesty, Humanity, Power of faith, National unity, Patriotism, Love for nature, Discipline.

Module 2: Personality and Behavior Development- Soul and scientific attitude, God and scientific attitude, Positive thinking, Integrity and discipline, Punctuality, Love and kindness, Avoiding fault finding, Free from anger, Dignity of labor, Universal brotherhood and

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religious tolerance, True friendship, Happiness vs. suffering love for truth, Aware of self destructive habits, Association and cooperation, Doing best, Saving nature.

Module 3: Character and Competence- Science vs. God, Holy books vs. blind faith, Self management and good health, Science of reincarnation, Equality, Nonviolence, Humility, Role of women, All religions and same message, Mind your mind, Self control, Honesty, Studying effectively.

Module 4: Human Rights- Jurisprudence of human rights nature and definition, Universal protection of human rights, Regional protection of human rights, National level protection of human rights, Human rights and vulnerable groups.

Module 5: Legislative Procedures- Indian constitution, Philosophy, fundamental rights and duties, Legislature, Executive and Judiciary, Constitution and function of parliament, Composition of council of states and house of people, Speaker, Passing of bills, Vigilance, Lokpal and functionaries.

Text Books:

1. Chakraborty, S.K., *Values and Ethics for Organizations Theory and Practice*, Oxford University Press, New Delhi, 2001.
2. Kapoor, S.K., *Human rights under International Law and Indian Law*, Prentice Hall of India, New Delhi, 2002.
3. Basu, D.D., *Indian Constitution*, Oxford University Press, New Delhi, 2002.

Reference Books:

1. Frankena, W.K., *Ethics*, Prentice Hall of India, New Delhi, 1990.
2. Meron Theodor, *Human Rights and International Law Legal Policy Issues*, Vol. 1 and 2, Oxford University Press, New Delhi, 2000.

PRACTICALS

BS 317: GEOLOGY LAB.

Credits: 2

1. Mineral Identification in hand specimen –
Quartz, Feldspar (Orthoclase, Plagioclase), Pyroxene,
Calcite, Magnesite, Kyanite, Sillimanite, Gypsum,
Magnetite, Pyrite, Haematite, Galena, Biotite,
Muscovite, Garnet, Chromite, Bauxite, Talc and
Different types of clay minerals, etc.
2. Study of rocks in hand specimen –
Granite, Basalt, Pegmatite, Sandstone, Shale of
Different varieties, Limestone, Schist, Gneiss,
Marble, Dolomite, Peat, Lignite, Bituminous coals,
Anthracite, etc.
3. Study of optical characteristics under polarising
Petrological microscope – Feldspar (Orthoclase, Albite, Microcline),
Kyanite, Sillimanite, Gypsum, Calcite, Garnet, Hornblende,
Muscovite, Biotite, Augite.
4. Basic ideas to simple structure, Map & its interpretation, etc.

ES -316: Unit Operation Lab:

Credits = 3

- 1.a) Determination of the diffusivity of moisture through a supplied wooden block (wet)
during its drying at $(100 \pm 10^\circ\text{C})$
- 2.b) Determination of the thermal conductivity of the supplied insulating plate by Lee's
method.
- 3.c) Determination of the effectiveness of the supplied 16 mesh screen in separating the
supplied clay powder mix.
- 4.d) Determination of the mixing index in blending the supplied two varieties of
granular solid under tumbling action for one hour.

- 5.e) Determination of the Determination of viscosity co-efficient by falling sphere method .
- 6.f) Determination of diffusivity of 2% ethylene glycol aqueous solution.
- 7.g) Comparison of the sedimentation rate of 20% china clay aq. Suspension to that of in presence of 0.1% NaCl.
- 8.h) Determination of specific surface area, average particle size of the supplied Quartz mixture by Screen analysis.
- 9.i) Determination of the rate of drying of the supplied wet mud at $(75 \pm 10^{\circ}\text{C})$.
10. j) Determination of the power requirement to crush manually the supplied rock from 4mm. Size to 0.5mm. size.
11. k) Determination of thermal diffusivity of the supplied metal slab.
12. l) Determination of the critical speed of the supplied laboratory ball mill.
13. m) Determination of the viscosity coefficient of the supplied liquid by capillary flow method.
14. n) Determination of mixing index for mixing 10% water with the supplied dried clay mass under mulling action for one hour.
15. o) Description with sketch the application of the supplied flow control devices for fluid flow in process plant.

CT – 311: Chemical Analysis Lab:

Credits= 3

- 1.a) Estimation of SiO_2 , Fe_2O_3 , Al_2O_3 , CaO and MgO in Dolomite.
- 2.b) Estimation of SiO_2 , Fe_2O_3 , Al_2O_3 , CaO and MgO in Lime stone.
- 3.c) Quantitative analysis of Bauxite.
- 4.d) Complete Analysis of Sea-Water Magnesia.
- 5.f) Complete Analysis of Fireclay.
- 6.g) Complete Analysis of Kyanite.

