



ANDHRA PRADESH STATE COUNCIL OF HIGHER EDUCATION

MINOR

Subject: Cement Science

w.e.f. AY 2023-24

COURSE STRUCTURE

Year	Semester	Course	Title of the Course	No. of Hrs /Week	No. of Credits
	II	1	Geology and Mining of Limestone	3	3
			Geology and Mining of Limestone Practical Course	2	1
II	III	2	Size Reduction and Pre-homogenisation	3	3
			Size Reduction and Pre-homogenisation Practical Course	2	1
	IV	3	Fuels and Firing Systems	3	3
			Fuels and Firing Systems Practical Course	2	1
		4	EIA and EMP of cement plant	3	3
			EIA and EMP of cement plant Practical Course	2	1
III	V	5	Pyro process in Cement Industry	3	3
			Pyro process in Cement Industry Practical Course	2	1
		6	Special Cements and Performance of Cement	3	3
			Special Cements and Performance of Cement Practical Course	2	1

COURSE 1: GEOLOGY AND MINING OF LIMESTONE

Theory

Credits: 3

3 hrs/week

Learning Objectives:

1. To impart and inculcate the basic geological knowledge to students
2. Create awareness in students about the Earth's environment, critical issues and need for sustainable development.
3. The course will help the students to exhibit an improved understanding of fundamental petrologic processes and common rock types and their occurrences.

II Learning outcomes:

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

1. Classify geological limestone origin in India.
2. Analyse cement grade limestone properties.
3. Describe geological exploration process.
4. Explain 3 mining equipment.
5. Apply environmental protection plans.

III Syllabus: (Total Teaching Hours : 45)

Unit I Stratigraphy & Geology of Limestone 9 Hrs

1. Indian stratigraphy. Types of rocks: Igneous, sedimentary and metamorphic rocks.
2. Structural geology - Fold, Fault, Joint, Unconformities
3. Origin & formation of calcareous rocks

Unit II Distribution and Characteristic of Cement Grade Limestone 8 hrs

1. Physical and chemical characteristics of Limestone. Petrographic study of limestone.
2. Classification of cement grade limestone deposits.
3. UNFC classification of limestone deposits.

Unit – III Exploration and Deposit Evaluation 9 hrs

1. Phases of Geological Exploration with reference to limestone deposits.
2. Geological Mapping, Preparation of Geological Maps and section, Surveying, Sampling practices.
3. Recoding of Exploration Data, Methods of Reserve estimation.

Unit- IV Mining of Limestone 10 hrs

1. Surface mining, method of mining of limestone deposits.
2. Estimation of block size and bench height, estimation of block wise bench wise grade and tonnage, Selection of mining equipment (Excavator, Dozer, Dumper etc.)
3. Blasting techniques, types of explosives used, Uses of explosives, Mine production scheduling and planning. Advance methods of limestone mining,

Unit V Environment around Mines 9 hrs

1. Blasting and resultant vibration, controlled and sequential blasting.
2. Ecological and environmental conditions around limestone mines, plantation, roads, water bodies, social forestry and safety measure Management Techniques.
3. Concept of clean development mechanism, Environmental Impact Analysis (EIA) and Environmental Management Plan (EMP). Brief idea about PL and ML application.

SEMESTER-II

COURSE 1: GEOLOGY AND MINING OF LIMESTONE

Practical

Credits: 1

2 hrs/week

IV. Skills Outcomes:

On successful completion of this practical course, student shall be able to:

1. Handle the Muffle Furnace
2. Acquire skill on reverse titration methods
3. Develop filtration techniques.
4. Perform volumetric analysis
5. List 3 oxides in limestone

V. Practical Syllabus: Hours: 30. (2 Hrs/ Week)

1. Determination of Loss on ignition
2. Estimation of Carbonates of Limestone
3. Determination of Insoluble matter in Limestone
4. Determination Calcium oxides in Limestone by volumetric method
5. Determination total oxides in Limestone (Al_2O_3 , Fe_2O_3 , MgO)

