ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
GUWAHATI

Course Structure and Syllabus
(From Academic Session 2018-19 onwards)

B.TECH
CIVIL ENGINEERING
8th SEMESTER

ASSAM SCIENCE AND TECHNOLOGY UNIVERSITY
Guwahati
Course Structure

(From Academic Session 2018-19 onwards)

B. Tech 8th Semester: Civil Engineering

Semester VIII/ B. TECH/CE

Sl. No	Sub-Code	Subject	Hours per Week			Credit	Marks	
			L	T	P	C	CE	ESE
Theory								
1	CE181801	Construction Engineering and Management	3	0	0	3	30	70
2	CE1818PE3*	Program Elective-3	3	0	0	3	30	70
3	CE1818PE4*	Program Elective-4	3	0	0	3	30	70
4	CE1818OE2*	Open Elective-2	3	0	0	3	30	70
5	CE1818OE3*	Open Elective-3	3	0	0	3	30	70
Practical								
1	CE181822	Project-2	0	0	8	4	100	50
TOTAL			**15**	**0**	**8**	**19**	**250**	**400**
Total Contact Hours per week : 23								
Total Credits: 19								

PROGRAMME ELECTIVE – 3 SUBJECTS		
Sl. No	**Subject Code**	**Subject**
1	CE1818PE31	Advanced Structural Design
2	CE1818PE32	Design of Hydraulic Structures
3	CE1818PE33	Geotechnical In-situ Testing
4	CE1818PE3*	Any other subject offered from time to time with the approval of the University

PROGRAMME ELECTIVE – 4 SUBJECTS		
Sl. No	**Subject Code**	**Subject**
1	CE1818PE41	Design of Substructures
2	CE1818PE42	Pavement Design and Construction
3	CE1818PE43	Bridge Engineering
4	CE1818PE44	Water Power Engineering
5	CE1818PE4*	Any other subject offered from time to time with the approval of the University

OPEN ELECTIVE – 2 SUBJECTS		
Sl. No	**Subject Code**	**Subject**
1	CE1818OE21	Disaster Risk Management
2	CE1818OE22	Solid and Hazardous Waste Management
3	CE1818OE2*	Any other subject offered from time to time with the approval of the University

OPEN ELECTIVE – 3 SUBJECTS		
Sl. No	**Subject Code**	**Subject**
1	CE1818OE31	Finite Element Method
2	CE1818OE32	Remote Sensing and Geographical Information System
3	CE1818OE3*	Any other subject offered from time to time with the approval of the University

Detailed Syllabus:

Course Code	Course Title	Hours per week L-T-P	Credit C
CE181801	**Construction Engineering and Management**	**3-0-0**	**3**

MODULE 1: Introduction to Construction Methods and Equipment

Introduction The construction industry, the construction process, Classification of construction equipment, need of construction equipment, Factors behind the selection of construction equipment, cost of owning and operating equipment, investment and operating costs, depreciation costs.

- Earthmoving equipment: tractors and attachments, dozers and rippers, scrapers, shovel, dragline, trenching machine, clamshell, hoe, track, dumper, roller, compactor.
- Drilling and blasting equipment; pumping equipment, stone crushing equipment, concrete manufacture, transport, placing and compacting equipment.
- Equipment for moving materials- builder's hoist, forklift, crane, belt conveyor, cableway, ropeway.
- Demolition: Advanced techniques and sequence for demolition and dismantling of old structures.
- Substructure construction: underwater construction of diaphragm wall and basement, sheet pile construction, shoring for deep cutting, well points, dewatering equipment for open excavation, piling, tunneling, ground improvement techniques.

Mechanical construction technology for multistory buildings.

MODULE 2: Project Life Cycle

Characteristics of Project life cycle, Phases of project life cycle, Brief description about the different phases project life cycle, Project management processes.

MODULE 3: Construction Planning and Scheduling

Introduction to Building Information Modeling (BIM), Application of PERT and CPM techniques for construction scheduling.