- 7.h) Determination of insoluble portion in Portland cement.
- 8.i) Determination of Free Lime content in Portland cement.
- 9.k) Complete analysis of Portland cement.
10. l) Complete Analysis of Water Glass.
11. m) Complete Analysis of Soda-lime – silica glass.
12. n) Complete Analysis of Firebrick.
13. o) Rapid estimation of silica in glass sand and glass.
14. p) Quantitative analysis of Talc.
15. q) Quantitative analysis of Blast Furnace Slag.
16. r) Quantitative analysis of Fly Ash

APPROVED DETAILED SYLLABI

SEMESTER IV

THEORY PAPERS

BS-408: Numerical Methods L-T-P = 2-1-0 Credits= 2

Approximation in numerical computation: Truncation and rounding errors, Fixed and floating-point arithmetic, Propagation of errors. (4)

Interpolation: Newton forward/backward interpolation, Lagrange's and Newton's divided difference Interpolation. (5)

Numerical integration: Trapezoidal rule, Simpson's 1/3 rule, Expression for corresponding error terms. (3)

Numerical solution of a system of linear equations:

Gauss elimination method, Matrix inversion, LU Factorization method, Gauss-Seidel iterative method. (6)

Numerical solution of Algebraic equation:

Bisection method, Regula-Falsi method, Newton-Raphson method. (4)

Numerical solution of ordinary differential equation: Euler's method, Runge-Kutta methods, Predictor-Corrector methods and Finite Difference method. (6)

Text Books:

1. C.Xavier: C Language and Numerical Methods.
2. Dutta & Jana: Introductory Numerical Analysis.
3. J.B.Scarborough: Numerical Mathematical Analysis.
4. Jain, Iyengar , & Jain: Numerical Methods (Problems and Solution).

References:

1. Balagurusamy: Numerical Methods, Scitech.
2. Baburam: Numerical Methods, Pearson Education.
3. N. Dutta: Computer Programming & Numerical Analysis, Universities Press.
4. Soumen Guha & Rajesh Srivastava: Numerical Methods, OUP.
5. Srimanta Pal: Numerical Methods, OUP.

1. Drying of Solids:

Drying principles and method, Type of dryers, Simple calculations on humidity, humid volume, humid heat, adiabatic saturation temperature, wet bulb temperature.

Equilibrium moisture content principle, Analysis of rate drying, constant-rate period, falling-rate period, Calculation of the drying process using the dry rate curve.

Drying principles, remove small amount of water/other liquid from solid material.

Drying methods: Thermal or mechanical, batch or continuous, agitated or unagitated, adiabatic/direct or non-adiabatic / indirect air drying, vacuum drying or freeze drying.

Type of dryers: Tray dryer, Tunnel dryer, Drum/ roller dryer, Spray dryer. Cross circulation and through circulation drying. 8L

2. Properties and handling of particulate solids: Characterization of solid particles, Mixed and average particle sizes, specific surface of mixtures, screen analysis, Properties of masses of particles.

Storage and conveying of solids, Bulk storage, Bin storage, Pressure in Bins and silos,

Flow out of Bins, Conveyers.

Mixing of solids, Performance of mixers, Mixers for Non cohesive and cohesive solids,

Mixer extruders, Muller Mixer, Mixing performances, Axial mixing.

Size reduction, characteristics of comminuted products, Energy and power requirement in comminution, Efficiency, Crushing law and work index, Equipment for size reduction, Crusher, Smooth roll crushers, Grinders, Hammer mill and impactors, Roller mills, Attrition mill, Tumbling mill, Conical Ball mill, Critical speed of Ball mill, Ultrafine grinders, Classifying hammer mill, Fluid energy mill, agitated mill, Colloidal mill, Cutting machine, Open circuit and closed circuit operation 14L

3. Mechanical Separation:

Filtration: Definition, Concept and Working of equipment, Filter media vs. filter aid, Pressure drop, Specific cake resistance, Constant pressure filtration: Batch process.

Settling and sedimentation: Equipment, Theory of settling, Gravitational force, Buoyant force, Drag force, Terminal velocity, drag coefficient, free settling, Hindered settling, Rigid vs. non rigid particles, Applications, Differential settling, Sedimentation and thickening.

Centrifugal separation: Introduction, Application, Equipment, Cyclone separator, Theory, Centrifugal force, Rate of settling, critical diameter. 8L

4. Membrane Separation:

Definition of membrane separation, Difference of membrane separation with other separation process, Advantages and disadvantages of Membrane separation process, Different types of Membrane separation processes, Types of membranes and applications of membrane separation processes, Membrane material, Micro-filtration – Basic information, Theoretical application, Concentration polarization, Models for solvent flux – Resistance model, Gel polarization model, Osmotic pressure model, Transport in membrane, Membrane for gas separation.

References:

1. B. K. Datta., Principles of Mass Transfer and Separation Process, Prentice Hall of India, New Delhi, 2007.
2. C. J. Geankoplis., Transport Processes and Unit Operations, 4th Edition, Prentice Hall, 2003.
3. W. M. McCabe., J. C. Smith., P. Harriot., Unit Operations of Chemical Engineering, 7th Ed., McGraw Hill, 2005.
4. J. D. Seader and E. J. Henley., Separation Process Principles, John Wiley, 1998.

