B.Tech. IV Year COURSE STRUCTURE (SR24 Regulations)

B.Tech. in CIVIL ENGINEERING Applicable from the Academic Year 2025-26

IV YEAR I SEMESTER

S. No.	Course	Course Title	L	T	P	Credits
1	S24CE701PC	Quantity Survey & Valuation	2	0	0	2
2	S24CE702PC	Project Management	2	0	0	2
3		Professional Elective – II	3	0	0	3
4		Professional Elective – III	3	0	0	3
5		Professional Elective - IV	3	0	0	3
6		Open Elective - II	3	0	0	3
7	S24CE703PC	Civil Engineering Software Laboratory	0	0	2	1
8	S24CE704PC	Project Stage - I	0	0	6	3
		Total Credits	16	0	8	20

IV YEAR II SEMESTER

S. No.	Course	Course Title	L	T	P	Credits
1		Professional Elective – V	3	0	0	3
2		Professional Elective - VI	3	0	0	3
3		Open Elective - III	3	0	0	3
4	S24CE801PC	Project Stage – II including seminar	0	0	22	11
		Total Credits	9	0	22	20

Professional Elective – I

S24CE611PE	Green Building Technologies
S24CE612PE	Geomatic Applications in Civil Engineering
S24CE613PE	Smart Cities Planning and Management

Professional Elective – II

S24CE721PE	Prestressed Concrete
S24CE722PE	Elements of Earthquake Engineering
S24CE723PE	Advanced Structural Analysis

Professional Elective-III

S24CE731PE	Earth Retaining Structures
S24CE732PE	Ground Improvement Techniques
S24CE733PE	Stability Analysis of Slopes

Professional Elective -IV

S24CE741PE	Design of Hydraulic Structures
S24CE742PE	Advanced Water Resources Engineering
S24CE743PE	Ground Water Hydrology

Professional Elective –V

S24CE851PE	**Solid Waste Management**
S24CE852PE	**Environmental Impact Assessment**
S24CE853PE	**Air pollution**

Professional Elective -VI

S24CE861PE	**Airports, Railways and Waterways**
S24CE862PE	**Pavement Asset Management**
S24CE863PE	**Pavement Analysis & Design**

SPHOORTHY ENGINEERING COLLEGE

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B. Tech (Civil) IV Year I Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE701PC: QUANTITY SURVEY & VALUATION

B.Tech. IV Year I Sem.

L	T	P	C
2	0	0	2

Course Objectives: The subject provide process of estimations required for various work in construction. To have knowledge of using SOR &SSR for analysis of rates on various works and basics of planning tools for a construction projects.

Course Outcomes: On completion of the course, the students will be able to:

Understand the technical specifications for various works to be performed for a project and how they impact the cost of a structure.

Quantify the worth of a structure by evaluating quantities of constituents, derive their cost rates and build up the overall cost of the structure.

UNIT – I

General items of work in Building – Standard Units Principles of working out quantities for detailed and abstract estimates – Approximate method of Estimating.

UNIT – II

Detailed estimation of single and multi storied building.

UNIT – III

Reinforcement bar bending and bar requirement schedules Earthwork for roads and canals.

UNIT – IV

Rate Analysis – Working out data for various items of work over head and contingent charges.

UNIT-V

Contracts – Types of contracts – Contract Documents – Conditions of contract, Valuation -Standard specifications for different items of building construction.

NOTE: NUMBER OF EXERCISES PROPOSED:

- **Three in flat Roof & one in Sloped Roof**
- **Exercises on Data – three Nos.**

TEXT BOOKS:

- **Estimating and Costing by B.N. Dutta, UBS publishers, 2000.**
- **Estimating and Costing by G.S. Birdie**
- **Punmia, B.C., Khandelwal, K.K., Project Planning with PERT and CPM, Laxmi Publications, 2016**
- **Chitkara, K. K. Construction Project Management. Tata McGraw-Hill Education, 2014**

REFERENCE BOOKS:

- **Standard Schedule of rates and standard data book by public works department.**
- **S. 1200 (Parts I to XXV – 1974/ method of measurement of building and Civil Engineering works – B.I.S.)**
- **Estimation, Costing and Specifications by M. Chakraborthi; Laxmi publications.**

- **Peurifoy, R.L. Construction Planning, Methods and Equipment, McGraw Hill, 2011**
- **Nunnally, S.W. Construction Methods and Management, Prentice Hall, 2006**
- **Jha, Kumar Neeraj., Construction Project management, Theory & Practice, Pearson Education India, 2015**

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B. Tech (Civil) IV Year I Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE702PC: PROJECT MANAGEMENT

L	T	P	C
2	0	0	2

B.Tech. IV Year I Sem.

Course Objective: The Objective of this course is to lay on important foundation to student in managing projects with a special focus on every phase such as project planning, execution, monitoring and evaluation.

Course Outcome: Students will be able to understand

Importance of Project Management.
Project Planning, Execution and implementation.
Significance of teams in projects.
Project evaluation techniques.

UNIT- I:

Introduction: Introduction to Project management – Project Characteristics-Project Life cycle- Project Identification. Formulation and implementation. Project management in different sectors: Construction, Services Sector, Public sector and Government Projects. Systems approach to project management.

UNIT- II:

Project Planning and Appraisal: Project Planning – Project Appraisal-Feasibility Study-Technical, Commercial, Economic, Financial, Management, Social Cost Benefit Analysis-Project Risk Analysis.

UNIT- III:

Project Finance: Project Cost Estimation, Project Financing-Investment Criteria. Project Evaluation Techniques - Pay Back Period, Accounting rate of return. Net present value, Internal Rate of return, Profitability Index, Cash Flows Estimation for new and replacement projects-Cost of Capital, Risk Analysis.

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UNIT- IV:

Project Planning and Control: Planning Steps-Scheduling- Network Diagrams. Network Analysis, Critical Path, Quality Management, Project Execution, Monitoring and control, Agile project Management, Scrum, Lean Production and project management.

UNIT- V; Organizational Behavior and Project Management: Organizational Structure and Integration, Role of Project manager, Roles in the project team, Project stakeholder engagement. Leadership in project management, participative management, team building approach. Conflict Management in Projects, Stress Management.

SUGGESTED READING:

- **Join M. Nicholas and Herman Steyn, Project Management for Engineering. Business and Technology, 5e, Routledge, 2017**
- **Prasanna Chandra, Projects. Planning, Analysis. Selection. Financing Implementation and review, 6e, TATA Mc Gaw Hill 2008.**
- **K. Nagrajan, Project Management, New Age International publishers, 7e 2015.**
- **Jack Gido, Jim Clements Rose Baker. Successful Project Management. Cengage Learning, 7e 2015.**
- **R Pancerselvam. P. Senthil Kumar, Project Management. PHI, 2009.**

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B. Tech (Civil) IV Year I Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE721PE: PRESTRESSED CONCRETE (Professional Elective – II)

B.Tech. IV Year I Sem. **L T P C**
3 0 0 3

Pre-Requisites: Reinforced Concrete Design

Course Objectives: The objectives of the course are to

Understand the principles & necessity of prestressed concrete structures. Know different techniques of prestressing.

Get the knowledge on various losses of prestress.

Understand Analysis and design of prestressed concrete members.

Course Outcomes: After the completion of the course student should be able to

Acquire the knowledge of evolution of process of prestressing. Acquire the knowledge of various prestressing techniques.

Develop skills in analysis design of prestressed structural elements as per the IS codal provisions.

UNIT - I:

Introduction: Historic development- General principles of prestressing pre-tensioning and post tensioning- Advantages and limitations of Prestressed concrete- General principles of PSC-Classification and types of prestressing- Materials- high strength concrete and high tensile steel their characteristics.

UNIT - II:

Methods and Systems of prestressing: Pre-tensioning and Posttensioning methods and systems of prestressing like Hoyer system, Magnel Blaton system, Freyssinet system and Gifford- Udall System-Lee McCall system. Losses of Prestress: Loss of prestress in pretensioned and posttensioned members due to various causes like elastic shortage of concrete, shrinkage of concrete, creep of concrete, relaxation of stress in steel, slip in anchorage, frictional losses.

UNIT - III:

Flexure: Analysis of sections for flexure- beams prestressed with straight, concentric, eccentric, bent and parabolic tendons- stress diagrams- Elastic design of PSC slabs and beams of rectangular and I sections- Kern line – Cable profile and cable layout.

Shear: General Considerations- Principal tension and compression- Improving shear resistance of concrete by horizontal and vertical prestressing and by using inclined or parabolic cables- Analysis of rectangular and I beams for shear – Design of shear reinforcements- IS Code provisions.

UNIT - IV:

Transfer of Prestress in Pretensioned Members: Transmission of prestressing force by bond – Transmission length – Flexural bond stresses – IS code provisions – Anchorage zone stresses in post tensioned members – stress distribution in End block – Analysis by Guyon, Magnel, Zienlinski and Rowe's methods – Anchorage zone reinforcement- IS Provisions

UNIT - V:

Composite Beams: Different Types- Propped and Unpropped- stress distribution- Differential shrinkage- Analysis of composite beams- General design considerations.

Deflections: Importance of control of deflections- Factors influencing deflections – Short term deflections of uncracked beams- prediction of long time deflections- IS code requirements.