MODULE 4: Introduction to Project cost management- Direct and Indirect cost estimate

MODULE 5: Introduction to Project Procurement Management

MODULE 6: Safety and Quality Assurance in Construction

Textbooks/ Reference Books:

1. CPM in Construction Management – By ConObrien, J. J., Plotnick, F. L. 7th. Edition. McGraw Hill. 2010.
2. Project Management- By Frederick Gould and Nancy Joyce

Course Code	Course Title	Hours per week L-T-P	Credit C
CE1818PE31	Advanced Structural Design	3-0-0	3

MODULE 1: Prestressed Concrete
Concept of Prestressing materials for Prestressed concrete, I.S. specifications; Analysis of Prestress-resultant stress at section, Thrust line, load balancing concept, stress in tendons. Design of simple section.

MODULE 2: Retaining Walls
Principles and analysis of Cantilever and Counterfort type retaining wall, Detailed design of different type of retaining walls for Active, Passive Earth Pressure and Surcharge.

MODULE 3: Flat Slabs, Grid Slab or Waffle Slabs
Analysis and Design of Flat Slabs, Grid slab or waffle slabs

MODULE 4: Water Tank
Design principles of underground and elevated water tanks, Detailed design of Rectangular and Circular elevated water tanks as per IS 3370, Design of Ring Beam and staging for elevated water tanks, Detailed Design of Intz Tanks, Pressed steel Tanks

MODULE 5: Design of Plate Girder, Gantry Girder
General- Components of Plate Girder- Optimum depth – Bending Strength – Shear Strength – Shear Buckling- Simple Post critical method- Tension Field method- Stiffeners-Bearing- Transverse stiffeners - Design Examples.

MODULE 6: Design of Industrial Steel Structure
General- Components of Industrial buildings and introductions, Structural Configuration, Wind zones, Evaluation of Wind Loads on Roofs and Waals, Permeability of Buildings, Exposure, External and Internal pressure co-efficient, Design examples.
Concept of Pre-engineered Building

Textbooks/ Reference Books:

1. IS-800-2007 - General Construction in Steel, Code of Practice
2. IS 804- Specifications for Rectangular Pressed Steel Tanks
3. IS:456 - 2000 - Plain and Reinforced concrete - Code of practice
4. IS:4326-1993 - Earthquake Resistant Design and Construction of Buildings - Code of Practice
5. IS: 875(Part3)-1987 - Wind Loads on Buildings and Structures
6. N. Krishna Raju, Advanced Reinforced Concrete Design, CBS Publishers and Distributors, 2007.
7. Punmia B.C. Ashok Kumar Jain and Arun K. Jain, RCC Designs(Reinforced Concrete Design), 10th Edition, Lakshmi Publishers, 2006

Course Code	Course Title	Hours per week L-T-P	Credit C
CE1818PE32	Design of Hydraulic Structures	3-0-0	3

MODULE 1: Gravity Dam

Introduction, Classification of Dam, Principles of Gravity Dam, Forces acting on Gravity Dam, Modes of Failure and Criteria for Structural Stability of Gravity Dams, Stability Analysis of Gravity Dams – 2D Gravity Method, Elementary and Practical Profile of a Gravity Dam, Design Considerations, Checking Stability Analysis of a Gravity Dam for Different Conditions (Numerical Problems)- Reservoir Empty Condition, Reservoir Full with Tail Water and without Tail Water Condition.

MODULE 2: Earthen Dam

Introduction, Types of earthen dam, Causes of Failures of Earthen Dam, Seepage Analysis – Seepage Discharge Through Isotropic & Non-isotropic Soils, Determination of Phreatic Line for Homogeneous Soil with or without Horizontal filter. - Numerical Problems. Stability of Slopes: u /s Slope due to Sudden Drawdown, d/s Slope under Steady Seepage and foundation from the considerations horizontal shear at base

MODULE 3: Spillways

Locations, Different Types, Ogee Spillway - Comprehensive Profile for Ogee Spillway as per USBR, Discharge Formula, Factors affecting Discharge Coefficient for Ogee Spillway. (Numericals). Side Channel Spillway- Dynamic equation for Spatially Varied Flow, Hind's solution for the design of Side Channel Spillway. Introduction to design concept of Siphon spillway.