BS: 409- Fundamentals Biology L-T-P =3-0-0 Credits= 2

Module 1A: Concepts in Biology covering, Chemical foundations and basic chemistry of cell- Carbon compounds and cell as a unit of life; Physical and chemical principles involved in maintenance of life processes; Scientific methods- Microscopy (principles and applications);

Module 1B: Cell structure and functions covering, Ultra-structure and functions of cellular components- Prokaryotic and Eukaryotic cells, cell wall, plasma membrane, endoplasmic reticulum; Biomolecules- Carbohydrates, Lipids, Amino Acids, Proteins, Nucleic acids;

Tissue systems- Overview of animal and plant tissue systems;

Module 2A: Metabolisms covering Bio-membranes, diffusion, absorption, osmo-regulation; Photo-synthesis and respiration

Module 2B: Chromosomes and Cell Divisions covering, Morphology of chromosomes; Cell theory- Cell cycle and phases; Mitosis and meiosis;

Module 3A: Genetics covering, Laws of heredity- Biological indicators, bio-sensors; Mutations- Cause, types and effects on species;

Module 3B: Organic Evolution covering, Origin of life- Haldane and Oparins concepts; Modern concept of natural selection and speciation- Lamarkism, Darwinism/Neo-Darwinism

Module 4 A Biomaterials - an Overview

[Background-Biomaterial Classifications](#), [Key Properties](#), [Applications--Orthopaedic Applications](#), [Dental Applications](#), [Cardiovascular Applications](#), [Cosmetic Surgery](#)

Module 4B Human Physiology –in brief with special emphasis on

Locomotion and movement, Skeletal system, joints, disorders of muscular and skeletal system

Body fluids and circulation-Blood groups, human circulatory system- heart, cardiac cycle, heart failure

Module 4 C Classification of Face and Teeth

Types of teeth and face, and Orthodontic disorders –crossbite, openbite, overbite, underbite, overjet

Recommended Books:-

1. BOOK OF BIOCHEMISTRY AND HUMAN BIOLOGY
BY G. P. TALWAR, L .M. SRIVASTAVA
2. CELL BIOLOGY AND GENETICS
BY GEETA BANSAL, M. C. BHATNAGAR
3. TEXTBOOK OF STRUCTURAL BIOLOGY
BY: ANDERS LILJAS, LARS LILJAS JURE PISKUR, GÖRAN LINDBLOM, POUL NISSEN AND
MORTEN KJELDGAARD
4. LEHNINGER-PRINCIPLES-OF-BIOCHEMISTRY-5TH-EDITION
5. TEXT BOOK OF BIOLOGY, BY S VENUGOPAL

CT: 403- Thermodynamics & Kinetics of Solids L-T-P =3-1-0 Credits=3

1. Enthalpy & Free energy:

Heat of reactions, Hess's law of enthalpies summation, Bond energy, Kirchoff's equation, Formation of solid, Born Haber Cycle, Born Lande equation, Gib's Free energy, Spontaneity of a process, Free energy diagram of polymorphic transformation of solid, Standard state, Standard free energy of formation, Partial molal volume and its applicability in glass melting process, Partial molal thermal quantities, Chemical potential, Gibbs -Duhem equation and its application, Helmholtz equation.

2. Free energy of Solid State reactions:

Free energy diagram for solid state reaction like calcination, dehydroxylation etc. Stability domain of different oxides phases, Ellingham Diagram, Chemical equilibrium and equilibrium constant, Reaction isotherm, Temperature dependence of equilibrium constant, Van't Hoff equation and its application

3. Statistical thermodynamics:

Thermodynamics probability and Configurational entropy of crystalline solid, Third Law of thermodynamics, Boltzman distribution Law, Partition function and its application

4. Phase equilibrium:

Phase, Component, Degree's of Freedom, Gibb's phase rule, Phase diagram of one and two component system, Eutectic and Peritectic reactions with examples.

5. Kinetics of Heterogeneous Reactions:

Rate, Order, molecularity and Activation energy of a diffusion controlled solid state reaction, Transformation of solid, Kinetic model of thickness of converted layer with fraction conversion for spherical and cylindrical particle, Jander modified kinetic model. Thermodynamically controlled and Kinetically controlled product. Kinetics of Decomposition reaction and Consecutive reaction.

Books & References:

1. Introduction to Ceramics— W. D. Kingery, H. K. Bowen & D. R. Uhlmann
2. Solid State Phase Transformation— V. Raghavan
3. Fundamentals of Ceramics—M. W. Barsoum
4. Physical Chemistry—P. C. Rakshit

CT: 404 - Process Ceramics L-T-P =3-1-0 Credits=3

- I. Introduction & Science in Ceramic Processing. (1)
- II. Material Characterization:
 - a) Characterization and specification of ceramic materials
 - b) Chemical and Phase compositions
 - c) Particle size and shapes
 - d) Density, pore structure and specific surface area.(3)
- III. Rheological behaviour of slurries and pastes:
Newtonian fluid, plastic flow, dilatant liquid, thixotropy, Deflocculation, Flocculation, Zeta potential, effect of electrolytes on Zeta potentials, applications in ceramic processing. (8)
- IV. Beneficiation process: Comminution – Equipments, milling, particle size distribution.
Batching and mixing: Mixing mechanism and mixing equipments.