REFERENCE BOOKS:

- **Prestressed concrete by Krishna Raju, Tata Mc Graw Hill Book – Co. New Delhi.**
- **Design of prestress concrete structures by T.Y. Lin and Burn, John Wiley, New York.**
- **Prestressed concrete by S. Ramamrutham Dhanpat Rai & Sons, Delhi.**

Prestressed Concrete by N. Rajagopalan Narosa Publishing House

Reference Codes: IS 1343:2016

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B. Tech (Civil) IV Year I Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE722PE: ELEMENTS OF EARTHQUAKE ENGINEERING (Professional Elective – II)

B.Tech. IV Year I Sem.

L	T	P	C
3	0	0	3

Pre-Requisites: Structural Engineering –II & RC Design.

Course Objectives: The objectives of the course are to

Understand Engineering Seismology.

Explain and discuss single degree of freedom systems subjected to free and forced vibrations. Acquire the knowledge of the conceptual design and principles of earthquake resistant designs as per IS codes.

understand importance of ductile detailing of RC structures.

Course Outcomes: After the completion of the course student should be able to

Explain and derive fundamental equations in structural dynamics.

Discuss and explain causes and Theories on earthquake, seismic waves, measurement of earthquakes.

Evaluate base shear using IS methods.

Design and Detail the reinforcement for earthquake forces.

UNIT - I

Engineering Seismology: Earthquake phenomenon - cause of earthquakes-Faults- Plate tectonics-Seismic waves- Terms associated with earthquakes-Magnitude/Intensity of an earthquake-scales-Energy Released-Earthquake measuring instruments seismogram -Seismoscope, Seismograph, - strong ground motions- Seismic zones of India.

Theory of Vibrations: Elements of a vibratory system- Degrees of Freedom-Continuous system-Lumped mass idealization-Oscillatory motion-Simple Harmonic Motion-Free vibration of single degree of freedom (SDOF) system- undamped and damped-critical damping-Logarithmic decrement-Forced vibrations-Harmonic excitation- Dynamic magnification factor-Excitation by rigid based translation for SDOF system-Earthquake ground motion.

UNIT - II

Conceptual design: Introduction-Functional Planning-Continuous load path-Overall form-simplicity and symmetry-elongated shapes-stiffness and strength-Horizontal and Vertical Members-Twisting of buildings- Ductility-definition-ductility relationships-flexible buildings-framing systems-choice of construction materials- unconfined concrete-confined concrete-masonry-reinforcing steel.

Introduction to earthquake resistant design: Seismic design requirements-regular and irregular configurations- basic assumptions-design earthquake loads-basic load combinations-permissible stresses-seismic methods of analysis-factors in seismic analysis-equivalent lateral force method.

UNIT - III

Reinforced Concrete Buildings: Principles of earthquake resistant deign of RC members- Structural models for frame buildings- Seismic methods of analysis- IS code based methods for seismic design-Vertical irregularities- Plan configuration problems- Lateral load resisting systems- Determination of design lateral forces as per IS 1893 (Part-1):2016- Equivalent lateral force procedure- Lateral distribution of base shear.

UNIT - IV

Masonry Buildings: Introduction- Elastic properties of masonry assemblage- Categories of masonry buildings- Behaviour of unreinforced and reinforced masonry walls- Behaviour of walls- Box action and bands- Behaviour of infill walls-Improving seismic behaviour of masonry buildings- Load combinations and permissible stresses- Seismic design requirements- Lateral load analysis of masonry buildings.

UNIT - V

Ductility: Considerations in Earthquake Resistant Design of RC Buildings: Introduction- Impact of Ductility- Requirements for Ductility- Assessment of Ductility- Factors affecting Ductility- Ductile detailing considerations as per IS 13920-2016 -Behaviour of beams, columns and joints in RC buildings during earthquakes

TEXT BOOKS:

- **Earthquake Resistant Design of structures – S. K. Duggal, Oxford University Press**
- **Earthquake Resistant Design of structures – Pankaj Agarwal and Manish Shrikhande, Prentice Hall of India Pvt. Ltd.**

REFERENCE BOOKS:

- **Seismic Design of Reinforced Concrete and Masonry Building – T. Paulay and M.J.N. Priestly, John Wiley & Sons.**
- **Earthquake Resistant Design of Building structures by Vinod Hosur, Wiley India Pvt. Ltd.**
- **Elements of Mechanical Vibration by R.N. Iyengar, I.K. International Publishing House Pvt. Ltd.**
- **Masory and Timber structures including earthquake Resistant Design –Anand S.Arya, Nemchand & Bros**
- **Earthquake Tips – Learning Earthquake Design and Construction, C.V.R. Murthy**

BIS Codes: 1. IS 1893(Part-1):2016. 2. IS 13920:2016. 3. IS 4326. 4. IS 456:200

SPHOORTHY ENGINEERING COLLEGE

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B. Tech (Civil) IV Year I Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE731PE: EARTH RETAINING STRUCTURES (PE – III)

B.Tech. IV Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives:

To estimate earth pressure under different loads and conditions.

To determine the stability of gravity and cantilever Retaining walls.

To design sheet pile walls and bracings.

To design Reinforced soil walls.

Course Outcome: At the end of the course the student will able to

Calculate the earth pressures under different applied loads and ground conditions.

Assess stability of conventional retaining walls.

Design flexible retaining walls under different soil and fixity conditions.

Design the supporting systems for excavations.

Design geosynthetic reinforced earth walls.

UNIT - I

Earth Pressure Theories: Rankine's and Coulomb's Earth pressure theories for cohesive and cohesionless soils, stresses due to compaction and surcharge loads.

UNIT - II

Conventional Retaining Wall: Types of retaining walls, Stability (sliding, overturning, bearing capacity & overall) of gravity and cantilever walls, Proportioning of retaining walls, Backfill material and drainage.

UNIT - III

Flexible Walls: Sheet pile walls, Construction methods- Cantilever and Anchored (Free and Fixed support methods) sheet pile walls in coarse and fine grained soils, Rowe's moment reduction method.

UNIT - IV

Braced Cuts: Lateral earth pressure in braced cuts, Design of various components, Stability of braced cuts, base heave and stability, yielding and settlement of ground surrounding excavation, Diaphragm walls – slurry support.

UNIT - V

Reinforced Soil Walls/Mechanically Stabilized Earth: - Introduction to geosynthetics – Functions and applications - Failure mechanisms of Reinforced soil walls -bond and rupture failures- Internal and external stability by Static analyses -Soil Nailing.

TEXT BOOKS:

- **Das, B. M. - Principles of Foundation Engineering 5th Edition Nelson Engineering (2004)**
- **Koerner, R. M (1994) – Designing with Geosynthetics – Prentice Hall, New Jersey**

REFERENCE BOOKS:

- **Bowles, J. E. - Foundation Analysis & Design 5th Edition McGraw-Hill Companies, Inc. (1996)**
- **Rowe, R. K. - Geotechnical & Geo-environmental Engineering Hand Book -Springer (2001)**
- **Hans Friedrich Winterkorn, Hsai-Yang Fang - Foundation Engineering Handbook, Van Nostrand Reinhold, 1975**
- **Donald P Coduto – Foundation Design Principles and Practices, 2nd edition, Pearson, Indian edition, 2012.**
- **Geotechnical Engineering by Manoj Dutta & Gulati S.K – Tata McGraw-Hill Publishers New Delhi.**

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B. Tech (Civil) IV Year I Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE732PE: GROUND IMPROVEMENT TECHNIQUES (PE – III)

B.Tech. IV Year I Sem.

L	T	P	C
3	0	0	3

Prerequisites: Geo-Technical Engineering, Foundation Engineering

Course Objectives:

To Identify difficult ground conditions in engineering practice.

To select suitable ground improvement techniques for problematic soils.

To assess suitable physical, chemical, mechanical and hydraulic modifications.

Course Outcomes: At the end of the course the student will able to

Understand the various ground improvement methods.

Assess different compaction methods for ground modification. Design dewatering systems to reduce the settlements.

Comprehend stabilizations with chemical and grouting techniques.

Understand the principles of soil reinforcement and confinement in engineering constructions.

UNIT - I

Introduction to Engineering Ground Modification: Need and objectives, Identification of soil types, In situ and laboratory tests to characterize problematic soils; Mechanical, Hydraulic, Physico-chemical, Electrical, Thermal methods, and their applications.

UNIT - II

Mechanical Modification – Deep Compaction Techniques- Blasting Vibrocompaction, Dynamic Tamping and Compaction piles.

UNIT - III

Hydraulic Modification – Objectives and techniques, traditional dewatering methods and their choice, Design of dewatering system, Electro-osmosis, Electro-kinetic dewatering. Filtration, Drainage and Seepage control with Geosynthetics, Preloading and vertical drains.

UNIT - IV

Physical and chemical modification: Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen; Grouting: Categories of grouting, Art of grouting, Grout materials, Grouting techniques and control.

UNIT - V

Modification by Inclusions and Confinement - Soil reinforcement, reinforcement with strip, and grid reinforced soil. In-situ ground reinforcement, ground anchors, rock bolting and soil nailing.