MODULE 4: Energy Dissipator

Introduction, Energy dissipator for different tail water conditions. Various Stilling Basins -Type-II, Type-III, Type -IV. Selection and Design of Stilling Basins (Numericals)

MODULE 5: Theories of Seepage & Design of Weirs and Barrages on permeable Foundations

Causes of failure by piping and by direct uplift, Bligh's creep theory for seepage flow, Khosla's theory and concept of Flow net. Determination of uplift pressure below composite weir profile adopting Schwarz Christoffel transformation by Khosla's method of design. Principle for weirs on permeable foundation. Factors Governing the design of the weir and a barrage. Design of weirs and barrages using Khosla's theory of independent variables.

References:

1. Design of Small Dam -U.S.B.R.
2. Irrigation & Hydraulic Structures - S. R. Sahasrabudhe
3. Irrigation and Water Power Engineering-P.N. Modi
4. Irrigation and Hydraulic Structure-S.K. Garg
5. Flow in Open Channel-Subramanya
6. C.B.I Publication No. 12.

Course Code	Course Title	Hours per week L-T-P	Credit C
CE1818PE33	**Geotechnical In-situ Testing**	**3-0-0**	**3**

Introduction: Necessity and Importance of soil exploration, Method of sub surface exploration, Test pits, Trenches, Caissons, Tunnels and drifts, Wash boring, Percussion drilling, Rotary drilling, Factors affecting the selection of a suitable method of boring. Extent of boring, Factors controlling spacing and depth of bore holes, Spacing and depth of various Civil engineering structures.
Indirect method of exploration- Seismic refraction method, electrical resistivity, resistivity sounding and profiling. Qualitative and quantitative interpretation of test results, comparison of resistivity and seismic surveys limitations and short comings
Sampling- Sources of disturbances and their influence. Types of samplers, Principle of design of samplers, Preservation and shipment of samples.
Ground water Observation: Different method of ground water observation: Time lag in observation, sampling of ground water.
Boring and sampling records, Preparation of bore-log
Penetration test: Standard penetration tests, Dynamic cone penetration test with and without bentonite slurry, Static cone penetration tests. Various corrections in the test results. Interpretation of test results for design and determination of modulus of deformation.Correlation among various test results.
Plate load tests under constant load, cyclic load, Determination of deformation modulus, sub-grade modulus, coefficient of elastic uniform compression. Limitations of plate load tests.
Pile load test – Methods by constant load, cyclic load, pull-out test, lateral pile load test
In-situ dynamic tests- Shear modulus test, vertical and horizontal block vibration test. Determination of different dynamic soil constants
Introduction to cross hole logging, SASW, MASW techniques.

Textbooks/ Reference Books:

1. M. Hvorsler, Subsurface exploration and sampling of soil for Civil Engg. Purpose
2. B. M Das, Principles of Foundation Engineering, Thomson Brooks/Cole
3. G.Ranjan and A S R Rao, Basic and Applied Soil Mechanics, New Age international Publishers.
4. H. F. Winterkorn and H Y Fang, Foundation Engineering Hand Book, Galgotia Book source
5. Simon and Cayton, Site Investigation.

Course Code	Course Title	Hours per week L-T-P	Credit C
CE1818PE41	Design of Substructures	3-0-0	3

Course Objective: Students should be able to-

- Gain familiarity with different types of foundation.
- Design of shallow foundations and deep foundations.
- Analyse the stability of well foundation.

Course Outcome: On completion of this course students will be able to –

- select appropriate foundations type based on available soil conditions.
- determine the load carrying capacity of various types of foundation.
- design reinforced concrete shallow foundations, pile foundations and well foundations.

MODULE 1: Geotechnical and Structural Design of Shallow Foundations
Loads for design, determination of safe bearing capacity & allowable bearing pressure of footings in clay & sand, dimensioning of single isolated footing, considerations for dimensioning of groups of footings for equal settlements – the standard current practices. Structural design of isolated footings, strip footings, combined footings.

MODULE 2: Raft in Clay & Sand
Types and their suitability, determination of safe bearing capacity & allowable bearing pressure. Structural design of raft by conventional (rigid) method as per IS: code of practice.

MODULE 3: Pile Foundation
Determination of allowable load on single & pile group in clay & sand, fixation of length, diameter, number and spacing of piles, introduction to micro piles. Analysis of Laterally loaded piles by Reese & Matlock approach. Structural design of pile, pile group and pile cap.