Particle separation, concentration and washing processes – particle sizing, filtration, washing, particle concentration processes.

Granulation – direct granulation, spray granulation. (6)
- V. Particle packing
 - a) Particle packing characteristics – Models of one, two of spherical balls, Different types of pores present in ceramic body. measurement of porosity, formation of porosity.
 - b) Gap grading, continuous grading (5)
- VI. Forming processes:
Dry pressing, Semi dry pressing – powder flow and die filling, compaction behaviour, ejection and transfer, die wall effects, control of compaction defects, Cold isostatic Pressing

Plastic forming – Extrusion, Jiggering, Jolleying

Casting process- Slip Casting, casting defects. (6)

- VII. Drying –drying processes, Mechanisms in drying, defects. (3)
- VIII. Firing – Firing system, Pre sintering processes, sintering, vitrification and cooling.(4)
- IX. Preliminary ideas of Glass processing – selection of raw materials, effects of different oxides on glass properties, batch preparation, melting in glass tank furnace, refining of glass. (6)

References:

1. J. S. Reed: - Introduction to the principles of ceramic processing
2. Singer and Singer: Industrial Ceramics
3. F. Moore : Rheology of Ceramic systems
4. Onoda and Hench : Ceramic Processing before firing
5. Rex W. Grimshaw: The Chemistry and Physics of clays and other ceramic materials.

Practicals

BS: 491- Numerical Methods Lab L-T-P = 0-0-3 Credits=2

1. Assignments on Newton forward / backward, Lagrange's interpolation.
2. Assignments on numerical integration using Trapezoidal rule, Simpson's 1/3 rule, Weddle's rule.
3. Assignments on numerical solution of a system of linear equations using Gauss elimination and Gauss-Seidel iterations.
4. Assignments on numerical solution of Algebraic Equation by Regular-falsi and Newton Raphson methods.
5. Assignments on ordinary differential equation: Euler's and Runge-Kutta methods.
6. Introduction to Software Packages: Matlab / Scilab / Labview / Mathematica.

CT: 411 Fuel Testing Lab L-T-P = 0-0-3 Credits=2

1. Proximate Analysis of coal:

Determination of Moisture Content, Volatile Matter Content, Ash Content and Fixed Carbon

2. Determination of Calorific Value of Coal/Oil
3. Determination of Viscosity at different temperatures and Viscosity Index of fuel oil / lube oil:
4. Determination of Flash Point and Fire Point of Fuel oils

5. Determination of Carbon Residue of Fuel Oil/Lube Oil
6. Performing Distillation Test for Petroleum Products
7. Determination of Calorific Value of Gas

CT: 412 Powder Preparation & Characterization Lab L-T-P=0-0-3 Credits=2

1. Outline of general Method of preparation of Ceramic powder materials
(a) Solvent Evaporation technique (b) Sol Gel Method (c) Precipitation and Co-Precipitation technique.
2. Some Ceramic powder preparation: (a) Micron and nano alumina (b) Silica Gel and precipitated Silica (c) Magnesiumalumino hydrate (MAH) and $MgAl_2O_4$ Spinel (d) Mullite (e) Ferrite
3. Characterization of Ceramic powder: (a) Tap density (b) DTA / TGA / DTGA (C) IR (d) Particle Size Analysis

CT: 413 Phys. Testing of Raw Materials L-T-P=0-0-3 Credits=2

- a) Determination of percentage Moisture content of clay.
- b) Determination of % Grit content of clay.
- c) Determination of Water of Plasticity of Clays.
- d) Determination of Atterberg's Plasticity of clays.
- e) Measurement of Drying Shrinkage of clay.
- f) Measurement of Dry Strength of clays.
- g) Measurement of Firing Shrinkage & firing colour of clays and feldspar.
- h) Determination of % Free iron content in Feldspar & Quartz powder.
- i) Determination of Vitrification Range of Clays.
- j) Determination of Water Absorption of Fired Ceramic Bodies.
- k) Determination of particle size distribution by Sedigraph

