

REVISED UG SYLLABUS UNDER CBCS  
(Implemented from Academic Year, 2020-21)  
PROGRAMME: FOUR YEAR B.Sc.(Hons)

Domain Subject: **CEMENT SCIENCE**

**Skill Enhancement Courses (SECs) for Semester V, from 2022-23** (Syllabus with Learning Outcomes, References, Co-curricular Activities & Model Q.P. Pattern)

**Structure of SECs for Semester-V**

(To choose One pair from the Five alternate pairs of SECs)

Univ Code	Course No.	Name of Course	Th.Hrs./Week	IE Marks	EE Marks	Credits	Prac.Hrs./Week	Marks	Credits
	6A	Fuels and Firing system	3	25	75	3	3	50	2
	7A	Safety and Pollution Control	3	25	75	3	3	50	2
<b>OR</b>									
	6B	Refractory Engineering	3	25	75	3	3	50	2
	7B	Material Handling System and Alternate Fuels	3	25	75	3	3	50	2
<b>OR</b>									
	6C	EIA & EMP of Cement Plant	3	25	75	3	3	50	2
	7C	Utility and Maintenance in Cement Plant	3	25	75	3	3	50	2

**Note-1:** For Semester-V, for the domain subject Cement Science, any one of the three pairs of SECs shall be chosen as courses 6 and 7, i.e., 6A&7A or 6B&7B or 6C&7C. The pair shall not be broken (ABC allotment is random, not on any priority basis).

**Note-2:** One of the main objectives of Skill Enhancement Courses (SEC) is to inculcate skills related to the domain subject in students. The syllabus of SEC will be partially skill oriented. Hence, teachers shall also impart practical training to students on the skills embedded in syllabus citing related real field situations.

# Semester-wise Revised Syllabus under CBCS, 2020-21

Four-year B.Sc.(Hons) Course Code:

Domain Subject: **CEMENT SCIENCE**

Semester-V

**Course6-A: Fuels and Firing system**

Max Marks: 100+50

(Skill Enhancement Course (Elective), Credits: 05)

## **I. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Analyze the coal
2. Differentiate 3 types of burners
3. Set up different flame shapes
4. Choose appropriate fuel for 3 types of firing systems.
5. Classify the refractories

**II. Syllabus :** (*Total Hours: 90 including Teaching, Lab, Field Skills Training, Unit tests etc.*)

## **Unit-1: Introduction and Characteristics of fuels 12 hours**

1. Type of fuels, Coal, Lignite, Oil and Natural Gas, Geological Origin of coal, Oil and Natural gas.
2. Distribution of coal and lignite deposits in India.
3. Introduction to alternative fuels for cement manufacture.
4. Physical and Chemical characteristics of different types of fuel,
5. Ultimate and Proximate analysis of coal, calculation of theoretical air requirement, Characteristics of coal& lignite and their influence in burning of clinker, preparation and handling of fuel.

## **Unit-2: Flames & Burners**

1. Introduction, types of flame, flame characteristics, flame adjustment, flame momentum.
2. Secondary firing and pre-calcinator, Combustion Indications.
3. Burners, types of burners, application.

## **Unit-3: Firing System - I**

1. Introduction to various types of firing systems in cement plant, their advantages and disadvantages.
2. Coal Firing System: Introduction, classification, selection criteria for coal firing.
3. Pulverized coal ash flame, Pulverized coal ash burner.

## **Unit-4: Firing System-II**

1. Oil Firing System: Introduction to Fuel oil, Fuel Oil transport and storage, Fuel oil Atomization, Fuel oil Burners, Control loops in fuel oil plant.
2. Gas firing System: Natural gas, Natural gas preparation, Natural gas burners, Flame adjustment, safety precautions.

## **Unit-5: Introduction and selection of Refractories**

1. Refractory classification, importance of refractories for cement production.
2. Types of refractories, its application, factors effecting wear of refractories in cement industry.
3. Castables, its types and composition, mortars. Selection of refractories and castables for different location of Cement plant.
4. Procedure for laying start up and stoppage of kiln for cement plant, measures to improve refractory life in rotary kiln in cement plant.