MODULE 4: Sheet Piles
Design of cantilever and anchored sheet piles, shoring piles.

MODULE 5: Elements of Bridge Sub Structure
Forces on bridge sub – structure (IRC & IRS specification), well foundation with components only.

Textbooks/ Reference Books:

1. Bowles.J.E., "Foundation Analysis and Design", McGraw Hill Publishing co., New York, 1986.
2. Swamy Saran," Analysis and Design of substructures", Oxford and IBH Publishing Co. Pvt. Ltd., 2006.
3. Tomlinson.M.J, "Foundation Design and Construction", Longman, Sixth Edition, New Delhi, 1995. Varghese.P.C, "Design of Reinforced Concrete Foundations" – PHI learning private limited, New Delhi – 2009.

Course Code	Course Title	Hours per week L-T-P	Credit C
CE1818PE42	Pavement Design and Construction	3-0-0	3

MODULE 1: Analysis of Pavement Stresses

Pavement Structure and Functional Attributes

Pavement structure and functional attributes, factor affecting pavement design, types of wheel load for highways and airports, development of design method for highway and airport pavements

Stresses in Pavements

Stresses in flexible pavements: 1-layer, 2-layer, 3-layer theories, EWLF, ESWL

Stresses in Rigid pavement: load, friction and temperature stresses, combined stresses

MODULE 2: Structural Design of Pavements Flexible Pavement Design

Airport pavement: Corps of Engineer's method, FAA method CDOT method, Asphalt institute method

Highway Pavement: Empirical method based on soil strength criteria: CBR method as specified by IRC, AASHTO method, Asphalt institute method, IRC-37: 2018 method

Rigid Pavement Design

Airport pavements: PCA methods, corps of Engineer's method, FAA method, Joints and reinforcement requirement

Highway pavement: IRC-58: 2015 method

MODULE 3: Construction of Pavement

Bituminous Road construction

Asphalt Mix Production: Batch Plant, Drum Plant

Asphalt Mix Transportation and laydown, Asphalt Mix compaction, Quality Control of HMA

Concrete Road Construction

Preparation of base form work, placing of reinforcement and concrete, compaction, finishing, curing, joints, Quality Control

MODULE 4: Pavement Maintenance and Rehabilitation

Flexible and rigid pavement Distresses-Identification, Causes and Treatments, Condition and Evaluation surveys, Present Serviceability Index, PCI curve, roughness measurement, IRI, structural strength, Benkelman beam deflections, design of overlays, routine maintenance, preventive maintenance and periodic maintenance, introduction to PMS

MODULE 5: Modern Pavement Technologies

Self-Compacting Concrete roads, Cast in situ concrete block pavements, ICBP-Interlocking Concrete Paver block pavements (IRC-SP: 63), Stone Matrix Asphalt (SMA), Mastic Asphalt, Warm Mix Asphalt, Cold Mix Asphalt, Wet Mix Macadam

Recycling of Asphalt Pavements: Benefits, Pavement Selection Strategy, Cold Milling, HMA recycling, Hot in Place Recycling, Cold in Place recycling, Full depth reclamation

Textbooks/ Reference Books:

1. Pavement Analysis & Design: Yang H. Huang
2. Analysis of Pavement Structures: Animesh Das
3. Principles of Transportation Engineering: Partha Chakroborty & Animesh Das
4. Bituminous Road Construction in India: Prithvi Singh Kandhal

Course Code	Course Title	Hours per week L-T-P	Credit C
CE1818PE43	Bridge Engineering	3-0-0	3

MODULE 1: General Consideration of Bridges
Introduction, historical review, Engineering and aesthetic requirements in bridge design, Introduction to bridge codes, economic evaluation of a bridge project, site investigation and planning, types of bridges, selection of suitable types of bridges.

MODULE 2: Bridge Hydrology
Water way, Scour depth, factors affecting scour and its evaluation, afflux.

MODULE 3: Geotechnical Investigation for Bridges
Bridge foundations - open, pile, well and caisson, piers, abutments and approach structures.

MODULE 4: Loading Standards
Introduction to IS and IRC codes, highway bridge loading standards, Impact factor, Analysis of IRC loadings, Railway bridge loading standards.