VI. References:

1. Text Book of Geology : P K Mukherjee
2. Chemistry of Cement and Concrete: F M Lea, Arnold, London
3. A Hand book on Surface Mining Technology : Samir Kumar Dash, Sagar prakashan, Khargpur
4. Cement Data Book: W. H Duda , Verlag G m Bh, Berlin.
5. Norms for limestone exploration for cement manufacture : NCCBM

VII. Co-curricular Activities:

1. Field work
2. Mines visit
3. Assignments on aspects of syllabus
4. Individual student seminars
5. Preparing Charts

SEMESTER-III

COURSE 2: SIZE REDUCTION AND PRE-HOMOGENIZATION

Theory

Credits: 3

3 hrs/week

I Learning Objectives:

1. Understand the principles, Laws and methods of size reduction
2. Describe various size reduction equipment's and their efficiencies
3. Focus on the importance of the Blending and Homogenizing process.

II Learning outcomes:

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

1. Describe 5 different screening equipment
2. Calculate size reduction energy requirements
3. Determine 4 crushers
4. Execute Air separators operational procedures
5. Interpret 4 clinker stacking methods

III Syllabus: (Total Teaching Hours : 45)

Unit I Particle Size Analysis 9 hrs

1. Sieve analysis, Cumulative and fractional plot, size distribution, size averaging and equivalence, size estimation in sub-micron range
2. Optimum sizes at various stages from extraction from mines. Influence of size fraction on reactivity of limestone
3. Screening equipments such as grizzlies, stationary, vibrating, curved and DSM screens & screen capacity

Unit II Size Reduction 9 hrs

1. Laws of size reduction -Bond's law, Rittinger's law & Kick's law, Working Index. Crushing efficiency
2. Size reduction machinery crushers by application of compression such as Jaw crusher, gyratory crushers, roll crushers, cone crushers
3. Size reduction machinery crushers by impact such as Impact crushers and Hammer mills

Unit – III Size Classification and Separators 9 hrs

1. Storage of Solids: Bins, silos, hoppers & feeders; storage of raw materials in piles
2. Size Classification and Air Separators: Methods of size classification, principles of air separators and different types of air separators used in cement manufacturing
3. Wet classification: hydro-cyclones, cyclone material balances in open circuit and closed circuit operations & separating efficiency.

Unit- IV Blending & Pre-homogenization 9 hrs

1. Preparation of cement raw meal as per raw mix design, combined & segregated pre-homogenization, Methods of pre-homogenisation.
2. Types of homogenisation silos: discontinuous batch homogenisation silos, continuous overflow homogenizing silos, continuous homogenizing silos.
3. Stacking of blending beds namely in longitudinal & circular stockpiles system & their comparison.

Unit V Stacking Methods

9 hrs

1. Stacking of blending beds, Chevron method , Windraw method , Areal stock piling , Axial stock piling, continuous stock piling .
2. Alternative stock piling Equipments used for reclaiming material from stockpiles such as scraper, bucket wheel, bucket wheel with slewing boom and drum re-claimers.
3. Blending bed theory: batch & continuous homogenization; Fuller's one- eight blending method.

SEMESTER-III

COURSE 2: SIZE REDUCTION AND PRE-HOMOGENIZATION

Practical

Credits: 1

2 hrs/week

IV. Skills Outcomes:

On successful completion of this practical course, student shall be able to:

1. Perform Sieve Analysis
2. Operate Jaw Crusher
3. Handle Crushing rolls
4. Calculate Critical Speed of Ball Mill
5. Maintain Grinding Bed of VRM

V. Practical Syllabus: Hours: 30. (2 Hrs/ Week)

1. To carry out differential and cumulative screen analysis of solid particles.
2. To study performance of Jaw Crusher and find out its crushing efficiency.
3. To study performance of Crushing Rolls and find out its crushing efficiency.
4. To study performance of Ball Mill and find out its crushing efficiency.
5. To study performance of Vertical Roller Mill and find out its crushing efficiency.