## **III. References**

1. Fuels and combustion : Samir Sarkar, New Delhi Reference Books:
2. Firing System: Process Technology: Cement Seminar, Holderbank
3. Flame & Burners : Process Technology: Cement Seminar, Holderbank.
4. Refractory Lining of Cement Kiln System : Process Technology: Cement Seminar, Holderbank

## **IV. Practical (Laboratory) Syllabus :**

### **Fuels and Firing system practical (30hrs) (Max.50 Mark)**

#### **I. Proximate analysis of Coal**

1. Determination of Moisture content
2. Determination of Volatile Matter
3. Determination of Fixed Carbon
4. Determination of Ash Content

#### **II. Determination of Gross Calorific Value.**

## **V. Recommended Co-Curricular activities:**

1. Assignments
2. Seminars
3. Cement Industry visits

# Semester-wise Revised Syllabus under CBCS, 2020-21

Four-year B.Sc.(Hons) Course Code:

Domain Subject: CEMENT SCIENCE

Semester-V

**Course 7-A: Safety and Pollution Control**

Max Marks: 100+50

(Skill Enhancement Course (Elective), Credits: 05)

## I. Learning Outcomes

1. Identify loss of industrial accidents
2. List appropriate PPE
3. Identify dust and gas emission sources
4. Utilize 5 techniques to control pollution
5. Operate Roto packer

**II. Syllabus :** (*Total Hours: 90 including Teaching, Lab, Field Skills Training, Unit tests etc.*)

### Unit-1: Occupational Health and Industrial Accidents

1. Importance of Safety Performance & its monitoring, Classification of Industrial Accidents Plant Safety Inspection / Procedures.
2. Accident Investigation System, Concept of root cause analysis.
3. Method for computation of Frequency and Severity rates for Industrial injuries accidents as per IS 3786 : 1983

### Unit-2: Safety

1. Introduction to process of safety, Importance of safety, type of accident & causes, direct and indirect effect of accident, accident and loss statistics.
2. Safety consideration and design of cement plant, protective and safety devices for personal and general hygienic management in and around premises, respirators and ventilation system- local and dilution.
3. Measure of risk , laws, rules and regulation conserving safety in cement plant for prevention of accident, managerial aspect of safety.

### Unit-3: Dust generation and Pollution Control Equipments

1. Both fugitive and point source of dust emissions in cement plant, classification of particle size distribution of dust, cement kiln dust characteristics, dust emission standards, health effects

on workers exposure to dust.

2. Air - Control measures for improving ambient air quality (AAQ) and fugitive dust, AAQ – Monitoring methods, Air Pollution Control Equipments for controlling Point Source Emissions – Bag Filter / Bag House, ESP, Hybrid Filter. Multi Cyclones, Wet Scrubber, Gravity Setting chamber.
3. Control of gaseous emissions by primary and secondary (SCR/ SNCR) techniques.
4. Green House Gas control measures–1. Blended cement, 2. Use of alternate fuels 3. carbon sequestration.

#### **Unit-4: Air and Noise Pollution Control**

1. Emission source of CO, CO<sub>2</sub>, NO<sub>x</sub> and SO<sub>x</sub>, concerns about green house gas emissions and climate change, health concern.
2. Source model- release and flow of toxic gases and particulates from the stack factors affecting their dispersion and modelling.
3. Measuring equipment of exit gases ,SO<sub>x</sub>, NO<sub>x</sub> and CO. Regulatory requirements, equipment required to control gaseous pollutants, recent development.
4. Noise of running machinery and mills, method of noise suppression, balancing of equipment, noise barriers, effect of plantation, effect on human health, regulatory requirement.

#### **Unit-5: Packing & Dispatch of Cement**

1. Introduction, types of packing, sacks, In-line packing machines, Rotary packers, fully automation operation, sack magazine.
2. Dispatch in sacks - individual sack loading, Pelletization, direct loading, bulk loading, loading installations, weighing systems.
3. Big Bag dispatch, shrink wrapping, automation of dispatch procedures.

### **III. References**

1. Cement Engineers Handbook IV Edition by B.Kohlhaas.
2. Cement engineers hand book by Otto Ladahn.
3. Cement Data Book: W. H Duda , Verlag G m Bh,Berlin vol.1& 2.