MODULE 5: Design of Super-Structure
Analysis and design of reinforced concrete slab bridge decks, box culverts, Tee beam and slab bridge deck, and balanced cantilever bridges.

MODULE 6: Bridge Bearings
Types of bearings, design of different type of bearings

MODULE 7: Design of Sub-Structure
Piers and abutments- types of piers, factors acting on piers, general features on abutments, stability analysis of abutments.
Bridge foundation- types of foundations, pile foundations, well foundations, caisson foundation.

Textbooks/ Reference Books:

1. Essentials of Bridge Engineering- D.J. Victor, CBS PUBLISHERS AND DISTRIBUTORS PVT LTD
2. Design of bridges- N Krishna Raju, OXFOR & IBH PUBLISHING CO. PVT LTD
3. Principles and Practices of Bridge Engineering- S P Bindra, DHANPAT RAI PUBLICATIONS
4. Elements of Bridge Engineering- A K Pant

Course Code	Course Title	Hours per week L-T-P	Credit C
CE1818PE44	Water Power Engineering	3-0-0	3

MODULE 1: Introduction
Water availability on earth, available water and technologically utilizable water, fields of water resources engineering, responsibilities of water resources engineers (estimation of water demands, estimation of water availability, identification of water user, investigation of water quality, investigation of geology, environmental & social acceptability, economic feasibility), planning of water resources projects, hydropower development and potential in India and North East, comparison between hydropower & thermal power.

MODULE 2: Reservoir
Definition, purpose, types, physical characteristics of reservoir, zones of storage in a reservoir, storage capacity determination from the site, reservoir site selection, life storage capacity by mass curve method, reservoir sedimentation, trap efficiency, distribution of sediment in a reservoir, useful life of reservoir, reservoir operation, reservoir sedimentation control, reservoir yield, economic height of a dam, reservoir working table, reservoir operation rule curves, planning data requirement, environmental considerations in planning, project target reliability, compatibility of hydro-power water use.

MODULE 3: Types of Hydropower Plants
High, medium and low head plants; runoff river plants, storage plants, diversion canal plants, pumped storage plants, tidal power plants; base load and peak load plants; concentrated fall and divided fall developments, components of hydropower schemes, general layout of hydropower plan with all its components, notable hydropower projects in North East, preparation of detailed project report.

MODULE 4: Estimation of Available Power
Work, Energy and Power, Water energy, Flow and power duration curves, firm power, secondary power, dump power, load distribution –load factor, capacity factor and plant use factor. Power potential study: Nonsequential or flow-duration curve, Sequential stream flow routing (SSR) and Economic analysis.

MODULE 5: Dams
General, Classification of dams, Selection of site and choice of dams, Gravity dam – forces acting, stability analysis, Embankment dam, Arch dam and Buttress dam.

MODULE 6: Water Conveyance
Intakes – types, trash rack, control gates; canals, fore bay, tunnels, pipes.
Penstock: Design criteria, economic diameter, anchor blocks, water hammer analysis
Surge Tanks: Functions, types, design criteria.
Turbines: Types, functions, characteristics, working principles, Pelton wheel, Francis turbine, Kaplan turbine, Turbine characteristics – specific speed, characteristic curves, selection of type and numbers of turbines; scroll case, draft tubes, governing of turbines.
Power House: Components, general layout – surface and underground power houses.

MODULE 7: Introduction to System Analysis

Definition of system, system modeling, broad system classification, system analysis, optimization model, types of optimization, basic elements of a model, application of optimization in water resources, simulation, types of simulation, necessity of simulation, advantages of simulation, limitations of simulation, components of a simulation model, difficulties in simulation, art of modeling (problem definition, model construction, model solution, model validity, implementation).

