CIVIL ENGINEERING MATERIALS

Course Code: CE 102

Lecturer: 2 **Year: I**
Tutorial: 0 **Part: II**
Practical: 1 **Course Credit: 2**

Course Objectives:

Provides students with an introductory knowledge of a wide range of materials used in construction of civil engineering projects. The focus of this course is on the properties, defects, production, preservation, alternatives and utilization of different building materials, which will help you choose the right material for your civil engineering project in design as well as construction. This helps provide a basis for material selection, proper considerations, and precautions during planning, design and construction.

	Teaching Schedule Hours/Week			**Evaluation Scheme**				
				Internal Evaluation		**Final Evaluation**		**Total**
	Lecture	Tutorial	Practical	Theory	Practical	Theory	Practical	75
Cr	2	0	1	20	25	30	0	

Unit 1 Basics of Civil Engineering Materials (2 hours)

1.1 Materials of civil constructions: buildings; road and bridges; irrigation and hydropower; water supply and sewerage; gas and petroleum supply

1.2 Classification of materials: existence in nature, functions or usage; metallurgy; composition of materials

1.3 Properties: physical; chemical; mechanical; thermal; optical; electrical; magnetic

1.4 Failure of materials: ductile and brittle failure

1.5 Factors affecting selection of materials: properties and performance; attributes and suitability; strength, durability and safety; availability, reliability and disposability; and economy and environmental impact

1.6 Environment interactions of materials: corrosion; weathering; erosion; thermal strain; exposure to moisture, sunlight, and chemicals

Unit 2 Stones and aggregates (3 hours)

2.1 Classification of rocks and aggregates: geological, physical and chemical classifications of rocks; introduction to coarse and fine aggregates

2.2 Properties of stones and aggregates: physical, chemical and mechanical properties

2.3 Characteristics of good stones and aggregates: appearance; structure; strength; porosity and absorption; weathering; fire resistance; hardness and toughness; specific gravity; thermal properties

2.4 Selection and use of stones and aggregates: selection criteria; various uses of stones in engineering constructions

2.5 Deterioration and preservation of stones and aggregates: deterioration and its retardation; preservation and preservatives used in stones

2.6 Production, storage and handling of stones and aggregates: natural bed of stones; selection of quarry site; methods of quarrying; dressing of stones

Unit 3 Clay and Clay Products (3 hours)

3.1 Clay: use of clay in constructions; classification/types of clays; properties of clays

3.2 Brick earth: ingredients; properties and testing (consistency test; molding property test; deformation and shrinkage test on burning, strength and quality of brick test)

3.3 Bricks: use of bricks; manufacturing of bricks; classification and properties (physical and mechanical) of bricks (unburnt and burnt bricks); characteristics of good bricks; standard tests for bricks (shape and size test; color test; soundness test; hardness test; water adsorption test; efflorescence test; compressive strength test)

3.4 Tiles: use of tiles; manufacturing process of tiles; types and properties of tiles (roof tiles, wall tiles, floor tiles, drain tiles); characteristics of good tiles

3.5 Terracotta, earthenware and glazing: properties; use; composition; production

3.6 Storage and handling of clay and clay products

Unit 4 Lime and pozzolanic materials (2 hours)

4.1 Sources and constituent of limestones: limestones and stone lime; kankar lime; shell lime; magnesian lime; impurities in limestones

4.2 Classification/types of limes: quick lime; flat lime, hydraulic lime, poor lime; hydrated lime; milk lime; lump lime

4.3 Characteristics of lime, hydration of lime, slaking nature of lime, solidification of lime

4.4 Manufacture/production of lime: Flow diagram of lime production from limestone and kankar

4.5 Storage, handling and use of different types of lime

4.6 Types of pozzolanic materials: volcanic ash; calcinated clay products; clay/kaolin pozzolana; mineral slag; ashes of organic origin and uses

Unit 5 Cement (4 hours)

5.1 Fundamentals of cement: ingredients of cement; Cement clinkers; compounds of cement clinkers and their functions in cement type and properties of cement; storage, handling and use of cement; characteristics of good cement

5.2 Manufacture of ordinary cement: dry manufacturing process; wet manufacturing process

5.3 Classification of cements: different types of cements, their composition, properties and applications (ordinary Portland cement (OPC), rapid hardening cement, slow setting cement, Portland pozzolana cement (PPC), white cement, colored cement)

5.4 Hydration of cement and testing: Formation of glue, chemical bonding, setting time (initial and final); field test; laboratory tests (fineness test, consistency test, initial and final setting time test, soundness test, compressive and tensile strength test)

5.6 Admixtures: Types of admixture (water proofers, accelerators, retarders, plasticizers, air entraining agents), uses of admixtures

Unit 6 Mortar (2 hours)

6.1 Function, classification and uses of different types of mortar

6.2 Properties of mortar: workability, inertness, setting and hardening, adhesion

6.3 Preparation (hand mixing, machine mixing), storage and handling of mortar

6.4 Selection of mortar for different construction works: selection criteria; characteristics of a good mortar

6.5 Testing of mortars: crushing strength test, tensile strength test, adhesiveness test on building unit

Unit 7 Timber (3 hours)

7.1 Tree and timber: growth and structure of tree; properties (including mechanical) and use of timber; defects in timber (during growth of trees, after felling of trees); characteristics of good timber