#### **IV. Practical (Laboratory) Syllabus :**

##### **Physical and chemical tests of water (30hrs) (Max.50 Mark)**

1. Ph
2. Electrical Conductivity,
3. Hardness,
4. Acidity,
5. Alkalinity,
6. Chloride

##### **V. Recommended Co-Curricular activities:**

1. Assignments
2. Review analysis
3. Group Discussion.

# Semester-wise Revised Syllabus under CBCS, 2020-21

Four-year B.Sc.(Hons) Course Code:

Domain Subject: **CEMENT SCIENCE**

Semester-V

**Course6-B: Refractory Engineering**

Max Marks: 100+50

(Skill Enhancement Course (Elective), Credits: 05)

## **I. Learning Outcomes**

1. Classify refractories
2. Understand lining of Kiln
3. Illustrate properties of refractories
4. Select suitable refractories
5. Apply Kiln startup & Stoppage procedures

**II. Syllabus :** (*Total Hours: 90 including Teaching, Lab, Field Skills Training, Unit tests etc.*)

### **Unit-1: Fundamentals of Refractory**

1. Refractory classification, importance of refractories for cement production,
2. Types of refractories, its application, factors effecting wear of refractories in cement industry.
3. Castables, its types and composition, mortars.

### **Unit-2: Drying and Firing Phase Diagram**

1. Drying and firing phase diagram, Manufacture and properties of silica, alumina silicate refractories.
2. Periclase, magnesite, magnesite-chrome, dolomite, high and low temperature insulating refractories.
3. Acid proof bricks and carbon based refractories.

### **Unit-3: Properties and Measurements**

1. Properties and measurement of cold crushing strength, refractoriness under load, hot modulus of rupture creep behaviour, abrasive resistance, thermal spalling, reaction of refractories.
2. Slag, glasses, Carbon monoxide, acids, alkalise, flue gases, corrosion of regenerated refractories by flue gases.

## **Unit-4: Subdivision of Burning Process of Refractories**

1. Subdivision of burning process & selection of refractory in kiln drying zone, preheating zone, calcining zone, transition zone, sintering zone, cooling zone.
2. Lining of preheater, kiln hood, coolers.
3. Features of refractory installation (brick joints, lining methods, rotating methods, screw jack method etc).

## **Unit-5: Selection of Refractories**

1. Selection of refractories and castables for different location of Cement plant.
2. Procedure for laying start up and stoppage of kiln for cement plant.
3. Measures to improve refractory life in rotary kiln in cement plant, cost effectiveness, case studies for payback calculation.

## **III. References**

1. Refractory Engineering and Kiln Maintenance in Cement Plant: J P Saxena, CRC Press, Technology & Engineering
2. Refractory Lining of Cement Kiln System : Process Technology: Cement Seminar, Holderbank
3. Hand Book of Industrial Refractories Technology: Stephen C, Carniglia Godon L Barma, Noyes Publication.
4. Refractory Linings: Thermo mechanical Design and Applications: Charles Schacht, CRC Press, Technology & Engineering.

## **IV. Practical (Laboratory) Syllabus :**

### **Methods of Testing of Refractories (30hrs) (Max.50 Mark)**

1. The study of refractories manufacturing process.
2. Determination of refractoriness.
3. Determination of modulus of rupture.
4. Determination of resistance to thermal shock (Spalling).

## **V. Recommended Co-Curricular activities:**

1. Assignments
2. Industry Visit
3. Group Discussion.



# Semester-wise Revised Syllabus under CBCS, 2020-21

Four-year B.Sc.(Hons) Course Code:

Domain Subject: **CEMENT SCIENCE**

Semester-V

**Course 7-B: Material Handling System and Alternate Fuels** Max Marks: 100+50

(Skill Enhancement Course (Elective), Credits: 05)

## I. Learning Outcomes

1. Understand 10 principles of material handling
2. Explain material handling equipment
3. Operate elevators
4. Compare 5 types of alternative fuels
5. Identify 3 heat sources in cement industry

**II. Syllabus :** (*Total Hours: 90 including Teaching, Lab, Field Skills Training, Unit tests etc.*)

### Unit-1: Introduction to Material Handling

1. Objective and Benefit of better handling, limitation and negative aspects, Importance.
2. Objective plant layout and material flow cycle, material handling equation. Principle of material handling: Systems, material handling.
3. The Material Flow, Simplification, Gravity, Space Utilization, safety and mechanization.
4. Equipment Selection, Flexibility, Dead Weight, Motion, Idle time, Maintenance, Control capacity and performance.

### Unit-2: Basic Handling Equipment Types and Systems

1. Equipment classifications. The Unit load Concept: Types of Unit load, advantages and disadvantages, Planning the Unit load systems, Unit load Efficiency.
2. Selected Material Handling Equipment: Conveyors, Cranes, Elevators, Hoists, Monorail, Industrial Vehicles Container and supports, Auxiliary Equipment.