Textbooks/ Reference Books:

1. Hydropower Structures – R.S. Varshney – N. C. Jain, Roorkee
2. Irrigation and Water Power Engineering – M. M. Das & M. D. Saikia – PHI Learning Pvt. Ltd., New Delhi.
3. Water Power Engineering – M. M. Dandekar& K. N. Sharma – Vikash Publishing House Pvt. Ltd., Noida, UP.
4. Irrigation Water Resources and Water Power Engineering – P. N. Modi – Standard Book House, Delhi – 110 006.
5. IS :11625-1986 – Criteria for Hydraulic Design of Penstocks.
6. IS :11639 (Part I)-1986 – Criteria for Structural Design of Penstocks (Surface Penstocks).
7. IS :11639 (Part II)-1995 – Criteria for Structural Design of Penstocks (Burried/Embedded Penstocks).
8. IS :11639 (Part III)-1996 – Criteria for Structural Design of Penstocks (Special Penstocks).
9. IS: 5330-1984 – Criteria for Design of Anchor Blocks for Penstocks with Expansion Joints.
10. VVK Rao (2006) Hydropower in The Northeast:Potential and Harnessing Analysis, Background Paper No.6.
11. Water Resources Engineering-by R.K. Linsley & J.B. Franzini, McGraw-Hill International Book Company
12. Irrigation and Water Resources Engineering –by G.L. Asawa, New Age International (P) Limited Publishers
13. Hydrology and Water Resources Engineering –by S.K. Garg, Khanna Publishers, Delhi
14. Irrigation and Water Resources Engineering –by B.C. Punmia, Pande & B.B. Lal, Standard Publishers Distributors, Delhi
15. River Behaviour Management and Training (Vol. I& II), Central Board of Irrigation and Power, 1994
16. Water Resources Systems Modelling Techniques and Analysis–by S. Vedula and P.P. Mujumdar, Tata McGraw-Hill Publishing Company Limited, New Delhi
17. Water Resources Systems Planning and Management An Introduction to Methods, Models and Applications- by Daniel P. Loucks and E.V. Beek, United Nations Educational Scientific and Cultural Organization
18. Water Resources Systems Planning and Analysis- by D.P. Loucks, J.R. Stedinger and D.A. Haith, Prentice Hall

Course Code	Course Title	Hours per week L-T-P	Credit C
CE1818OE21	Disaster Risk Management	3-0-0	3

MODULE 1: Introduction

Understanding Disaster Management (DM), Definition of Disaster, necessity of studying DM, Basic terms- Hazard, Vulnerability and Risk and understanding their inter-relationship, Types of vulnerability, Emergency & Disaster situation. Types of disaster – Causes and speed of onset.

MODULE 2: Disaster Management Cycle

Phase I: - Mitigation: - Introduction- definition of components of DM cycle, Disaster Mitigation- structural, Nonstructural, Do's and Don'ts to avoid disaster Hazard identification & vulnerability analysis and various mitigation strategies. Role of Civil Engineers in mainstreaming DM to development projects.

Phase II: - Preparedness: Different measures- DRR, DM plan or Emergency Operation Plan (EOP) - Developing & writing the DM plan or EOP.

Phase III & IV: - Response & Recovery: Terminology, Aims of disaster response, Disaster Response Activities, Modern methods of disaster response. Disaster recovery- definition- The recovery plan.

MODULE 3: Disaster Education and Public Awareness

Necessity & Stake holders roles and responsibilities-, Safety of Schools and Hospitals, work places and home.

MODULE 4: Role of Technology in DM and Risk Management

Risk and Emergency management system - Application of GIS & Remote Sensing technology. Introduction to Incident Command System (ICD)

MODULE 5: Introduction to Probable disasters in N.E. Region of India

i. Earthquake disaster Causes, vulnerability, mitigation, preparedness
ii. Flood disaster: Causes, vulnerability, mitigation, preparedness
iii. Wind/Cyclone/Extreme-Weather/Landslide disaster: Causes, vulnerability, mitigation, preparedness

Textbooks/ Reference Books:

1. Disaster Management Act 2005
2. Disaster Management Guidelines. GOI-UNDP Disaster Risk Reduction Programme (2009-2012.
3. https://ndma.gov.in/images/guidelines/national-dm-policy2009.pdf
4. https://ndma.gov.in/en/ndma-guidelines.html
5. https://ndma.gov.in/images/guidelines/earthquakes.pdf
6. https://ndma.gov.in/images/cbt/presentations/Mr.%20Sreedhar%2013.10.11.pdf
7. https://ndma.gov.in/en/disaster-management-cycle.html
8. https://ndma.gov.in/en/ongoing-programmes/school-safety-project.html
9. https://ncrmp.gov.in/
10. https://ndma.gov.in/images/cbt/booklets/Booklet1.pdf
11. https://ndma.gov.in/images/cbt/booklets/Booklet2.pdf
12. https://ndma.gov.in/images/cbt/booklets/Booklet3.pdf
13. https://ndma.gov.in/images/cbt/booklets/Booklet4.pdf
14. https://ndma.gov.in/images/cbt/booklets/Handbook.pdf
15. Geneva: Sphere Project. http://www.sphereproject.org/ handbook/
16. Coppola P Damon, 2007. Introduction to International Disaster Management, Carter, Nick 1991. Disaster Management: A Disaster Manager's Handbook. Asian Development Bank, Manil
17. https://ndma.gov.in/en/media-public-awareness/media-kit.html