TEXT BOOKS:

- **Hausmann, M. R. (1990) – Engineering Principles of Ground Modifications, McGraw Hill publications**
- **M. P. Moseley and K. Krisch (2006) – Ground Improvement, II Edition, Taylor and Francis**
- **Koerner, R. M (1994) – Designing with Geosynthetics – Prentice Hall, New Jersey.**

REFERENCE BOOKS:

- **Jones C. J. F. P. (1985) – Earth Reinforcement and soil structures – Butterworths, London.**
- **Xianthakos, Abreimson and Bruce - Ground Control and Improvement, John Wiley & Sons, 1994.**

- **K. Krisch& F. Krisch (2010) - Ground Improvement by Deep Vibratory Methods, Spon Press, Taylor and Francis.**
- **Donald P Coduto – Foundation Design Principles and Practices, 2nd edition, Pearson, Indian edition, 2012.**

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B. Tech (Civil) IV Year I Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE733PE: STABILITY ANALYSIS OF SLOPES – (PE-III)

B.Tech. IV Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives:

To know the basic concepts of slope stability.

To identify various causes of failure of slopes.

To analyse and design the slopes under various loading.

To adopt slope protection methods.

Course Outcomes: At the end of the course the student will able to

Select suitable site and materials for the construction of earth / rockfill dams.

Analyse seepage through a given earth / rockfill dam section and propose suitable seepage control measures.

Analyse the stability of earthen dams.

Design the slopes by using different analytical methods.

Implement slope protection methods.

UNIT - I

Earth and Rock fill Dams: General features, Selection of site; Merits and demerits of the earth and rock fill dams, Classification of earth dams, Causes of failure, Safe design criteria. Instrumentation in earth dams: Pore pressure measurements, Settlement gauges, Inclinometers, Stress measurements, Seismic measurements.

UNIT - II

Failures, Damages and Protection of Earth Dams: Nature and importance of failure, piping through embankment and foundations, Methods of seepage control through embankments and foundations, Design Criteria for filters.

UNIT - III

Slope Stability Analysis: Types of Failure: Failure surfaces - Planar surfaces, Circular surfaces, Non-circular surfaces, Limit equilibrium methods, Total stress analysis versus effective Stress analysis, Use of Bishop's pore pressure parameters, Short term and Long term stability in slopes. Taylor Charts.

UNIT - IV

Methods of Slope Stability: Method of Slices, Effect of Tension Cracks, Vertical Cuts. Bishop's Analysis, Bishop and Morgenstern Analysis, Non-circular Failure Surfaces: Janbu Analysis, Sliding Block Analysis, Introduction to eismic stability, Stabilization of slopes: Soil reinforcement (geosynthetics/soil nailing/micro piles etc), soil treatment (cement/lime treatment), surface protection (vegetation/erosion control mats/shotcrete).

UNIT - V

Slope Protection and Rock fill Dams: Stabilization of slopes: Soil reinforcement (geosynthetics/soil nailing/micro piles etc), soil treatment (cement/lime treatment), surface protection (vegetation/erosion control mats/shotcrete). Requirements of compacted rockfill, Shear strength of rockfill, Rockfill mixtures, Rockfill embankments, Earth-core Rockfill dams, Stability, Upstream & Downstream slopes.

TEXT BOOKS:

- **Engineering for Embankment Dams, B. Singh and R. S. Varshney, A.A. Balkema, 1995.**
- **Embankment Dams, H.D. Sharma, Oxford and IBH Publishing Co., 1991.**

REFERENCE BOOKS:

- **Earth and Earth Rock Dams, J. L. Sherard, John Wiley & Sons Inc, 1963.**
- **Earth and Rockfill Dams, Christian Kutzner, A.A. Balkema, 1997**
- **Bharat Singh and Sharma, H. D. – Earth and Rockfill Dams, 1999.**
- **Sowers, G.F. and Salley, H. I. – Earth and Rockfill Dams, Willams, R.C., and Willace, T.S. 1965.**
- **Abramson, L. W., Lee, T. S. and Sharma, S. - Slope Stability and Stabilization methods – John Wiley & sons. (2002).**
- **Bromhead, E. N. (1992). The Stability of Slopes, Blackie academic and professional, London.**

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B. Tech (Civil) IV Year I Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE741PE: DESIGN OF HYDRAULIC STRUCTURES (PE – IV)

B.Tech. IV Year I Sem.

L	T	P	C
3	0	0	3

Pre-Requisites: Hydraulics, Hydrology &Water Resources Engineering

Course Objectives: To study various types of storage works and, diversion headwork, their components and design principles for their construction.

Course Outcomes: At the end of the course, the student will be able to:

Know types of water retaining structures for multiple purposes and its key parameters considered for planning and designing.

Understand details in any Irrigation System and its requirements. Know,

Analyze and Design of a irrigation system components.

UNIT - I

Storage Works-Reservoirs - Types of reservoirs, selection of site for reservoir, zones of storage of a reservoir, reservoir yield, estimation of capacity of reservoir using mass curve- Reservoir Sedimentation – Life of Reservoir. Types of dams, factors affecting selection of type of dam, factors governing selection of site for a dam.

UNIT - II

Gravity dams: Forces acting on a gravity dam, causes of failure of a gravity dam, elementary profile, and practical profile of a gravity dam, limiting height of a low gravity dam, Factors of Safety - Stability Analysis, Foundation for a Gravity Dam, drainage and inspection galleries.

UNIT- III

Earth dams: types of Earth dams, causes of failure of earth dam, criteria for safe design of earth dam, seepage through earth dam-graphical method, measures for control of seepage. Spillways: types of spillways, Design principles of Ogee spillways - Spillway gates. Energy Dissipaters and Stilling Basins Significance of Jump Height Curve and Tail Water Rating Curve - USBR and Indian types of Stilling Basins.

UNIT- IV

Diversion Head works: Types of Diversion head works- weirs and barrages, layout of diversion head work - components. Causes and failure of Weirs and Barrages on permeable foundations, -Silt Ejectors and Silt Excluders

Weirs on Permeable Foundations – Creep Theories - Bligh's, Lane's and Khosla's theories, Determination of uplift pressure- Various Correction Factors – Design principles of weirs on permeable foundations using Creep theories - exit gradient, U/s and D/s Sheet Piles - Launching Apron.

UNIT- V

Canal Falls - types of falls and their location, Design principles of Notch Fall and Sarada type Fall. Canal regulation works, principles of design of cross and distributary head regulators, types of Canal escapes - types of canal modules, oportionality, sensitivity, setting and flexibility. Cross Drainage works: types, selection of suitable type, various types, design considerations for cross drainage works

TEXT BOOKS:

- **Irrigation Engineering and Hydraulic structures by Santhosh Kumar Garg, Khanna Publishers.**
- **Irrigation engineering by K. R. Arora Standard Publishers.**
- **Irrigation and water power engineering by Punmia & Lal, Laxmi publications Pvt. Ltd., New**
- **Theory and Design of Hydraulic structures by Varshney, Gupta & Gupta**
- **Irrigation Engineering by R.K. Sharma and T.K. Sharma, S. Chand Publishers 2015.**

- **Irrigation Theory and Practice by A. M. Micheal Vikas Publishing House 2015.**
- **Irrigation and water resources engineering by G.L. Asawa, New Age International Publishers.**

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B. Tech (Civil) IV Year I Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE742PE: ADVANCED WATER RESOURCES ENGINEERING (PE – IV)

B.Tech. IV Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives:

Overview of Statistical applications in Hydrology.
General Idea of Flood routing.
Summary of various flood mitigation measures.
Overview of climate and causes of climate change. Summary
of Optimization models and applications.

Course Outcomes: Students are expected to have gained knowledge of

Ability to apply statistical techniques for flood frequency studies and hydrological events and Applications of Regression Models for estimation of various parameters.
Applications of flood routing, flood forecasting techniques for real time flood studies.
Understanding of various mitigation measures for control of floods.
Understanding of climate change using GCM models.
Ability to formulate optimization models and soft computing applications

UNIT - I:

Statistics in Hydrology: Random variables, probability of hydrologic events, probability (Gumbel, Log-Pearson type-III distribution) and statistical methods for flood frequency, trend analysis for hydrologic events.

Regression Analysis: Identification of appropriate models, parameters estimation by the least square method, measures of goodness fit, uncertainty features of LS based model parameters, statistical Inferences of Regression Coefficients, confidence Interval. Multivariate linear regression and correlation.

UNIT - II:

Flood Routing: Mathematics of flood routing, various methods of flood routing, Hydrologic and Hydraulic routing. -Modified Puls Method- Muskhinghum Method-flood forecasting (unit hydrograph method)

UNIT - III

Flood mitigation: flood ways, channel improvement, evacuation and flood proofing, land management, flood plain management, estimating benefits of flood mitigation.Flood plain adjustments and regulations: Results of controlling floods, alternatives to controlling floods, range of possible adjustments, practical range of choice, critical characteristics of flood hazards**.**

UNIT - IV

Climate System- Weather and Climate- Overview of earth-atmosphere- vertical structure of atmosphere- Radiation and Temperature- Temperature variation- vertical variation in Air temperature-temperature extremes. Causes of climate change - Modeling of climate change-General circulation models (GCMs) –IPCC scenarios - IPCC Assessment Report (AR5) - Physical Science basis.

UNIT - V

Optimization Techniques, Model Formulation, models, General L.P Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Model. Formulation of a LPP - revised simplex method - duality theory - dual simplex method - sensitivity analysis. Introduction and Applications of ANN, Machine and Deep Learning in water resources Engineering.