APPROVED DETAILED SYLLABI

SEMESTER – V

CT: 505 (Refractories Technology): L-T-P= 3-1-0 Credits = 3

1. Introduction: Scope of Refractory Industry, Definition and classification of refractories. (2)
2. Binary phase diagrams related to refractory oxide systems eg. $\text{Al}_2\text{O}_3 - \text{SiO}_2$, $\text{Al}_2\text{O}_3 - \text{MgO}$, $\text{MgO} - \text{Cr}_2\text{O}_3$, $\text{MgO} - \text{CaO}$. (6)
3. Manufacturing, Properties and applications of the following refractories:
 - a) Silica Refractories: Super duty, Moderate heat duty and Low heat duty silica refractories. (2)
 - b) Alumino-silicate Refractories: Significance of Phase diagram in the development of different phases –High alumina refractories. (6)
 - c) Basic Refractories : Magnesite, dolomite, lime, Chemically bonded and Direct bonded refractories. (7)
 - d) Chromite and mullite refractories. (4)
 - e) Carbon bearing refractories – $\text{MgO} - \text{C}$ and $\text{Al}_2\text{O}_3 - \text{MgO} - \text{C}$ etc. (6)
4. Testing of important properties of refractories:
A.P., B.D., Total Porosity, Sp. Gravity, Pore size distribution, C.C.S.,
Cold MOR., Hot MOR., PCE., RUL., Compressive Strength, PLCAR,
Spalling Resistance., Reversible Thermal Expansion., CO – disintegration,
Corrosion resistance. (8)

References:

1. Refractories – Production and properties – J. H. Chester
2. High Temperature Oxides, Part – I, A. M. Alper
3. The Technology of ceramics and refractories – P. P. Budnikov
4. Refractories – F. H. Norton

CT: 506 Glass Science & Technology L-T-P=3-1-0 Credits = 3

1. The non-crystalline solids & the glasses. Formation from liquid phase. Formation from a gaseous phase. Formation from a solid phase. Definition of glass.
2. Rheological properties of glasses, Viscosity, Elastic & Visco-elastic properties of glasses. 02L
3. Vitreous transition. Phenomenological study. Thermodynamic study. Theory of vitreous transition. Relaxation behaviour of glass in the transition interval. Determination of transition temperature. 05L
4. Conditions of vitrification. Structural theory (Zachariasen model etc.). Kinetic theory of glass (Nucleation & Growth). 04L
5. Structural models of glass. Reaction mechanisms. Ion exchange & network breakdown processes. Glass durability controlling factors. Improvement of durability.
6. Thermodynamic basis of phase separation in glasses. Immiscibility in glasses. Spinodal decomposition. 05L
7. Density & Thermal expansion measurements & their implications and their dependence on compositions. Thermal history effects. Effect of crystallization. Additive rule. 04L
8. Diffusion in Glasses. Electrical conductivity of glasses. Dielectric properties;
9. Thermal Properties of glasses, Specific heat, Thermal conductivity, Thermal expansion. 04L
10. Glass production, Basic processes of glass making, Batch process, Continuous process, Raw materials selection, Batch house & mixing, Batch transportation, Tank furnace, Batch feeding, Melting & refining, Bottle glass, Sheet glass, Other glasses, Annealing, Thermal treatment, Chemical treatment, Production control & planning, Optical fibre glass production & processes.
11. Batch calculation of the glass and determination of the oxide composition of the glass

04L

Reference:

- 1) Handbook of Glass Manufacture - F.V. Tooley
- 2) Glass Engineering Handbook – E. B. Shand.
- 3) Handbook of Glass Properties – G. W. Morey.
- 4) Handbook of Glasses – R. H. Doremus
- 5) Chemistry of Glasses - A. Paul
- 6) Inorganic Glass - Arun K. Varsheneya

CT: 507 Whitewares

L-T-P= 3-1-0

Credits = 3

1. Scope & Application of Whiteware product, Characteristics of Whiteware product, Earthenware, Stoneware, China & Porcelain 2L
2. Raw Materials used in Whiteware industry : Clay, Quartz, Feldspar, Wollastonite, Pyrophyllite, Talc, Bone ash, 3L
3. Body Preparation & Fabrication process: 5L
Crushing and Grinding, Screening, Magnetic separation, Transport, Storage, Batching and body composition, Aging, Slip casting, properties of slip, plastic forming
4. Drying: 5L
Types of water present, Factors affecting drying (internal & external factors), Different types of dryers and its operations & maintenance, sources of heat for drying & Drying schedule, Defects of dried body at green stage, its causes & remedies.
5. Glazing: 7L
Purpose & advantages of glazing, Raw glazes, Fritted glazes, Semiconducting Glaze, Fusibility of glazes, Glaze Opacifiers, Stains, Colloidal colours, Different colouring oxides, Adherence and Flow properties of glaze slip, Glaze defects, Glazing techniques, Testing of glazes.
6. Firing: 5L
Firing schedule of whiteware bodies, Reactions at different temperatures, Microstructure development and phase formation of porcelain bodies, Firing defects – causes & remedies, Different type of kilns and operation techniques.
7. Kiln Furniture: 4L
Characteristics, Different types of Kiln Furniture, Cordierite, SiC based Kiln Furniture, Silicon nitride bonded SiC kiln furniture, Low thermal mass Kiln car.