### Unit-3: Material Handling and Feeding Systems

1. Various systems of material handling; haulage and transportation from mines, trucks, dumpers etc.
2. General introduction, Belt conveyors and steel band conveyors.
3. Bucket elevators- general explanation, Belt bucket elevators, chain bucket elevators, swing bucket elevators.
4. Conveying of Solids: Conveyor selection, classification of conveyors , Chain Conveyors- Flight conveyors, continuous flow conveyors, apron conveyors, vibratory conveyors, screw

conveyors, pneumatic conveyors,

5. Feeders, Weighing equipment.

#### **Unit-4: Types of Alternative Fuels**

1. Types of alternative fuels for cement kiln : Refused Derived Fuel from MSW, used tyres,
2. Biomass, industrial plastics, waste oils and solvents, domestic waste, ETP sludge, saw dust, rice husk, spent wash, pharmaceutical waste.
3. Characteristics of alternate fuels, various handling & pre processing equipment of alternate fuels.
4. Advantages and disadvantages of alternate fuels, environmental consideration in use of alternate fuels in cement kiln.

#### **Unit-5: Recovery of Energy**

1. Recovery of energy from in cement industry-Possible Heat Sources such as Kiln Shell, clinker cooler, kiln system exit gas.
2. Waste heat recovery/thermal energy storage applications: Sensible Heat Storage.

### **III. References**

1. Material Handling System Design: James M Apple, Gerogia Institute of Technology, The Ronald press company, New York.
2. Cement Data Book: W. H Duda , Verlag G m Bh,Berlin
3. Cement Engineers Hand Book: Labhaanand Kolhaans.
4. "Urban Environment Management" Local Govt and community action, Concept publishing company, New Delhi, 2003. Archana Ghose
5. Assessment of utilization of Industrial solid Wastes in cement manufacturing ,CPCB
6. Guidelines on Co-processing in Cement /Power/Steel industry, Central Pollution Control Board,February 2010.

### **IV. Practical (Laboratory) Syllabus :**

#### **Fuels and Firing System Practical (30hrs) (Max.50 Mark)**

I. Proximate analysis of Coal

1. Determination of Moisture content
2. Determination of Volatile Matter
3. Determination of Fixed Carbon
4. Determination of Ash Content

II. Determination of Gross Calorific Value.

### **V. Recommended Co-Curricular activities:**

1. Assignments
2. Industry Visit
3. Quiz

## Semester-wise Revised Syllabus under CBCS, 2020-21

Four-year B.Sc.(Hons) Course Code:

Domain Subject: **CEMENT SCIENCE**

Semester-V

**Course6-C: EIA & EMP of Cement Plant**

Max Marks: 100+50

(Skill Enhancement Course (Elective), Credits: 05)

### **I. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Check water quality
2. Utilize 5 techniques to control pollution
3. Understand impacts of Cement plant on Environment
4. Demonstrate 6 Environment Management Acts
5. Identify ambient air quality

**II. Syllabus :** (*Total Hours: 90 including Teaching, Lab, Field Skills Training, Unit tests etc.*)

### **Unit-1: Introduction**

1. The Environment, Interaction of Humans and Environment.
2. Role of an engineer in Environmental improvement. Present Environmental Scenario: socio economic studies , buffer zone , demographic profile.
3. Environmental quality , air environment , micro-meteorology, dust environment , water quality , noise level.

### **Unit-2: Sources of Pollution in Cement Industry**

1. Air Water ,Noise –Solid and Hazardous Waste :Control measures for improving ambient air quality (AAQ) Pollution Control Equipments for controlling Point Source Emissions – Bag Filter / Bag House, ESP, Hybrid Filter, Multi Cyclones,
2. Wet Scrubber, Gravity Setting chamber, primary and (SCR/ SNCR) techniques.
3. Stack monitoring ,carbon sequestration.

### **Unit-3: Environmental Impact Assessment**

1. Impact on socio economic factors , Impact due to land degradation , impact on topography and drainage , impact due to solid waste , impact due to coal stocks , impact on flora and fauna.
2. Impact on safety , impact on environmental quality , ambient air quality , impact on

water quality , impact on noise levels.