TEXT BOOKS:

- **Vedula S. and. Mujumdar P.P. 'Water resources Systems', McGraw-Hill Publishing Company, New Delhi. 2005**
- **Ven TeChow, 'Hand book of Applied Hydrology' McGraw-Hill Book Company, New York., 1964**
- **Subramanya, K. 'Hydrology for Engineers', Tata McGraw-Hill Publishing Company, New Delhi. (1984.**
- **Raja Sekharan S. and Vijaya Laxmi Pai G. A., 'Neural Networks, Fuzzy Logic, and Genetic Algorithm', Prentice-Hall of India, New Delhi. 2003**

REFERENCE BOOKS:

- **Snedecor, G.W., and W.G. Cochran, 'Statistical Methods', East West Press, New Delhi. 1994**
- **Alfredo, H.S. and Tang Wah, 'Probability Concepts in Engineering Planning and Design: Vol-I (Basic Principles), John Wiley & Sons, New York. 1975**
- **RL Wilby, SP charles, E Zoritaa, B Timbal, P WHetton, LO Mearns - Guide lines for use of climate science from Statistical Modeling models. 2004**
- **Physical science basis of AR 5 report of IPCC - working group I contribution to Assessment Report- https://ipcc.ch/report/ar5/wg1/ 2013.**

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B. Tech (Civil) IV Year I Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE743PE: GROUND WATER HYDROLOGY (PE – IV)

B.Tech. IV Year I Sem.

L	T	P	C
3	0	0	3

Pre-Requisites: Hydraulics & Fluid Mechanics

Course objectives: The objectives of the course are:

To explain the concepts of Groundwater Development and Management.

To demonstrate and derive the basic equations used in Groundwater development and management and the corresponding equations.

To know the investigations, field studies to conduct basic ground water studies.

Course Outcomes: On successful completion of this course, students should be able to:

Identify different fundamental equations and concepts as applied in the Groundwater studies. Discuss and derive differential equation governing groundwater flow in three dimensions.

To solve groundwater mathematical equations and analyze pumping tests in steady and non-steady flow cases.

Distinguish and understand the saline water intrusion problem in costal aquifers.

UNIT- I

Ground Water Occurrence: Ground water hydrologic cycle, origin of ground water, rock properties effecting ground water, Vertical distribution of ground water, zone of aeration and zone of saturation, geologic formation as aquifers, types of aquifers, porosity, specific yield and specific retention. Ground Water Movement- Permeability, Darcy's law, storage coefficient, Transmissivity, Differential equation governing ground water flow in three dimensions derivation, ground water flow equation in polar coordinate system, ground water flow contours and their applications.

UNIT- II

Analysis of Pumping Test Data-I: Steady flow ground water flow towards a well in confined and unconfined aquifers-Dupit's and Theism's equations, assumptions, formation constants, yield of an open well interface and well tests.

UNIT- III

Analysis of Pumping Test Data-II: Unsteady flow towards well-Non-Equilibrium equations, Thesis solution, Jocob and Chow's simplifications, Leak aquifers.

UNIT- IV

Surface and sub-surface Investigation: Surface methods of exploration-Electrical resistivity method and Seismic refraction methods. Subsurface methods geophysical logging and resistivity logging. Concept of artificial recharge of ground water, recharge methods, Applications of GIS and RS in artificial recharge of ground water along with case studies.

UNIT- V

Saline water intrusion in aquifer: Occurrence of saline water intrusion, Ghyben-Herzberg relation, Shape of interface, control of water intrusion. Ground water basin management-case studies.

TEXT BOOKS:

- **Ground water Hydrology by David Keith Todd, John Wiley & Son, New York.**
- **Ground water by H. M. Raghunath, Wiley Eastern Ltd.**
- **Groundwater System Planning & Management, R. Willes & W.W.G. Yeh, Prentice Hall.**

REFERENCE BOOKS:

- **Ground water by Bawvwr, John Wiley & Sons.**
- **Applied Hydrogeology by C. W. Fetta, CBS Publishers & Distributors.**
- **Ground Water Assessment, Development and Management by K R Karanth, McGraw Hill Publications.**

SPHOORTHY ENGINEERING COLLEGE

(UGC Autonomous)

B. Tech (Civil) IV Year I Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE721OE: REMOTE SENSING & GEOGRAPHICAL INFORMATION SYSTEMS (OE – II)

B.Tech. IV Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives: The objectives of the course are to

Know the concepts of Remote Sensing, its interpreting Techniques and concepts of Digital images.

know the concept of Geographical Information System (GIS), coordinate system GIS Data and its types.

Understand the students managing the spatial Data Using GIS. Understand

Implementation of GIS interface for practical usage.

Course Outcomes: After the completion of the course student should be able to

Describe different concepts and terms used in Remote Sensing and its data.

Understand the Data conversion and Process in different coordinate systems of GIS interface.

Evaluate the accuracy of Data and implementing a GIS.

Understand the applicability of RS and GIS for various applications.

UNIT - I

Concepts of Remote Sensing Basics of remote sensing- elements involved in remote sensing, electromagnetic spectrum, remote sensing terminology & units, energy resources, energy interactions with earth surface features & atmosphere, atmospheric effects, satellite orbits, Sensor Resolution, types of sensors. Remote Sensing Platforms and Sensors, IRS satellites.

Remote Sensing Data Interpretation Visual interpretation techniques, basic elements, converging evidence, interpretation for terrain evaluation, spectral properties of soil, water and vegetation. Concepts of Digital image processing, image enhancements, qualitative & quantitative analysis and pattern recognition, classification techniques and accuracy estimation.

UNIT - II:

Introduction to GIS: Introduction, History of GIS, GIS Components, GIS Applications in Real life, The Nature of geographic data, Maps, Types of maps, Map scale, Types of scale, Map and Globe, Co-ordinate systems, Map projections, Map transformation, Geo-referencing. Spatial Database Management System: Introduction: Spatial DBMS, Data storage, Database structure models, database management system, entity-relationship model, normalization. Data models and data structures: Introduction, GIS Data model, vector data structure, raster data structure, attribute data, geo-database and metadata.

UNIT - III:

Spatial Data input and Editing: Data input methods – keyboard entry, digitization, scanning, conversion of existing data, remotely sensed data, errors in data input, Data accuracy, Micro and Macro components of accuracy, sources of error in GIS.

Spatial Analysis: Introduction, topology, spatial analysis, vector data analysis, Network analysis, raster data analysis, Spatial data interpolation techniques.

UNIT - IV:

Awareness and digitization of GIS: Awareness, developing system requirements, evaluation of alternative systems, decision making using GIS.

UNIT - V:

Applications of GIS: GIS based road network planning, Mineral mapping using GIS, Shortest path detection using GIS, Hazard Zonation using remote sensing and GIS, GIS for solving multi criteria problems, GIS for business

TEXT BOOKS:

- **Remote Sensing and GIS by Basudeb Bhatta, Oxford University Press, 2nd Edition, 2011.**
- **Introduction to Geographic Information systems by Kang-tsung Chang, McGraw-Hill Education (Indian Edition), 7th Edition, 2015.**
- **Fundamentals of Geographic Information systems by Michael N. Demers, 4th Edition, Wiley Publishers, 2012.**

REFERENCE BOOKS:

- **Remote Sensing and Image Interpretation by Thomas M. Lillesand and Ralph W. Kiefer, Wiley Publishers, 7th Edition, 2015.**
- **Geographic Information systems – An Introduction by Tor Bernhardsen, Wiley India Publication, 3rd Edition, 2010.**
- **Advanced Surveying: Total Station, GIS and Remote Sensing by Satheesh Gopi, R. Sathi Kumar, N. Madhu, Pearson Education, 1st Edition, 2007.**
- **Textbook of Remote Sensing and Geographical Information systems by M.Anji Reddy**

SPHOORTHY ENGINEERING COLLEGE

(UGC Autonomous)

B. Tech (Civil) IV Year I Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE722OE: SUSTAINABLE INFRASTRUCTURE DEVELOPMENT (OE – II)

B.Tech. IV Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives:

Presenting elements and components of sustainable infrastructure creation and management. Introducing practices of water management, greenhouse gas reduction, and greencity planning.

Course Outcomes:

The students will acquire fundamentals and principles of sustainable engineering design.
Knowledge of existing frameworks to achieve long-term sustainability.
Methods and techniques for waste water management and greenhouse gas emission reduction.
Knowledge on the civil engineering aspects overall green city planning.

UNIT - I

Process of Sustainable Engineering Design: Key principle of sustainability; Integration of architecture and engineering; Design drivers for sustainable infrastructure system; implementation.

UNIT - II

Sustainable infrastructure framework: Green building rating system; Sustainable Infrastructure frameworks: Pillars of sustainability, scale-density framework, transect, built form-ecology framework.

UNIT - III

Water conservation and supply: water management plans; achieving water balance; analyzing water resources; water supply strategies Integrated water management: integrated storm water management; urban storm water treatment strategies; constraints and barriers to implementation; gray water treatment and reuse; integrating gray water into a water resources master plan; Black water management approaches.