8. Production of the following whiteware bodies with process flowcharts, Body Composition & properties:

(i) Electrical Porcelain 1L (ii) Wall & floor tiles 3L (iii) Sanitary wares
2L

(iv) Spark plug Insulators 1L (v) Bone China 3L

References:

1. Ceramic Whitewares – Sudhir Sen
2. Industrial Ceramics – Singer & Singer
3. Fine Ceramics – F.H. Norton.
4. The Technology of Ceramics and Refractories – P.P. Budnikov.

CT: 508 Cement & Concrete L-T-P= 3-1-0 Credits = 3.

1. Pozzolana Cement:

Definition, classifications, Pozzolanic activity and its influencing factors, Lime – Pozzolana reaction and products formation, Applications. 2L

2. Portland Cement:

Definition, Raw materials and their physico – chemical characteristics, manufacturing process, cement making kilns viz, Rotary and shaft kiln. Refractory used in Rotary kiln, reactions occurred in different zones of rotary kiln, Hydration of cement, Setting and hardening of Portland cement, Heat of Hydration, Action of acid & sulphate water on cement, Flash set and False set of cement, Alkali – Aggregate reaction in Portland cement. 10L Applications.

3. Special Cements:

Rapid hardening Portland cement, Quick setting cement, White Portland Cement, coloured cement, Sulphate resisting cement, Low heat Portland cement, Oil – well cement, Waterproofed Portland cement, Sorel cement, Blended Cement, Macro defect Free (MDF) Cement, Sulphated Cement, Refractory Cement, Cement paints. 6L

4. Testing of Cements : Insoluble residue in cement, estimation of free lime in cement, fineness of cement, standard consistency of cement, Initial and Final

setting of cement, soundness of cement, slump test of concrete, Flow table test of mortar , 6L

5. High Alumina Cement:

Introduction to Refractory cement, Raw Materials used, classification and composition of HAC, manufacturing process, Mineralogical phases of HAC, Hydration of HAC on the basis of CaO-Al₂O₃-H₂O Phase diagram, Strength Development, HAC castables and uses. 8L

6. Concrete:

Introduction, Gap Grade concrete, continuous grade concrete, light, normal and heavy concrete, properties of concrete, installation technique of concrete, uses of various concretes. 8L

Books:

- a) Chemistry of cement by F.M. Lea
- b) Cement Chemistry by F.W. H. Taylor
- c) High Alumina Cement by T. D. Robson
- d) Concrete Technology by Neville.

OPEN ELECTIVE (One to be chosen from the following)

OE: 501 Database Management System (DBMS) L-T-P= 2-1-0 Credits= 3

Introduction [4L]

Concept & Overview of DBMS, Data Models, Database Languages, Database Administrator, Database Users, Three Schema architecture of DBMS.

Entity-Relationship Model [6L]

Basic concepts, Design Issues, Mapping Constraints, Keys, Entity-Relationship Diagram, Weak Entity Sets, Extended E-R features.

Relational Model [5L]

Structure of relational Databases, Relational Algebra, Relational Calculus, Extended Relational Algebra Operations, Views, Modifications Of the Database.

SQL and Integrity Constraints [8L]

Concept of DDL, DML, DCL. Basic Structure, Set operations, Aggregate Functions, Null Values, Domain Constraints, Referential Integrity Constraints, assertions, views, Nested Subqueries, Database security application development using SQL, Stored procedures and triggers.

Relational Database Design [9L]

Functional Dependency, Different anomalies in designing a Database., Normalization using functional dependencies, Decomposition, Boyce-Codd Normal Form, 3NF, Normalization using multi-valued dependencies, 4NF, 5NF

Internals of RDBMS [7L]

Physical data structures, Query optimization : join algorithm, statistics and cost based optimization. Transaction processing, Concurrency control and Recovery Management : transaction model properties, state serializability, lock based protocols, two phase locking.

File Organization & Index Structures [6L]

File & Record Concept, Placing file records on Disk, Fixed and Variable sized Records, Types of Single-Level Index (primary, secondary, clustering), Multilevel Indexes, Dynamic Multilevel Indexes using B tree and B+ tree .

Text Books:

1. Henry F. Korth and Silberschatz Abraham, "Database System Concepts", Mc.Graw Hill.
2. Elmasri Ramez and Navathe Shamkant, "Fundamentals of Database Systems", Benjamin Cummings Publishing Company.
3. Ramakrishnan: Database Management System , McGraw-Hill
4. Gray Jim and Reuter Address, "Transaction Processing : Concepts and Techniques", Morgan Kaufman Publishers.
5. Jain: Advanced Database Management System CyberTech
6. Date C. J., "Introduction to Database Management", Vol. I, II, III, Addison Wesley.
7. Ullman JD., "Principles of Database Systems", Galgotia Publication.

Reference:

1. James Martin, "Principles of Database Management Systems", 1985, Prentice Hall of India, New Delhi
2. "Fundamentals of Database Systems", Ramez Elmasri, Shamkant B.Navathe, Addison Wesley Publishing Edition
3. "Database Management Systems", Arun K.Majumdar, Pritimay Bhattacharya, Tata McGraw Hill

OE: 501 Operation Research(OR) L-T-P=2-1-0 Credits=3**Module I****Linear Programming Problems (LPP):**

Basic LPP and Applications; Various Components of LP Problem Formulation.