3. Mathematical modelling for dispersion of air pollutants, Battelle Environmental Evaluation System.

#### **Unit-4: Environment Management Act**

1. Introduction to various Environmental Act & Regulations, Environment Protection Act 1986, Water (Prevention and Control of Pollution) act, Water (Prevention and Control of Pollution) Cess act, Air (Prevention and Control of Pollution) act,
2. Forest (Conservation) Act, Hazardous Waste (Management, Handling and trans boundary movement) Rules, Solid Waste Management Rules, Corporate Responsibility for ENV Protection (CREP).
3. Environment Management Tools :EMS – ISO 14001, Environmental Audit / Statement, Clean Development Mechanism (CDM).

#### **Unit-5: Environmental Management Plan**

1. Socio economic factors, rehabilitation , compensatory afforestation , welfare measures, environmental quality , ambient air quality , green belt development , water quality , noise levels control measures ,
2. Occupational health, disaster and hazard management.
3. Post Project environmental monitoring programme : organisational structure , monitoring scheme, equipments required for monitoring , budgetary provision for EMP.

### **III. References**

1. Environmental Pollution Control Engineering : C S Rao
2. Air Pollution : M N Rao, H.V.N. Rao
3. Environmental Engineering : Peavy and Rowe
4. Air Pollution Control by S P Mahajan, T.V. Ramachandra
5. Pollution Control in Process Industries : S P Mahajan

### **IV. Practical (Laboratory) Syllabus :**

#### **Testing of Waste Water & Noise and Ground Vibration (30hrs) (Max.50 Mark)**

1. Determination of BOD
2. Determination of COD
3. Determination of SVI
4. Determination of Sulphides
5. Determination of Chlorides

6. Determination of Nitrates
7. Noise Monitoring (Leq, Ld, Ln, Ldn)
8. Ground Vibration Monitoring using Blast Mate

**V. Recommended Co-Curricular activities:**

1. Seminars
2. Industry lab Visit
3. Quiz

## Semester-wise Revised Syllabus under CBCS, 2020-21 Four-year B.Sc.(Hons) Course Code:

Domain Subject: **CEMENT SCIENCE**

Semester-V

**Course7-C: Utility and Maintenance in Cement Plant**

Max Marks: 100+50

(Skill Enhancement Course (Elective), Credits: 05)

### **I. Learning Outcomes:**

Students after successful completion of the course will be able to:

1. Describe cement plant operational problems
2. Compare 3 grinding aids
3. Illustrate kiln conditions
4. Understand cement plant lay out
5. Operate 5 conveyors

**II. Syllabus :** (*Total Hours: 90 including Teaching, Lab, Field Skills Training, Unit tests etc.*)

### **Unit-1: Operational Problem**

1. Cause and measure to solve them, coating, ball formation.
2. Cyclone jamming, other emerging conditions, wear in cement plant- abrasion, erosion, corrosion, causes and control measures.

### **Unit-2: Packing and dispatch**

1. Finish grinding of clinker with gypsum and other additives.
2. Combined grinding and separate grinding packing machines, use of grinding aids.
3. Type of packing medium, tolerances, bag and bulk supply, dispatch of cement.

### **Unit-3: Maintenance**

1. Maintenance strategies, preventive maintenance, condition monitoring for predictive Maintenance, check for kiln alignment and shell ovality, annual maintenance.
2. Shutdown Maintenance, economic life of refractories , and machineries, check lists, shutdowns, upset kiln conditions- causes and controls.

#### **Unit-4: Typical Lay out in a Cement Plant**

1. Typical lay out in a cement plant related to material handling, Material Handling lay out for water.
2. Water supply in cement plant, requirement in plant and colonies, water for cooling and quenching, water for fire fighting, water treatment.

#### **Unit-5: Material Handling Lay out**

1. Material Handling lay out for air ,: Air supply to kiln system, compressed air, blowers and compressors, exhaust, pumps.
2. Movement of materials , conveyors, F K pumps, Dense phase transport.

### **III. References**

1. Cement Data Book: W. H Duda , Verlag G m Bh,Berlin
2. Handbook of Material Handling
3. Maintenance Engineers Hand book,
4. Cement Engineers Hand Book: Labhaanand Kolhaans
5. Operational Norms for cement plant: NCCBM publication

### **IV. Practical (Laboratory) Syllabus :**

#### **Physical Testing of Cement by BIS Method (30hrs) (Max.50 Mark)**

1. Determination of density
2. Determination of specific surface
3. Determination of normal consistency
4. Determination of setting time
5. Determination of soundness test by Le Chatelier Autoclave
6. Determination of compressive strength
7. Determination of drying shrinkage

### **V. Recommended Co-Curricular activities:**

1. Seminars

2. Industry lab Visit

3. Quiz