UNIT - IV

Energy and greenhouse gases: reducing demand by design; Designing Sustainable power supplies; Addressing climate change and reducing carbon footprint; Policy measures for increasing energy security and efficiency; Design guidelines and Performance standards.

UNIT - V

Sustainable site planning: Built systems, and Material flows: Sustainable site planning; Green streets and transportation network; working with the land, material and waste flows.

TEXT BOOKS:

- **S. BrySarté (2010) Sustainable Infrastructure. John Wiles & Sons, Inc. ISBN 978-0-470-912**
- **Sustainable Infrastructure: Sustainable Buildings – Elisabeth Green, Tristram Hope & Alan Yates.**
- **Sustainable Development spiritual dimension – Krishnan Saigal**

REFERENCE BOOKS:

- **Dredging for sustainable infrastructure – aarninkhof, Stefan laboyrie polite/koningsveld, mark van – cedaiadc**
- **Sustainable infrastructure: Breakthrough in Research & Practice.**

SPHOORTHY ENGINEERING COLLEGE

(UGC Autonomous)

B. Tech (Civil) IV Year I Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE723OE: SOLID WASTE MANAGEMENT (OE – II)

B.Tech. IV Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives: The objectives of the course are to

Define the terms and understand the necessity of solid waste management. Explain the strategies for the collection of solid waste.

Describe the solid waste disposal methods.

Categorize Hazardous Waste.

Course Outcomes: At the end of the course the student will able to:

Identify the physical and chemical composition of solid wastes. Analyze the functional elements for solid waste management.

Understand the techniques and methods used in transformation, conservation, and recovery of materials from solid wastes.

Identify and design waste disposal systems.

UNIT - I

Solid Waste: Definitions, Types of solid wastes, sources of solid wastes, Characteristics, and perspectives; properties of solid wastes, Sampling of Solid wastes, Elements of solid waste management - Integrated solid waste management, Solid Waste Management Rules 2016.

UNIT - II

Engineering Systems for Solid Waste Management: Solid waste generation; on-site handling, storage and processing; collection of solid wastes; Stationary container system and Hauled container systems – Route planning - transfer and transport; processing techniques.

UNIT - III

Engineering Systems for Resource and Energy Recovery: Processing techniques; materials recovery systems; recovery of biological conversion products – Composting, pre and post processing, types of composting, Critical parameters, Problems with composing - recovery of thermal conversion products; Pyrolisis, Gasification, RDF - recovery of energy from conversion products; materials and energy recovery systems.

UNIT - IV

Landfills: Evolution of landfills – Types and Construction of landfills – Design considerations – Life of landfills- Landfill Problems – Lining of landfills – Types of liners – Leachate pollution and control – Monitoring landfills – Landfills reclamation.

UNIT - V

Hazardous waste Management: Sources and characteristics, Effects on environment, Risk assessment – Disposal of hazardous wastes – Secured landfills, incineration - Monitoring – Biomedical waste disposal, E-waste management, Nuclear Wastes, Industrial waste Management

TEXT BOOKS:

- **Tchobanoglous G, Theisen H and Vigil SA 'Integrated Solid Waste Management, Engineering Principles and Management Issues' McGraw-Hill, 1993.**
- **Vesilind PA, Worrell W and Reinhart D, 'Solid Waste Engineering' Brooks/Cole Thomson Learning Inc., 2002.**

- **Peavy, H.S, Rowe, D.R., and G. Tchobanoglous, 'Environmental Engineering', McGraw Hill Inc., New York, 1985.**
- **Qian X, Koerner RM and Gray DH, 'Geotechnical Aspects of Landfill Design and Construction' Prentice Hall, 2002.**

SPHOORTHY ENGINEERING COLLEGE

(UGC Autonomous)

B. Tech (Civil) IV Year I Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE724OE: PROFESSIONAL PRACTICE, LAW & ETHICS (OE - II)

B.Tech. IV Year I Sem.

L	T	P	C
3	0	0	3

Course Objectives:

To make the students understand the types of roles they are expected to play in the society as practitioners of the civil engineering profession.

To develop some ideas of the legal and practical aspects of their profession.

Course Outcome:

The students will understand the importance of professional practice, Law and Ethics in their personal lives and professional careers.

The students will learn the rights and responsibilities as an employee, team member and a global citizen.

UNIT - I

Professional Practice and Ethics: Definition of Ethics, Professional Ethics - Engineering Ethics, Personal Ethics; Code of Ethics - Profession, Professionalism, Professional Responsibility, Conflict of Interest, Gift Vs Bribery, Environmental breaches, Negligence, Deficiencies in state-of-the-art; Vigil Mechanism, Whistle blowing, protected disclosures. Introduction to GST- Various Roles of Various Stake holders.

UNIT – II

Law of Contract: Nature of Contract and Essential elements of valid contract, Offer and Acceptance, Consideration, Capacity to contract and Free Consent, Legality of Object. Unlawful and illegal agreements, Contingent Contracts, Performance and discharge of Contracts, Remedies for breach of contract. Contracts-II: Indemnity and guarantee, Contract of Agency, Sale of goods Act -1930: General Principles, Conditions & Warranties, Performance of Contract of Sale.

UNIT – III

Arbitration, Conciliation and ADR (Alternative Dispute Resolution) system: Arbitration – meaning, scope and types – distinction between laws of 1940 and 1996; UNCITRAL model law – Arbitration and expert determination; Extent of judicial intervention; International commercial arbitration; Arbitration agreements – essential and kinds, validity, reference and interim measures by court; Arbitration tribunal – appointment, challenge, jurisdiction of arbitral tribunal, powers, grounds of challenge, procedure and court assistance; Distinction between conciliation, negotiation, mediation and arbitration, confidentiality, resort to judicial proceedings, costs; Dispute Resolution Boards; Lok Adalats.

UNIT- IV

Engagement of Labour and Labour & other construction-related Laws: Role of Labour in Civil Engineering; Methods of engaging labour- on rolls, labour sub-contract, piecerate work; Industrial Disputes Act, 1947; Collective bargaining; Industrial Employment (Standing Orders) Act, 1946; Workmen's Compensation Act, 1923; Building & Other - Construction Workers (regulation of employment and conditions of service) Act (1996) and Rules (1998); RERA Act 2017, NBC 2017.

UNIT - V

Law relating to Intellectual property: Introduction – meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; Law relating to Copyright in India including Historical evolution of Copy Rights Act, 1957, Meaning of copyright – computer programs, Ownership of copyrights and assignment, Criteria of infringement, Piracy in Internet – Remedies and procedures in India; Law relating to Patents under Patents Act, 1970.

TEXT BOOKS:

- **Professional Ethics: R. Subramanian, Oxford University Press, 2015.**
- **Ravinder Kaur, Legal Aspects of Business, 4e, Cengage Learning, 2016.**

REFERENCE BOOKS:

- **RERA Act, 2017.**
- **Wadhera (2004), Intellectual Property Rights, Universal Law Publishing Co.**
- **T. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House.**
- **O.P. Malhotra, Law of Industrial Disputes, N.M. Tripathi Publishers.**

SPHOORTHY ENGINEERING COLLEGE

(UGC Autonomous)

B. Tech (Civil) IV Year I Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE703PC: CIVIL ENGINEERING SOFTWARE LAB

B.Tech. IV Year I Sem.

L	T	P	C
0	0	2	1

Course Objectives:

Analyze and design structural elements. Apply
water resources related problems.
Design various geometric elements using transportation software. Analyze
slope stability and seepage determination.
Estimate the quantities of civil engineering structures.

Course Outcomes: At the end of the course the student should be able to:

Understand the features and capabilities of the software.
Apply fundamental principles in problem solving using software tools. Apply
the software algorithm in the domain area.
Develop solution for a range of problem of civil engineering using software tools and prepare technical report.

Student Version Softwares:

Group 1	Group 2	Group 3	Group 4	Group 5
1. STAAD 2. DESIGN BUILDER 3. MIDAS 4. ETabs	1. CIVIL 3D 2. ISSIM 3. ISSUM 4. MX Road	1. Plaxis 2. Geo Studio	1. eQuest 2. EPA SWMM 3. EPA EPZ Suite 4. EPA NET 5. QGIS 6. HECRAS	1. PRIMAVERA 2. TEKLA 3. RS & GIS

***Note:**

1.) Open/education/academic version of software is desirable.
2.) The student may choose any software one from each of the groups.

List of experiments:

- **Estimate, planning and management of any one civil engineering structure.**
- **Analyze and design G+3 building.**
- **Design various geometric elements and intersections for any Highway.**
- **Analyze slope stability and seepage determination.**
- **Analyze and design water networks, storm water, channel flow and flood determination.**

SPHOORTHY ENGINEERING COLLEGE

(UGC Autonomous)

B. Tech (Civil) IV Year II Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE851PE: SOLID WASTE MANAGEMENT (PE – V)

B.Tech. IV Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives: The objectives of the course are to

Define the terms and understand the necessity of solid waste management.

Explain the strategies for the collection of solid waste.

Describe the solid waste disposal methods.

Categorize Hazardous Waste.

Course Outcomes: At the end of the course the student will able to:

Identify the physical and chemical composition of solid wastes. Analyze the functional elements for solid waste management.

Understand the techniques and methods used in transformation, conservation, and recovery of materials from solid wastes.

Identify and design waste disposal systems.