Solution of Linear Programming Problems:

Solution of LPP: Using Simultaneous Equations and Graphical Method;

Definitions: Feasible Solution, Basic and non-basic Variables, Basic Feasible Solution, Degenerate and Non-degenerate Solution, Convex set and explanation with examples. **5L**

Solution of LPP by Simplex Method; Charnes' Big-M Method; Duality Theory. Transportation Problems and Assignment Problems. **12L**

Module II**Network Analysis:**

Shortest Path: Floyd Algorithm; Maximal Flow Problem (Ford-Fulkerson); PERT-CPM (Cost Analysis, Crashing, Resource Allocation excluded). **6L**

Inventory Control:

Introduction to EOQ Models of Deterministic and Probabilistic ; Safety Stock; Buffer Stock. **3L**

Module III**Game Theory:**

Introduction; 2-Person Zero-sum Game; Saddle Point; Mini-Max and Maxi-Min Theorems (statement only) and problems; Games without Saddle Point; Graphical Method; Principle of Dominance. **5L**

Module IV

Queuing Theory:

Introduction; Basic Definitions and Notations; Axiomatic Derivation of the Arrival & Departure (Poisson Queue). Poisson Queue Models: (M/M/1): (∞ / FIFO) and (M/M/1: N / FIFO) and problems.

5L

Text Books:

1. H. A. Taha, "Operations Research", Pearson
2. P. M. Karak – "Linear Programming and Theory of Games", ABS Publishing House
3. Ghosh and Chakraborty, "Linear Programming and Theory of Games", Central Book Agency
4. Ravindran, Philips and Solberg - "Operations Research", WILEY INDIA

References:

1. Kanti Swaroop – "Operations Research", Sultan Chand & Sons
2. Rathindra P. Sen—"Operations Research: Algorithms and Applications", PHI
3. R. Panneerselvam - "Operations Research", PHI
4. A.M. Natarajan, P. Balasubramani and A. Tamilarasi - "Operations Research", Pearson
5. M. V. Durga Prasad – "Operations Research", CENGAGE Learning
6. J. K. Sharma - "Operations Research", Macmillan Publishing Company

OE:501 Object Oriented Programming(OOP) L-T-P=2-1-0 Credits=3

Object oriented design [10 L]

Concepts of object oriented programming language, Major and minor elements, Object, Class, relationships among objects, aggregation, links, relationships among classes-association, aggregation, using, instantiation, meta-class, grouping constructs.

Object oriented concepts [4 L]

Difference between OOP and other conventional programming – advantages and disadvantages. Class, object, message passing, inheritance, encapsulation, polymorphism

Basic concepts of object oriented programming using Java [22 L]

Implementation of Object oriented concepts using Java.

Language features to be covered:

Class & Object proprieties [6L]

Basic concepts of java programming – advantages of java, byte-code & JVM, data types, access specifiers, operators, control statements & loops, array, creation of class, object, constructor, finalize and garbage collection, use of method overloading, this keyword, use of objects as parameter & methods returning objects, call by value & call by reference, static variables & methods, garbage collection, nested & inner classes, basic string handling concepts- String (discuss charAt() , compareTo(), equals(), equalsIgnoreCase(), indexOf(), length() , substring(), toCharArray() , toLowerCase(), toString(), toUpperCase() , trim() , valueOf() methods) & StringBuffer classes (discuss append(), capacity(), charAt(), delete(), deleteCharAt(), ensureCapacity(), getChars(), indexOf(), insert(), length(), setCharAt(), setLength(), substring(), toString() methods), concept of mutable and immutable string, command line arguments, basics of I/O operations – keyboard input using BufferedReader & Scanner classes.

Reusability properties[6L] – Super class & subclasses including multilevel hierarchy, process of constructor calling in inheritance, use of super and final keywords with super() method, dynamic method dispatch, use of abstract classes & methods, interfaces.

Creation of packages, importing packages, member access for packages.

Exception handling & Multithreading [6L] – Exception handling basics, different types of exception classes, use of try & catch with throw, throws & finally, creation of user defined exception classes. Basics of multithreading, main thread, thread life cycle, creation of multiple threads, thread priorities, thread synchronization, interthread communication, deadlocks for threads, suspending & resuming threads.

Applet Programming (using swing) [4L] – Basics of applet programming, applet life cycle, difference between application & applet programming, parameter passing in applets, concept of delegation event model and listener, I/O in applets, use of repaint(),

getDocumentBase(), getCodeBase() methods, layout manager (basic concept), creation of buttons (JButton class only) & text fields.