VI. References:

1. Cement Data Book: W. H Duda , Verlag G m Bh, Berlin
2. Cement Engineers Hand Book: Labhaanand Kolhaans
3. Operational Norms for cement plant: NCCBM publication
4. Introduction to the Principles of Size Reduction of Particles by Mechanical Means By Richard R. Klimpel
5. Size Reduction of Divided Solids, Author: Jean-Paul Duroudier

VII. Co-curricular Activities:

1. Quiz
2. Review analysis
3. Group discussions.
4. Seminars
5. Assignments

SEMESTER-IV

COURSE 3: FUELS AND FIRING SYSTEMS

Theory

Credits: 3

3 hrs/week

I Learning Objectives:

1. Understand solid, liquid and gaseous fuel properties, analysis, process and handling.
2. Use simple symbol equations to explain combustion reactions and calculate theoretical air requirement for combustion.
3. Apply the knowledge for flame stabilization in various types of industrial burners.

II Learning outcomes:

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

1. Differentiate fuels
2. Analyze Flue gas
3. Choose appropriate fuel for 3 types of firing systems.
4. List safety precautions
5. Classify lubricants

III Syllabus: (Total Teaching Hours : 45)

Unit I Introduction to fuels 9 hours

1. Type of fuels, Coal, Lignite, Oil and Natural Gas.
2. Geological Origin and distribution of coal, Lignite and Oil and Natural gas. Distribution of coal and lignite deposits in India.
3. Introduction to alternative fuels for cement manufacture.

Unit II Characteristics of Fuels 9 hours

1. Physical characteristics of different types of fuels - and Chemical characteristics of different types of fuels, Ultimate and Proximate analysis of coal.
2. Calculation of theoretical air requirement, preparation and handling of fuel, safety hazards.
3. Flue gas analysis, Otto Halfmann's byproduct Oven method, Preparation Coke from Coal

Unit III Firing System – I 9 hours

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 IV Firing System - II 9 Hrs

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.
3. Production and Characterization of Alternative Fuels, Performance and Emission Characteristics, Future Scope.

Unit V Flames and Burners

9 Hrs

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

SEMESTER-IV

COURSE 3: FUELS AND FIRING SYSTEMS

Practical

Credits: 1

2 hrs/week

IV. Skills Outcomes:

On successful completion of this practical course, student shall be able to:

1. Analyze the moisture in coal
2. Determine volatile matters
3. Handle the furnace
4. Estimate fixed carbon in fuel
5. Calculate Gross Calorific value

V. Practical Syllabus: Hours: 30. (2 Hrs/ Week)

1. Determination of Moisture content of Coal
2. Determination of Volatile Matter present in Coal
3. Determination of Ash Content present in Coal
4. Determination of Fixed Carbon present in Coal
5. Determination of Gross Calorific Value of Coal

VI. 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
5. Cement Data Book: W. H Duda , Verlag G m Bh, Berlin.

VII. Co-curricular Activities:

1. Assignments
2. Seminars
3. Cement Industry visits
4. Industry experts interaction
5. Review Analysis

SEMESTER-IV

COURSE 4: EIA AND EMP OF CEMENT PLANT

Theory

Credits: 3

3 hrs/week

I Learning Objectives:

1. Understand the importance of Social Impact Assessments and public participation in the EIA process.
2. Identification of mitigating strategies, such as prevention and control, for each environmental component, as well as a restoration and resettlement strategy.
3. Describe all monitoring procedures required to identify environmental impacts.

II 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

III Syllabus: (Total Teaching Hours : 45)

Unit I Introduction

9 Hrs

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 II Sources of Pollution in Cement Industry

9 Hrs

1. Air Pollution – Sources, Ambient Air Quality, Fugitive dust, Point Source – Green House Gas, particulate matter (PM), SO₂, NO_x, CO, HCl, HF, Heavy Metals, Dioxins & Furans, TOC, TVOC etc.
2. Water pollution – Sources, Consumption, waste water generation, storm water.
3. Noise pollution – Sources, Solid and Hazardous Waste – utilization.

Unit III Environmental Impact Assessment

9 Hrs

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 IV Environment Management Act

9 Hrs

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).