Course Code	Course Title	Hours per week L-T-P	Credit C
CE1818OE22	Solid and Hazardous Waste Management	3-0-0	3

Course Objective: Students should be able-

- To provide comprehensive overview of solid, biomedical and hazardous waste management.
- To provide knowledge on solid waste management design aspects.
- To learn about the different methods of solid waste management.

Course Outcome: Upon successful completion of this course, students will be able to –

- Know solid waste remedial measures and their importance.
- Undertake projects related to solid waste management.

MODULE 1: Solid Waste

Sources and engineering classification, characterization, generation and quantification. Transport - collection systems, collection equipment, transfer stations, collection route optimization.

MODULE 2: Treatment Methods

Various methods of refuse processing, recovery, recycle and reuse, composting –aerobic and anaerobic, incineration, pyrolysis and energy recovery, Disposal methods –Impacts of open dumping, site selection, sanitary land filling –design criteria and design examples, leachate and gas collection systems, leachate treatment.

MODULE 3: Biomedical Waste Management

Sources, treatment and disposal Hazardous Waste Management-Introduction, Sources, Classification, Physico-chemical, Chemical and Biological Treatment of hazardous waste, regulations.
Module IV Thermal treatment -Incineration and pyrolysis. Soil contamination and site remediation – bioremediation processes, monitoring of disposal sites.

Textbooks/ Reference Books:

1. Tchobanoglous G., Theissen H., and EIiassen R.(1991), "Solid Waste Engineering -Principles and Management Issues",McGraw Hill, New York.
2. Pavoni J.L(1973)., "Handbook of Solid Waste Disposal".'
3. Peavy, Rowe and Tchobanoglous (1985), "Environmental Engineering", McGraw Hill Co. 4th Edition
4. Mantell C.L., (1975), "Solid Waste Management", John Wiley.
5. CPHEEO, Manualon Municipal Solid waste management, Central Public Health and Environmental Engineering Organisation, Government of India, New Delhi, 2000.
6. WHO Manual on Solid Waste Management.
7. Vesiland A. (2002), "Solid Waste Engineering", Thompson Books.
8. Hazardous waste (management and handling) rules, 20019. Biomedical (Handling and Management) Rules 2008

Course Code	Course Title	Hours per week L-T-P	Credit C
CE1818OE31	**Finite Element Method**	**3-0-0**	**3**

MODULE 1:
Introduction to Finite Element Analysis, Introduction, Basic Concepts of Finite Element Analysis, Introduction to Elasticity, Steps in Finite Element Analysis.

MODULE 2:
Finite Element Formulation Techniques, Virtual Work and Variational Principle, Galerkin Method, Finite Element Method: Displacement Approach, Stiffness Matrix and Boundary Conditions.

MODULE 3:
Introduction to Element Properties, Natural Coordinates, Triangular Elements, Rectangular Elements, Lagrange and Serendipity Elements, Solid Elements, Isoparametric Formulation, Stiffness Matrix of Isoparametric Elements, Numerical Integration: One Dimensional Numerical Integration: Two and Three Dimensional

MODULE 4:
Analysis of Frame Structures Stiffness of Truss Members, Analysis of Truss, Stiffness of Beam Members, Finite Element Analysis of Continuous Beam, Plane Frame Analysis, Analysis of Grid and Space Frame.