7.2 Classification of tree and properties of wood, hard wood, soft wood

7.3 Seasoning of timber: definition and importance of seasoning; types of seasoning (natural and artificial seasoning)

7.4 Deterioration and preservation of timber: deterioration (physical, chemical, biological); types of preservatives; methods of preservation

7.5 Commercial product of timber: veneers and ply wood; boards (laminated boards, fiber boards, block boards, and batten boards); impreg and compreg timbers

7.6 Bamboo: properties (including mechanical) of bamboo; structural use of bamboo

Unit 8 Metals and Alloys (4 hours)

8.1 Metals: classification (ferrous and nonferrous metals); properties (physical, chemical, mechanical, electrical, thermal, magnetic)

8.2 Sources, composition, properties and uses of ferrous metals: pig iron, cast iron, wrought iron, steel, alloys of steel

8.3 Sources, properties and uses of nonferrous metals: aluminum, copper, lead, tin, zinc, magnesium, nickel

8.4 Heat treatment process and its importance in metals: annealing, normalizing, quenching or hardening, tempering, surface hardening (case hardening, nitriding, cyaniding, flame/ induction/laser hardening), defects in heat treatments

8.5 Commercial forms of metals and their uses: sheets, channel sections (I, C, angle, tubular), bars

8.6 Corrosion and its prevention in steel: theory of corrosion and its prevention with enameling; applying metal coatings – galvanizing, tin plating, electroplating; applying coatings – painting and tarring.

Unit 9 Paints and Varnishes (3 hours)

9.1 Paints: function and ingredients of paints; characteristics of good paint

9.2 Type, composition, properties and uses of paints: Oil paints; Aluminum paints; Asbestos paints; Bituminous paints; Cellulose paints; Cement paints; Colloidal paints; Emulsion paints; Enamel paints; Graphite paints; Silicate paints; Anticorrosion paints; Plastic paints; Synthetic rubber paints; Distempers

9.3 Varnishes: function and ingredients of varnishes; characteristics of good varnishes

9.4 Type, composition, properties and uses of varnishes: Oil varnish; Turpentine varnish; Spirit varnish; Water varnish; Asphalt varnish; Spar varnish; Flat varnish

9.5 Process of application of different paints and varnishes: application in new surfaces; application in old surfaces

9.6 Defects in paints and varnishes: effects of background (dampness, cleanness movement reactions); effects of weather (blistering, peeling, checking, cracking, flaking, chalking, alligatoring, wrinkling, running and sagging, mildew, bloom, flashing, grining)

Unit 10 Miscellaneous Materials (4 hours)

10.1 Asphalt: origin, composition, properties, types and uses

10.2 Bitumen: origin, composition, properties, types and uses

10.3 Tar: origin, composition, properties, types and uses

10.4 Composition, properties, types and uses of :– glass, plastic materials, rubber materials, insulating materials, gypsum products, adhesive and sealant materials, anti-termite materials, water proofer, geosynthetics, fibers

10.5 Composite materials: composition, properties, types and uses of – cement steel reinforced concrete, fiber reinforced plastics, fiber reinforced cement concrete and plastics, metal matrix composite

10.6 Emerging materials: Calcium silicate bricks; Concrete blocks; Aerated Autoclave Concrete blocks (AAC blocks); Interlocking Compressed Stabilized Earth Blocks (Interlocking CSEB), panels and boards

Practical (15 Hours)

There shall be related practical study in class. Practical work shall be as given below considering specified chapters.

1. Water absorption test of (i) Brick, and (ii) Stone (2 hours)
2. Bulk density test of (i) Brick, (ii) Cement, (iii) Sand, and (iv) timber (2 hours)
3. Specific gravity test of (i) Cement, (ii) Sand, (iii) Aggregate and (iv) Brick (3 hours)
4. Consistency and setting time (initial and final) of test of cement (4 hours)
5. Fineness and soundness test of cement (2 hours)
6. Compressive strength test of (i) Brick (ii) Mortar Cube, (iii) Cement Cube, and (iv) concrete cube (2 hours)

Reference

1. Duggal, S. K. (2008). Building Materials. New Delhi: New Age International (P) Ltd., Publishers.

2. Mamlouk, M. S., & Zaniewski, J. P. (2018). Materials for Civil and Construction Engineers. Harlow: Pearson Education Limited.

3. Rajput, R. K. (2004). Engineering Materials. S. Chand & Company Ltd

4. Singh, P. (2010). Civil Engineering Materials. New Delhi: S K Kataria & Sons

5. Thornton, P. A., & Prentice, V. J. (1985). Fundadmental of Engineering Materials . Hall Publishing Company.

Evaluation Schedule:

The final evaluation will have questions from all units. The marks distribution from different units shall be as follows:

Units	Unit Title	Scheduled Hours	Marks
Unit 1	Basics of Civil Engineering Materials	2	2
Unit 2	Stones and aggregates	3	3
Unit 3	Clay and Clay Products	3	3
Unit 4	Lime and pozzolanic materials	2	2
Unit 5	Cement	4	4
Unit 6	Mortar	2	2
Unit 7	Timber	3	3
Unit 8	Metals and Alloys	4	4
Unit 9	Paints and Varnishes	3	3
Unit 10	Miscellaneous Materials	4	4
	Total	**30**	**30**

Note: The marks distribution shown in the table above might be subjected to minor changes.