SEMESTER-IV

COURSE 4: EIA AND EMP OF CEMENT PLANT

Practical

Credits: 1

2 hrs/week

IV. Skills Outcomes:

1. Estimation of Hardness of water
2. Perform volumetric titrations
3. Select suitable Indicator
4. Operate PH meter
5. Use Conductometer

V. Practical Syllabus: Hours: 30. (2 Hrs/ Week)

1. Estimation of Hardness of water
2. Determination of Alkalinity of water
3. Determination of Acidity of water
4. Operate and calibrate of pH meter
5. Determine of Conductivity of water

VI. 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

VII. Co-curricular Activities:

1. Assignments
2. Health camps
3. Quiz
4. Poster Presentation
5. Eco clubs

SEMESTER-V

COURSE 5: PYRO PROCESS IN CEMENT INDUSTRY

Theory

Credits: 3

3 hrs/week

I Learning Objectives:

1. Classify various types of clinker coolers in cement manufacturing.
2. Equipment operation and processes such as the Kiln, Preheater, and process fans.
3. Explain thermal heat calculations, sizing of kiln.

II Learning outcomes:

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

1. Evaluate kiln parameters
2. Categorise pre-heaters and pre-calciners
3. Operate 6 process fans
4. Differentiate 4 clinker coolers
5. Explain grinding aids

III Syllabus: (Total Teaching Hours : 45)

Unit I Types of Preheaters 9 hrs

1. Types of Preheater, Comparison, selection of different stages(4/5/6) preheaters.
2. Pre-calciners- Features, advantages and disadvantages of pre-calciners. Primary air, Secondary air, Tertiary air.
3. Optimization of kiln output, factors affecting the kiln output. Determination of parameters of kiln evaluation: thermal loading, volumetric loading, % filling, kiln bypass system.

UNIT-II Types of kiln 9 hrs

1. Rotary Kiln, different type of clinkerisation process. Advantages and Disadvantages of each process; Dry process, Semidry process. Wet Process; Long wet process Kiln.
2. Introduction to preheater and pre-calculator. Modern rotary kiln, Thermal heat calculation, sizing of kiln.
3. Heat balance of kiln, air balance of kilns, inlet seal, Methods used to feed raw meal in the kilns.

UNIT-III Process Fans 9 hrs

1. Purpose of fan, types of fans, their application.
2. Concept of pressure, velocity pressure, total pressure in an air stream.
3. Characteristic curves of fans, fan laws, comparison and selection of principal types of fans.

UNIT-IV Cooling of Clinker 9 hrs

1. Purpose of clinker cooling, types of coolers: Grate Cooler, Reciprocating grate cooler, History, Design features of modern coolers, Cooler control, Cooler de dusting, Non-ventilating cooler, Travelling grate cooler.
2. Rotary Cooler: General design, Cooling performance, Advantages / Disadvantages. Planetary Cooler: General design features, Internal heat transfer equipment, Heat transfer and efficiency, Enhanced cooling, Advantages / Disadvantages.
3. Other Systems: g-cooler, Shaft cooler Comparison of Coolers : Range of application, Operating data and heat balance, Capital and operating costs.

UNIT –V Clinker Storage

9 hrs

1. Method of clinker storage: Silos and Gantry, Clinker Shipment. Gypsum and other additives, grinding aids. Types of cement grinding system and their comparison,
2. Cement conveying to storage, single and multi component silos.
3. Cement packing & Transportation, Bulk Loading.

SEMESTER-V

COURSE 5: PYRO PROCESS IN CEMENT INDUSTRY

Practical

Credits: 1

2 hrs/week

IV. Skills Outcomes:

On successful completion of this practical course, student shall be able to:

1. Handle Hot Air Oven
2. Use Silica Crucibles
3. Perform filtration process
4. Estimate Iron Oxide
5. Handle Muffle Furnace

V. Practical Syllabus: Hours: 30. (2 Hrs/ Week)

1. Determination of Loss on Ignition of Kiln Feed.
2. Estimation of SiO_2 present in Kiln feed
3. Determination of Al_2O_3 present in Kiln feed
4. Determination of Fe_2O_3 present in Kiln feed
5. Estimation of CaO present in Kiln feed