UNIT - I

Solid Waste: Definitions, Types of solid wastes, sources of solid wastes, Characteristics, and perspectives; properties of solid wastes, Sampling of Solid wastes, Elements of solid waste management - Integrated solid waste management, Solid Waste Management Rules 2016.

UNIT - II

Engineering Systems for Solid Waste Management: Solid waste generation; on-site handling, storage and processing; collection of solid wastes; Stationary container system and Hauled container systems – Route planning - transfer and transport; processing techniques.

UNIT - III

Engineering Systems for Resource and Energy Recovery: Processing techniques; materials recovery systems; recovery of biological conversion products – Composting, pre and post processing, types of composting, Critical parameters, Problems with composing - recovery of thermal conversion products; Pyrolisis, Gasification, RDF - recovery of energy from conversion products; materials and energy recovery systems.

UNIT - IV

Landfills: Evolution of landfills – Types and Construction of landfills – Design considerations – Life of landfills- Landfill Problems – Lining of landfills – Types of liners – Leachate pollution and control – Monitoring landfills – Landfills reclamation.

UNIT - V

Hazardous waste Management: Sources and characteristics, Effects on environment, Risk assessment – Disposal of hazardous wastes – Secured landfills, incineration - Monitoring – Biomedical waste disposal, E-waste management, Nuclear Wastes, Industrial waste Management

TEXT BOOKS:

- **Tchobanoglous G, Theisen H and Vigil SA 'Integrated Solid Waste Management, Engineering Principles and Management Issues' McGraw-Hill, 1993.**
- **Vesilind PA, Worrell W and Reinhart D, 'Solid Waste Engineering' Brooks/Cole Thomson Learning Inc., 2002.**

- **Peavy, H.S, Rowe, D.R., and G. Tchobanoglous, 'Environmental Engineering', McGraw Hill Inc., New York, 1985.**
- **Qian X, Koerner RM and Gray DH, 'Geotechnical Aspects of Landfill Design and Construction' Prentice Hall, 2002.**

SPHOORTHY ENGINEERING COLLEGE

(UGC Autonomous)

B. Tech (Civil) IV Year II Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE852PE: ENVIRONMENTAL IMPACT ASSESSMENT (PE – V)

B.Tech. IV Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives: The objectives of the course are to

Define and Classify Environmental Impacts and the terminology.
Understands the environmental Impact assessment procedure. Explain the EIA methodology.
List and describe environmental audits.

Course Outcomes: At the end of the course the student will be able to

Identify the environmental attributes to be considered for the EIA study.
Formulate objectives of the EIA studies.
Identify the methodology to prepare rapid EIA.
Prepare EIA reports and environmental management plans.

UNIT - I

Introduction: The Need for EIA, Indian Policies Requiring EIA, The EIA Cycle and Procedures, Screening, Scoping, Baseline Data, Impact Prediction, Assessment of Alternatives, Delineation of Mitigation Measure and EIA Report, Public Hearing, Decision Making, Monitoring the Clearance Conditions, Components of EIA, Roles in the EIA Process. Government of India Ministry of Environment and Forest Notification (2000), List of projects requiring Environmental clearance, Application form, Composition of Expert Committee, Ecological sensitive places, International agreements.

UNIT - II

EIA Methodologies: Environmental attributes-Criteria for the selection of EIA methodology, impact identification, impact measurement, impact interpretation & Evaluation, impact communication, Methods-Adhoc methods, Checklists methods, Matrices methods, Networks methods, Overlays methods. EIA review- Baseline Conditions - Construction Stage Impacts, post project impacts.

UNIT - III

Environmental Management Plan: EMP preparation, Monitoring Environmental Management Plan, Identification of Significant or Unacceptable Impacts Requiring Mitigation, Mitigation Plans and Relief & Rehabilitation, Stipulating the Conditions, Monitoring Methods, Pre- Appraisal and Appraisal.

UNIT - IV

Environmental Legislation and Life cycle Assessment: Environmental laws and protection acts, Constitutional provisions-powers and functions of Central and State government, The Environment (Protection) Act 1986, The Water Act 1974, The Air act 1981, Wild Life act 1972, Guidelines for control of noise, loss of biodiversity, solid and Hazardous waste management rules. Life cycle assessment: Life cycle analysis, Methodology, Management, Flow of materials-cost criteria-case studies.

UNIT - V

Case Studies: Preparation of EIA for developmental projects- Factors to be considered in making assessment decisions, Water Resources Project, Pharmaceutical industry, thermal plant, Nuclear fuel complex, Highway project, Sewage treatment plant, Municipal Solid waste processing plant, Airports.

TEXT BOOKS:

- **Anjaneyulu.Y and Manickam. V. Environmental Impact Assessment Methodologies, B.S. Publications, Hyderabad, 2007**
- **Barthwal, R. R., Environmental Impact Assessment, New Age International Publishers, 2002**

REFERENCE BOOKS:

- **Jain, R.K., Urban, L.V., Stracy, G.S., Environmental Impact Analysis, Van Nostrand Reinhold Co., New York, 1991.**
- **Rau, J.G. and Wooten, D.C., Environmental Impact Assessment, McGraw Hill Pub. Co., New York, 1996.**

SPHOORTHY ENGINEERING COLLEGE

(UGC Autonomous)

B. Tech (Civil) IV Year II Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE853PE: AIR POLLUTION (PE – V)

B.Tech. IV Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives: The objectives of the course is to

Understand the Air pollution Concepts. Identify the source of air pollution.

Know Air pollution Control devices.

Distinguish the Air quality monitoring devices.

Course Outcomes: At the end of the course the student will be able to

Identify sampling and analysis techniques for air quality assessment. Describe the plume behavior for atmospheric stability conditions.

Apply plume dispersion modelling and assess the concentrations.

Design air pollution controlling devices.

UNIT - I

Air Pollution: Definition of Air Pollution - Sources & Classification of Air Pollutants - Effects of air pollution- Global effects– Ambient Air Quality and standards– Monitoring air pollution, Sampling and analysis of Pollutants in ambient air – Stack sampling.

UNIT - II

Meteorology and Air Pollution: Factors influencing air pollution , Windrose , Mixing Depths , Lapse rates and dispersion - Atmospheric stability, Plume behavior, Plume rise and dispersion, Prediction of air quality, Box model - Gaussian model - Dispersion coefficient - Application of tall chimney for Pollutant dispersion.

UNIT - III

Control of Particulate Pollutants: Properties of particulate pollution - Particle size distribution - Control mechanism Dust removal equipment – Working principles and operation of settling chambers, cyclones, wet dust scrubbers, fabric filters & ESP.

UNIT - IV

Control of Gaseous Pollutants: Process and equipment for the removal by chemical methods - Working principles and operation of absorption and adsorption equipment - Combustion and condensation equipment.

UNIT - V

Automobile and Indoor Pollution: Vehicular pollution – Sources and types of emission – Effect of operating conditions-Alternate fuels and emissions-Emission controls and standards, Strategies to control automobile pollution– Causes of indoor air pollution-changes in indoor air quality-control and air cleaning systems-indoor air quality.

TEXT BOOKS:

- **M. N. Rao and HVN Rao, Air Pollution, Tata McGraw Hill Publishers**
- **Noel, D. N., Air Pollution Control Engineering, Tata McGraw Hill Publishers, 1999.**

REFERENCE BOOKS:

- **Air Pollution Control Engineering by Nevers, , McGraw-Hill, Inc., 2000.**
- **Fundamentals of Air Pollution by Dr. B.S.N. Raju, Oxford &I.B.H.**
- **Air Pollution and Health by T. Holgate, Hillel S. Koren, Jonathan M. Samet, Robert L. Maynard publisher Academic Press.**

SPHOORTHY ENGINEERING COLLEGE

(UGC Autonomous)

B. Tech (Civil) IV Year II Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE861PE: AIRPORT, RAILWAYS AND WATERWAYS (PE – VI)

B.Tech. IV Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives: The objectives of the course are to

Deal with the characteristics of aircrafts related to airport design; runway and taxiway design, runway orientation, length, grading and drainage.

Introduce component of railway tracks, train resistance, crossing, signalling, high speed tracks and Metro Rail.

Explain the classes of harbours, features, planning and design of port facilities.

Course Outcomes: At the end of this course, the students will develop:

An ability to design of runways and taxiways.

An ability to design the infrastructure for large and small airports.

An ability to design Super elevation and transition curve for railway horizontal curves. An ability to design various crossing sturnout and signals in Railway Projects.

An ability plan the harbours and ports projects including the infrastructure required for new ports and harbours.

UNIT - I

Airport Engineering: Introduction to Air Transportation - Aircraft Characteristics - Factors Affecting Selection of site for Airport – Aprons – Taxiway – Hanger – Geometric design - Computation of Runway Length, Correction for Runway Length, Orientation of Runway, Wind Rose Diagram

UNIT - II

Introduction to Railways: Role of Indian Railways in national development – Railways for Urban Transportation – LRT, Mono Rail, Metro Rail &MRTS. Permanent Way: Components and their Functions: Rails Types of Rails, Rail Fastenings, Concept of Gauges, Coning of Wheels, Creeps and kinks Sleepers – Functions, Materials, Density – Ballast, Functions, Materials, Ballast less Tracks, Subgrade and Embankments –Functions and Materials**.**

UNIT - III

Geometric Design of Railway Track: Gradients and Grade Compensation, Super-Elevation, Widening of Gauges in Curves, Transition Curves, Horizontal/Vertical Curves.