Textbooks/References:

1. Rambaugh, James Michael, Blaha – "Object Oriented Modelling and Design" – Prentice Hall, India
2. Ali Bahrami – "Object Oriented System Development" – Mc Graw Hill
3. Patrick Naughton, Herbert Schildt – "The complete reference-Java2" – TMH
4. R.K Das – "Core Java For Beginners" – VIKAS PUBLISHING
5. Deitel and Deitel – "Java How to Program" – 6th Ed. – Pearson
6. Ivor Horton's Beginning Java 2 SDK – Wrox
7. E. Balagurusamy – " Programming With Java: A Primer" – 3rd Ed. – TMH

PRACTICAL PAPERS

CT: 515 Refractories Lab L-T-P=0-0-3 Credits = 2

- a) Powder Preparation – Crushing of fireclay grog. Size separation of grog.
- b) Determination of Packing Density of refractory raw materials
- c) Fabrication of refractory bodies using best packed refractory raw materials.
- c) Firing of refractory bodies at different temperatures
- d) Study of effect of Composition, Forming pressure & Firing temperature on some properties of refractory bodies.
- e) Testing of various important properties of refractories as per IS.
- f) Refractory corrosion test.
- g) Spalling Resistance Test (Thermal Shock Resistance) of refractory bodies.

CT:516 Glass Lab L-T-P=0-0-3 Credits = 2

- a) Preparation of Soda-Lime-Silica glass with different colouring oxides,
e.g. CoO, FeO etc.
- b) Preparation of Boro-silicate glass with alkali & alkaline earth oxides.
- c) Preparation of Opal glass with different opacifying agents -- Fluoride &
Phosphate opal.
- d) Preparation of low melting Phosphate glass in various systems.
- e) Determination of Alkali resistance of glass.
- f) Determination of alkalinity of glass
- g) determination of Chemical durability of different types of glasses
- h) Thermal shock test on glass wares.
- i) Determination of density of glass.
- j) Determination of strain in glass wares by polariscope.
- k) Demonstration of cord viewers.

CT: 517 Whitewares Lab L-T-P=0-0-3

Credits = 2

- a) Preparation of Whiteware Body >> Milling of raw materials, measurement of slip properties, green body preparation, slip casting/plastic forming/pressing.
- b) Preparation of glazes & application of glaze on body, drying and firing.
- c) Determination of water absorption, True density, Bulk density & Modulus of rupture of various fired whiteware bodies.
- d) Determination of thermal shock resistance of fired whiteware bodies
- e) Measurement of glaze thickness by Penetrometer.
- f) Determination of acid solubility of ceramic body & glaze.
- g) Determination of alkali solubility of ceramic body & glaze.

CT:518 Cement & Concrete Lab L-T-P=0-0-3

Credits = 2

- a) Tests like Consistency of cement, Initial Setting time, Final Setting Time, CCS as per standard specification,
- b) Study of strength properties both as a function of composition and setting time of cement-sand mortars & concrete.
- c) Setting time of various grades of cements.
- d) Slump test of concrete.
- e) Vee- Bee consistometer test of concrete.
- f) Compaction factor test of concrete.
- g) NDT of cement-sand mortars/concrete blocks by Schmidt test hammer.
- h) Soundness of cement.
- i) Flow table test of mortar.

Open Elective (Any one of the following)

OE: 511 Database Management System Lab L-T-P=0-0-3 Credits=2

Structured Query Language

1. Creating Database

- Creating a Database
- Creating a Table
- Specifying Relational Data Types
- Specifying Constraints
- Creating Indexes

2. Table and Record Handling

- a. INSERT statement
- b. Using SELECT and INSERT together
- c. DELETE, UPDATE, TRUNCATE statements
- d. DROP, ALTER statements

3. Retrieving Data from a Database

- The SELECT statement
- Using the WHERE clause
- Using Logical Operators in the WHERE clause
- Using IN, BETWEEN, LIKE, ORDER BY, GROUP BY and HAVING

Clause

- Using Aggregate Functions
- Combining Tables Using JOINS
- Subqueries

4. Database Management

- Creating Views
- Creating Column Aliases
- Creating Database Users
- Using GRANT and REVOKE

Cursors in Oracle PL / SQL

Writing Oracle PL / SQL Stored Procedures

OE: 511 Operation Research Lab L-T-P=0-0-3 Credits=2

Software based lab using C /C++

1. Assignment on Transportation problem.
2. Assignment on Assignment problem
3. Assignment on Duality
4. Assignment on Simplex method (Including Charns' Big-M Method)
5. Assignment on Shortest Path by using Dijkstra's or Floyd's Algorithm
6. Assignment on Maximal Flow Problem (Ford-Fulkerson Method).
7. Assignment on PERT/CPM
8. Familiarization with O.R package: TORA

OE:511 Object Oriented Programming(OOP) Lab L-T-P=0-0-3 Credits=2

1. Assignments on class, constructor, overloading, inheritance, overriding
2. Assignments on wrapper class, arrays
3. Assignments on developing interfaces- multiple inheritance, extending interfaces
4. Assignments on creating and accessing packages
5. Assignments on multithreaded programming
6. Assignments on applet programming

Note: Use Java for programming

Preferably download "java_ee_sdk-6u4-jdk7-windows.exe" from

<http://www.oracle.com/technetwork/java/javase/downloads/java-ee-sdk-6u3-jdk-7u1-downloads-523391.html>