MODULE 5:
FEM for Two and Three Dimensional Solids Constant Strain Triangle, Linear Strain Triangle, Rectangular Elements, Numerical Evaluation of Element Stiffness, Computation of Stresses, Geometric Non linearity and Static Condensation, Axisymmetric Element

MODULE 6:
FEM for Plates and Shells, Introduction to Plate Bending Problems

MODULE 7:
Introduction to Additional Applications of FEM, Finite Elements for Elastic Stability, Finite Elements in Civil Engineering, Dynamic Analysis.

Textbooks/ Reference Books:

1. S. Krishnamoorty, Finite Element Analysis, Tata Mc Graw-Hill
2. P. N. Godbole , Introduction to Finite Element Methods, I K International Publishing House Pvt. Ltd
3. David V. Hutton, Fundamentals of Finite Element Analysis, Mc GrawHill
4. Maity, Computer Analysis of Framed Structures, I. K. International Pvt. Ltd. New Delhi
5. Erik G. Thompson, Introduction to the Finite Element Method: Theory, Programming and Applications, John Wiley
6. H. C. Martin and G. F. Carey, Introduction to Finite Element Analysis-Theory and Application, New York, McGraw-Hill
7. Irving H. Shames, CliveL. Dym, Energy and Finite Element Methods in Structural Mechanics; New Age International

8. K. J. Bathe, Finite Element Procedures, Prentice-Hall of India, New Delhi, India
9. M. Mukhopadhyay, Matrix, Finite Element, Computer and Structural Analysis, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, India
10. Zienkiewicz and Y. K. Cheung, The Finite Element Method in Structural and Soild Mechanics, Mc Graw Hill, London
11. Ceruzzi, A History of Modern Computing, The MIT Press, Cambridge, MA, 1998.
12. D. Cook, Concepts and Applications of Finite Element Analysis, Wiley
13. S. Rao, Finite Element Analysis, Elsevier Butterworth-Heinemann
14. W. Weaver Jr. and J. M. Gere, Matrix Analysis of Framed Structure, CBS Publishers

Course Code	Course Title	Hours per week L-T-P	Credit C
CE1818OE32	Remote Sensing and Geographical Information System	3-0-0	3

MODULE 1: Introduction to Remote Sensing
Principles, Electromagnetic Radiation, Laws of radiation, Interaction mechanisms, Ideal and practical remote sensing system, Atmospheric window, Spectral signature, Resolution

MODULE 2: Platform and Sensors for Remote Sensing
Terrestrial and Aerial platforms, satellites and orbits, space platforms – Landsat, spot. IRS. Characteristics of various sensor photo theodolite, aerial camera, MSS, RBV, TM, HRV and LISS system Radiometers.

MODULE 3: Characteristics and use of various Data Product
B& W, colored and Infrared photographs, B&W satellite imageries, F.C.C., high-density tapes, CCT, Image classification

MODULE 4: Interpretation and analysis of R.S. Data
Visual interpretation – interpretation element and key. Digital image processing – advantage over visual techniques. Components of image processing system

MODULE 5: Application of Remote Sensing in Resource Management
Fundamental analysis of Landforms, Geomorphology, Land use land cover, Application to highway planning and engineering.

MODULE 6: Geographical Information System
Basic concept, Principles, Data types, Analysis and decision making, components usefulness and application area.

MODULE 7: Global Positioning System
Working principles, Capabilities and uses

Textbooks/ Reference Books:

1. 'Remote Sensing and Image Interpretation', T.M. Lillesand and R.W. Kiefer, John Wiley & Sons, Singapore, 2002.
2. 'Introduction to Remote Sensing', J.B. Cambell, Taylor & Francis, UK, 2002.
3. 'Remote Sensing - Principles and Interpretation', F.F. Sabins Jr, W.H. Freeman & Co., New York, 1986.
4. Course material of 3rd Basic Course on RS & GIS, NESAC 2018
5. 'Remote Sensing - Models and Methods for Image Processing', R.A. Schowengerdt, Elsevier India Pvt. Ltd., New Delhi, 2006.
6. 'Remote Sensing and GIS', Basudeb Bhatta, Oxford University Press, New Delhi 02.
7. 'Introduction to Remote Sensing - Principles and Concepts' by Paul J Gibson, Routledge - Taylor & Francis, 2000.
8. 'Introduction to Remote Sensing - Digital Image Processing and Applications' by Paul J Gibson and Clare H Power, Routledge - Taylor & Francis, 2000.

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