UNIT - IV

Track maintenance and Operation: Points and Crossings - Turnouts, Stations and Yards - Level Crossings. Signalling and Interlocking - Track Circuiting - Track Maintenance.

UNIT - V

Dock & Harbour Engineering: Water Transportation: Ports and Harbours - Types of water transportation, water transportation in India, Ports and harbours: requirements, classification. Harbour works: breakwaters, jetties, fenders, piers, wharves, dolphins, etc., Navigational aids: types, requirements, light house, beacon lights, buoys, Port facilities: general layout, development, planning, facilities, terminals. Docks and repair facilities: design, dry docks, wet docks, slipways, Locks and lock gates: materials, size, Dredging: classification, dredgers, uses of dredged materials.

TEXT BOOKS:

- **Venkataramaiah C (2016), "Transportation Engineering Vol II – Railways, Airports, Docks, Harbors, Bridges and Tunnels", Universities Press (India) Private Limited, Hyderabad**
- **J S Mundrey, Railway Track Engineering (5th Edition) McGraw Hill Education 2017**

REFERENCE BOOKS:

- **Subhash C. Saxena (2008) Airport Engineering, Planning and Design, CBS Publishers and Distributors, New Delhi. (Reprint 2015)**
- **R. Srinivasan (2016), Harbour, Dock and Tunnel Engineering 28th Edition, Charotar Publishing House Pvt. Ltd.**
- **Saxena SC and Arora S C (2010) A Text Book of Railway Engineering Paperback – 2010, Dhanpat Rai Publications (Reprint 2015)**
- **Robert Horonjeff, Francis X. McKelvey, Willian J Sproule, Seth B. Young (2010), Planning & Design of Airports, McGraw-Hill Professional.**
- **Transportation Engineering by R. Srinivasa Kumar, University Press India.**

SPHOORTHY ENGINEERING COLLEGE

(UGC Autonomous)

B. Tech (Civil) IV Year II Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE862PE: PAVEMENT ASSET MANAGEMENT (PE – VI)

B.Tech. IV Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives: The objectives of the course are to

Understand the role of Pavement Asset Management.

Understand the Flexible pavement failures and importance of maintenance. Understand the Rigid pavement failures and importance of maintenance.

Understand pavement evaluation.

Understand pavement performance and deterioration modeling.

Course Outcomes: At the end of this course, the students will be able to :

Understand the role of Pavement Asset Management.

Understand the Flexible and Rigid pavement failures and importance of maintenance.

Understand importance of pavement evaluation.

Understand pavement performance and deterioration modeling.

UNIT - I:

Introduction to Pavement Asset Management

Introduction to road assets: Pavement structure, shoulders, road side tree plantations, street lighting, traffic signs, traffic signals, intersection elements, interchange elements; Pavement Management as a part of Road Asset Management: Evolution and Development of Pavement Management Systems (PMS), Components of PMS and their inter linkages, Project and Network level PMS.

UNIT - II:

Flexible Pavement Failures and Maintenance

Flexible Pavement Failures: Identification, measurement, causative factors and remedies for all the varieties of failure under the headings of surface defects, deformation and disintegration of flexible pavements.

Maintenance of Flexible Pavements: Periodic maintenance: periodic renewals, need and importance of periodic renewals, planning and programming of renewals, identification of stretches to be renewed, types of renewal treatments, periodicity of renewal, rectification of profile at the time of renewal; pothole filling / patching, tools and equipment for pothole / patch repairs, modern mobile mechanized pothole filling/road patching technologies, arrangements for traffic and safety measures during road maintenance, preventive maintenance: introduction, selection of preventive maintenance treatment, warrants for preventive maintenance, flexible pavement preservation tools.

Importance of maintenance: Homogeneous sections by AASHTO's cumulative difference approach, types of maintenance – Preventive maintenance, minor rehabilitation, major rehabilitation, reconstruction; planning of maintenance activities.

UNIT - III:

Rigid Pavement Failures and Maintenance

Rigid Pavement Failures: Identification, measurement, causative factors and remedies for all the varieties of failure under the headings of joint spalling, faulting, polished aggregate, shrinkage cracking, pumping, linear cracking, durability cracking;

Maintenance of Rigid Pavements: Assessing maintenance needs, methods for repairing concrete pavements, crack sealing and joint resealing, crack stitching (cross stitching), partial-depth repair, full depth repair, slab stabilization, special techniques for rehabilitation of rigid pavements, repair materials, tools and plant, planning the maintenance operations, arrangement for traffic and safety, rigid pavement preservation tools.

UNIT - IV:

Pavement Evaluation: Pavement Structural Condition Evaluation: Importance of structural condition evaluation of pavements, benkelman beam technique for flexible pavement evaluation, falling weight deflectometer technique for both flexible and rigid pavements

Pavement Functional Condition Evaluation: Importance of functional condition evaluation of pavements, pavement roughness concepts; instrumentation used to assess pavement roughness, international roughness index and its importance, measurement of surface defects in both flexible and rigid pavements

Pavement Safety Condition Evaluation: Pavement texture, importance of surface friction characteristics on pavement safety, discussion on the methods of evaluation of pavement safety

UNIT - V:

Pavement Performance and Deterioration Modelling: Structural condition (Distress) models, functional condition models, initiation models and progression models; Combined measures of pavement quality, discussions on condition indices and serviceability indices, pavement condition rating, introduction to pavement rating manuals by different agencies.

TEXT BOOKS:

- **Ralph Haas, Ronald Hudson, Zanieswki with Lynne Cowe Falls, "Pavement Asset Management', Wiley, 2015.**
- **Shahin, M.Y., "Pavement Management for Airports, Roads and Parking Lots", Springer, 2nd Edition, 2005**

REFERENCE BOOKS:

- **IRC 82: 2015, First Revision, Code of Practice for maintenance of Bituminous Road Surfaces**
- **IRC SP 83: 2018, First Revision, Guidelines for maintenance, repair and rehabilitation of cement concrete pavements**
- **Feng Li, Jinyan Feng, Youxin Li, Siqi Zhou, Preventive Maintenance Technology for Asphalt Pavement, Springer, 2021**
- **ACRP Synthesis 22, Common Airport Maintenance Practices, Transportation Research Board, Washington DC, 2011**
- **R. Keith Moble, An Introduction to Predictive Maintenance, Second Edition, Butterworth Heinemann Publications, 2002**
- **NCHRP 523 – "Optimal Timing of Pavement Preventive Maintenance Treatment Applications", Transport Research Board, 2004**
- **NCHRP Synthesis 501 – "Pavement Management Systems: Putting data to work – A Synthesis of Highway Practice, Transport Research Board, 2017**

SPHOORTHY ENGINEERING COLLEGE

(UGC Autonomous)

B. Tech (Civil) IV Year II Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE863PE: PAVEMENT ANALYSIS & DESIGN (PE – VI)

B.Tech. IV Year II Sem.

L	T	P	C
3	0	0	3

Pre-Requisites: Transportation Engineering.

Course Objectives:

Engineering analysis of stresses and strains in typical highway pavement structures due to loading from traffic and climate.

Characterization of paving materials; structural pavement design by IRC, and AASHTO for flexible and rigid pavement are discussed.

Overlay design for Flexible and Rigid pavement is discussed.

Course Outcomes: The student will be able to

Understand Factors Affecting Pavement Design.

Understand Stresses In Pavements and Material Characteristics.

Design Flexible and Rigid Pavements.

Design of Pavement for Low Volume Roads

UNIT – I

Factors Affecting Pavement Design: Variables Considered in Pavement Design, Types of Pavements, Functions of Individual Layers, Classification of Axle Types of Rigid Chassis and Articulated Commercial Vehicles, Legal Axle and Gross Weights on Single and Multiple Units, Tire Pressure, Contact Pressure, EAL and ESWL Concepts, Traffic Analysis: ADT, AADT, Truck Factor, Growth Factor, Lane, Directional Distributions & Vehicle Damage Factors, Effect of Transient & Moving Loads.

UNIT – II

Stresses In Pavements: Vehicle-Pavement Interaction: Transient, Random & Damping Vibrations, Steady State of Vibration, Experiments on Vibration, Stress Inducing Factors in Flexible and Rigid pavements. Stresses In Flexible Pavements: Visco-Elastic Theory and Assumptions, Layered Systems Concepts, Stress Solutions for One, Two- and Three-Layered Systems, Fundamental Design Concepts. Stresses In Rigid Pavements: Westergaard's Theory and Assumptions, Stresses due to Curling, Stresses and Deflections due to Loading, Frictional Stresses, Stresses in Dowel Bars & Tie Bars.

UNIT – III

Material Characteristics: CBR and Modulus of Subgrade Reaction of Soil, Mineral aggregates – Blending of aggregates, binders, polymer and rubber modified bitumen, Resilient, Diametral Resilient and Complex (Dynamic) Moduli of Bituminous Mixes, Permanent Deformation Parameters and other Properties, Effects and Methods of Stabilization and Use of Geo Synthetics.

UNIT - IV

Design Of Flexible Pavements: Flexible Pavement Design Concepts, Asphalt Institute's Methods with HMA and other Base Combinations, AASHTO, IRC Methods.