VI. References:

1. Cement Data Book: W. H Duda ,Verlag G mBh,Berlin.
2. Kiln System : Process Technology: Cement Seminar, Holderbank
3. Preclincing System : Process Technology: Cement Seminar, Holderbank
4. Clinker Cooler : Process Technology: Cement Seminar,Holderbank
5. Rotary Kilns: Transport Phenomena and Transport Processes (2nd edition) by A.A. Boateng

VII. Co-curricular Activities:

1. Assignments
2. Mini project
3. Poster presentation
4. Cement Industry Rotary Kiln Visit
5. Interaction with Cement Industry Experts

SEMESTER-V

COURSE 6: SPECIAL CEMENTS AND PERFORMANCE OF CEMENT

Theory

Credits: 3

3 hrs/week

I Learning Objectives:

1. Know various types of special cements manufacturing, properties & its application.
2. To get a broad perspective of special cement performance.
3. To understand durability consideration of concrete

II Learning outcomes:

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

1. Describe Cement Kilns developments
2. Classify kilns based on reaction zone length
3. Operate and control the temperatures of kiln at multiple locations
4. Explain preheater, kiln tube and cooler design aspects
5. Identify internal cycles of inorganic elements

III Syllabus: (Total Teaching Hours : 45)

Unit I Characteristics of Cementious Materials 9 Hrs

1. Characteristic of fly ash, Granulated blast furnace slag, other Pozzolanic materials for cement production.
2. Introduction to Geopolymeric cement, alternate Cementious materials other than OPC
3. Performance of Blended Cement, advantages of Portland Pozzolana Cements (PPC) and Portland Slag Cement (PSC).

Unit II Special Cements 9 Hrs

1. Introduction, Sorel cement, Very High Strength Cement, Decorative Portland Cements, Chemical Cements.
2. Special Portland Type Cements, Calcium Aluminate Cement
3. Production of Low Energy Cements, Gypsum Plaster Cement, Portland Cements with Improved Reactivity, Alkali Activated Slags and Other Alumino Silicates.

Unit III Performance requirements 9 Hrs

1. Performance Requirement of cement: Concrete and mortars, introduction to various infrastructure and use of cement.
2. Requirement of setting, strength and durability of different concrete constructions, effect of chemical composition and physical characteristic of cement on performance.
3. Fineness and particle size distribution, tailoring performance of cements.

Unit IV Operational Problems 9 Hrs

1. Operational Problems - Cause and measure to solve them- Coating, ball formation, cyclone jamming, other emerging conditions.
2. Wear in cement plant- abrasion, erosion, corrosion, causes and control measures.
3. Durability consideration of concrete, sulphate attacks, corrosion of reinforcing steel in concrete, attack by acid and other aggressive agencies.

Unit V Maintenance

9 Hrs

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

SEMESTER-V

COURSE 6: SPECIAL CEMENTS AND PERFORMANCE OF CEMENT

Practical

Credits: 1

2 hrs/week

IV. Skills Outcomes:

On successful completion of this practical course, student shall be able to:

1. Use filtration techniques
2. Operate Muffle furnace
3. Perform Separation techniques
4. Perform various weighing techniques
5. Perform various titration methods

V. Practical Syllabus: Hours: 30. (2 Hrs/ Week)

1. Determination of CaO in Cement
2. Estimation of Al_2O_3 present in Cement
3. Determination MgO present in Cement
4. Calculation of SO_3 present in Cement
5. Determination of Chlorides present in Cement

VI. References:

1. Chemistry of Cement and Concrete: F M Lea, Arnold, London
2. Properties of Concrete : Neville, A.M. Longmans.
3. Cement Industry Data Book, CAM , New Delhi
4. World Cement Directory: CEMBUREAU
5. Cement Data Book: W. H Duda , Verlag G m Bh, Berlin

VII. Co-curricular Activities:

1. Seminars
2. Construction Sites Visit
3. Industry lab Visit
4. Quiz
5. Assignments