Design Of Rigid Pavements: Calibrated Mechanistic Design Process, PCA, AASHTO & IRC Specifications, Introduction to Prestressed and Continuously Reinforced Cement Concrete Pavement Design.

UNIT – V

Design of Pavement for Low Volume Roads: Pavement design for low volume roads, Rural Road designs – code of practice. Design of Overlays: Types of Overlays, Suitability, Design of overlays.

TEXT BOOKS:

- **Concrete Pavements, AF Stock, Elsevier, Applied Science Publishers.**
- **Pavement Analysis & Design, Yang H. Huang, Prentice Hall Inc.**

REFERENCE BOOKS:

- **Design of Functional Pavements, Nai C. Yang, McGraw Hill Publications**
- **Principles of Pavement Design, Yoder.J. &Witzorac Mathew, W. John Wiley & Sons Inc**
- **Pavement and Surfacings for Highway & Airports, Micheal Sargious, Applied Science Publishers Limited.**
- **IRC Codes 37,58,62,81 for Flexible and Rigid Pavements design, low volume roads and over lays.**

SPHOORTHY ENGINEERING COLLEGE

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B. Tech (Civil) IV Year II Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE831OE: ENERGY EFFICIENT BUILDINGS (OE – III)

B.Tech. IV Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives: To introduce the different concepts of sustainable design and green building techniques to achieve energy efficient buildings concepts and how they may be synthesized to best fit a specific construction project.

Course Outcomes: The students completing the course will have ability to describe the concepts of sustainable design and green building techniques including energy efficiency and indoor environmental quality management.

UNIT - I:

Introduction: Life Cycle impacts of materials and products – sustainable design concepts – strategies of Design for the Environment -The sun-earth relationship and the energy balance on the earth's surface, climate, wind – Solar radiation and solar temperature – Sun shading and solar radiation on surfaces – Energy impact on the shape and orientation of buildings – Thermal properties of building materials. Studying the Nation Building Code (NBC 2005) code with respect to the Chapter 11 on Sustainability.

UNIT - II:

Energy Efficient Buildings: Passive cooling and day lighting – Active solar and photovoltaic- Building energy analysis methods- Building energy simulation- Building energy efficiency standards- Lighting system design- Lighting economics and aesthetics- Impacts of lighting efficiency – Energy audit and energy targeting- Technological options for energy management.

UNIT - III:

Indoor Environmental Quality Management: Psychometric- Comfort conditions- Thermal comfort- Ventilation and air quality-Air conditioning requirement- Visual perception- Illumination requirement- Auditory requirement- Energy management options- -Air conditioning systems- Energy conservation in pumps- Fans and blowers- Refrigerating machines- Heat rejection equipment- Energy efficient motors- Insulation.

UNIT - IV:

Energy Conservation Building Codes: Energy Efficiency, Energy Efficient Design (Achieving Efficiency through design) Energy Conservation Building Codes (ECBC) Codes 2007 Learning Different Energy Simulation Techniques (Energy / Lighting) Advanced Energy Efficient Standards and Systems HVAC Lighting Appliances and Equipments Building Envelope Understanding and calculation of energy consumption of a House, office building.

UNIT - V:

Concepts of Sustainable Building Social, Economic and Environmental aspects Different types of Indian and International Rating Systems (GRIHA, LEED, IGBC, Eco Housing, BREEAM, CASBEE, etc)

TEXT BOOKS:

- **Kibert, C. "Sustainable Construction: Green Building Design and Delivery", John Wiley & Sons, 2005**
- **Edward G Pita, "An Energy Approach- Air-conditioning Principles and Systems", Pearson Education, 2003.**

REFERENCE BOOKS:

- **Colin Porteous, "The New Eco-Architecture", Spon Press, 2002.**
- **Energy Conservation Building Codes: www.bee-india.nic.in**

SPHOORTHY ENGINEERING COLLEGE

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B. Tech (Civil) IV Year II Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE832OE: MULTI CRITERION DECISION MAKING (OE – III)

B.Tech. IV Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives: To introduce Normalization approaches, cluster analysis. Understand the role of optimization and analyze data using various techniques.

UNIT - I:

Introduction to the course and role of optimization, data mining, MCDM methods in sustainable and effective decision making, Linear Programming Nonlinear Programming and other methods, Introduction to Fuzzy Logic, Membership development, Various types of membership functions.

UNIT - II:

Normalization approaches: Rating method, Entropy method, Analytic Hierarchy Process, Fuzzy Analytic Hierarchy Process; MATLAB perspective; Weighting methods: Constraint method, Case study, MATLAB perspective.

UNIT - III:

K-Means Cluster Analysis, Fuzzy Cluster Analysis, Artificial Neural Networks, Kohonen Neural Networks, Cluster Validation Techniques, Case Study, SPSS perspective, MATLAB perspective, Introduction to Discrete MCDM methods, Compromise Programming, Co-Operative Game Theory, TOPSIS, PROMETHEE, Weighted average, Multi Attribute Utility Theory, Analytic Hierarchy Process, Case Studies, MATLAB perspective.

UNIT - IV:

Role of uncertainty in decision making, Normalization techniques, Fuzzy TOPSIS, MATLAB perspective, Spearman rank correlation coefficient, Kendall rank correlation coefficient, Group decision making algorithms, SPSS perspective, MATLAB perspective, Data Envelopment Analysis (DEA): Methodology, Drawbacks and remedial measures, further topics in DEA.

UNIT - V:

Taguchi methodology: Description, ranking process, Ant colony optimization, Particle swarm optimization, Expert systems, Web-based decision making, Geographic Information System, MATLAB perspective, Case Studies.

TEXT BOOK:

- **K. Srinivasa Raju, D. Nagesh Kumar, Multicriterion Analysis in Engineering and Management, PHI Learning Private Limited, New Delhi, 2014.**

REFERENCE BOOKS:

- **S. N. Sivanandam and S. N. Deepa, Principles of Soft Computing, Wiley, 2013.**
- **Ross TJ, Fuzzy Logic with Engineering Applications, John Wiley and Sons, 2013.**

SPHOORTHY ENGINEERING COLLEGE

(UGC Autonomous)

B. Tech (Civil) IV Year II Semester

Syllabus (SR24) From Academic Year 2025-26

S24CE833OE: ENVIRONMENTAL POLLUTION AND CONTROL (OE – III)

B.Tech. IV Year II Sem.

L	T	P	C
3	0	0	3

Course Objectives:

Impart knowledge on aspects of air pollution & control and noise pollution. Impart concepts of treatment of waste water from industrial source.

Differentiate the solid and hazardous waste based on characterization.

Introduce sanitation methods essential for protection of community health.

Provide basic knowledge on sustainable development.

Course Outcomes: At the end of the course, the students will be able to:

Understand the fundamentals of solid waste management, practices adopted in his town/village and its importance in keeping the health of the city.

Identify the air pollutant control devices and have knowledge on the NAAQ standards and air emission standards.

Differentiate the treatment techniques used for sewage and industrial wastewater treatment.

Inventing the methods of environmental sanitation and the management of community facilities without spread of epidemics.

Appreciate the importance of sustainable development while planning a project or executing an activity.

UNIT – I:

Air Pollution:

Air pollution Control Methods–Particulate control devices – Methods of Controlling Gaseous Emissions – Air quality standards. Noise Pollution: Noise standards, Measurement and control methods – Reducing residential and industrial noise – ISO:14000.

UNIT –II:

Industrial waste water Management:

Strategies for pollution control – Volume and Strength reduction – Neutralization – Equalization – Proportioning – Common Effluent Treatment Plants – Recirculation of industrial wastes – Effluent standards.

UNIT – III:

Solid Waste Management: solid waste characteristics – basics of on-site handling and collection – separation and processing – Incineration- Composting-Solid waste disposal methods – fundamentals of Land filling. Hazardous Waste: Characterization – Nuclear waste – Biomedical wastes – Electronic wastes – Chemical wastes – Treatment and management of hazardous waste-Disposal and Control methods.

UNIT – IV:

Environmental Sanitation: Environmental Sanitation Methods for Hostels and Hotels, Hospitals, Swimming pools and public bathing places, social gatherings (melas and fares), Schools and Institutions, Rural Sanitation-low cost waste disposal methods.

UNIT – V:

Sustainable Development: Definition- elements of sustainable developments-Indicators of sustainable development-Sustainability Strategies- Barriers to Sustainability–Industrialization and sustainable development – Cleaner production in achieving sustainability- sustainable development.

TEXT BOOKS:

- **Peavy, H. S., Rowe, D. R, Tchobanoglous, "Environmental Engineering", Mc-Graw Hill International Editions, New York 1985.**
- **J. G. Henry and G.W. Heinke, "Environmental Science and Engineering", Pearson Education.**

REFERENCE BOOKS:

- **G. L. Karia and R.A. Christian, "Waste water treatment- concepts and design approach", Prentice Hall of India**
- **M. N. Rao and H. V. N. Rao, "Air pollution", Tata McGraw Hill Company.**
- **Ruth F. "Weiner and Robin Matthews Environmental Engineering", 4th Edition Elsevier, 2003.**
- **K. V. S. G. Murali Krishna, "Air Pollution and Control" by, Kousal & Co. Publications, New Delhi.**