# OPEN ELECTIVES / SPECIALIZATIONS

# List of Open Electives / Specializations

| Specialization | Semester | Subject Code | Subject name |
|---|---|---|---|
| **Natural Hazards and Disaster Management** | III | CE201A2/A8 | Engineering Geology |
| | IV | CE204A2/A8 | Natural Hazards |
| | V | CE301A2/A8 | Engineering Seismology |
| | VI | CE305A2/A8 | Flood & Drought |
| | VII | CE401A2/A8 | Landside Hazard |
| | VIII | CE405A2/A8 | Disaster Management |
| | | | |
| **Earthquake Engineering** | III | CE201A2/A8 | Engineering Geology |
| | IV | CE205A2/A8 | Numerical Methods & Statistics |
| | V | CE301A2/A8 | Engineering Seismology |
| | VI | CE306A2/A8 | Introduction to Structural Dynamics |
| | VII | CE402A2/A8 | Earthquake resistant Design and Construction |
| | VIII | CE406A2/A8 | Disaster Management |
| | | | |
| **Geoinformatics** | III | CE202A2/A8 | Remote Sensing |
| | IV | CE206A2/A8 | Geographic Information Systems |
| | V | CE303A2/A8 | Digital Image Processing |
| | VI | CE307A2/A8 | Pattern Recognition |
| | VII | CE403A2/A8 | Adv. Remote Sensing Techniques |
| | VIII | CE407A2/A8 | Adv. Geospatial Modelling |
| | | | |
| **Environmental Engineering** | III | CE203A2/A8 | Environment Management |
| | IV | CE207A2/A8 | Solid Waste Management |
| | V | CE304A2/A8 | Air Pollution and Control |
| | VI | CE308A2/A8 | Hazardous Waste Management |
| | VII | CE404A2/A8 | Environmental Impact Assessment |
| | VIII | CE408A2/A8 | Sustainable Engineering Concepts and Life Cycle Analysis |

Prof. (Dr.) Chandrashekhar Bhuiyan
(Professor & Head)

# NATURAL HAZARD
# AND
# DISASTER MANAGEMENT

## (Semester: III)

# CE 201A2/A8 ENGINEERING GEOLOGY [ 3 1 0 4 ]

**SCHEME OF EXAMINATION**
Questions to be set: 05 (All Compulsory)

**Course Outcomes (CO):**

After completion of this course, students should be able to

1. Remembering the properties of minerals and rocks, processes of their formation, and their relevance in Civil Engineering.
2. Interpretation of various geological structures, their roles and influences on Civil Engineering planning and construction.
3. Applying the concept of hydrogeology for assessment and management of water resources
4. Analysing the geological set-up to evaluate suitability of sites and stability of Civil Engineering structures.
5. Understanding the working principles and applications of various geophysical techniques for interpretation of subsurface geology.

## MODULE 1

### Introduction
Geology and Civil Engineering, Earth as a planet, its structure and composition.

[02]

### Mineralogy and Petrology
Sources of rocks and minerals, important rock forming and ore minerals, Rock types (Igneous, Sedimentary, Metamorphic), texture and structure in rocks, Rock cycle, Engineering properties of rocks.

[06]

## MODULE 2

### Physical Geology
Weathering of rocks, kinds of weathering, agencies, causes and products of weathering. Geological works of wind, rivers, glaciers, and groundwater on rocks.

[04]

### Structural Geology
Outcrop, dip and strike, clinometer, compass. Folds, faults, joints and unconformity and their recognition in the field and their importance in Civil Engineering projects.

[04]

## MODULE 3

### Engineering Geology

Geological consideration in selection of sites for dams and reservoirs, tunnels, bridges and highways, landslides – their causes and prevention. Earthquake waves, seismic zones of India and world, earthquakes in India, causes and effects, micro-seismic zoning, engineering consideration against earthquakes.

[08]

## MODULE 4

### Engineering Properties of Rocks

Test for engineering properties of rocks, Tests for rocks used as foundation sites of construction, Tests for rocks used as building stones, Tests for rocks used as aggregates.

[03]

### Rock Mechanics

Introduction to rock mechanics and rock engineering, simple failure criteria, Rock masses: strength, deformability, failure criteria, Rock mass classification schemes: Q and RMR, Foundations and slope stability: foundations on discontinuous rock, slope instability basic mechanisms and static equilibrium solutions, Q and RMR.

[05]

## MODULE 5

### Geophysical Techniques

Different types of geophysical techniques: gravity, magnetic, electrical resistivity, electromagnetic, seismic methods; Theories, working principles, instruments, advantages and disadvantages; Various applications.

[04]

### Hydrogeology

Occurrence of ground water, types of aquifers, aquifer properties, factors controlling aquifer recharge and yield, geo-hydrological zones in India, groundwater development in India, fracture characterisation, well site selection, hydrogeological investigations.

[04]

Total contact hours: **40**

### Reference Books:


1. Mukherjee P K, **A Text Book of Geology.**
2. Breth F G H and De Freitas, **Geology for Engineering**.
3. Krayrine and Judd, **Principles of Engineering Geology and Geotechnics**.
4. Gokhale W, **Manual of Geological Maps** (1987) CBS Publishers, New Delhi.
5. Fetter C W, **Applied Hydrogeology** (2000), Prentice Hall; 4 edition
6. Singhal BBS and Gupta RP, **Applied Hydrogeology of Fractured Rocks** (1999), Springer
7. Goodman R E, **Introduction to Rock Mechanics** (1989), Wiley, 2nd edition.
8. N Chenna Kesavulu, **Textbook of Engineering Geology** (2020), Trinity Press, 3rd edition.

## (Semester: IV)

# CE 202A2/A8 NATURAL HAZARDS [3 1 0 4]

**SCHEME OF EXAMINATION**
Questions to be set: 05 (All Compulsory)

**Course Outcomes (CO):**

After completion of this course, students should be able to

1. Understand the nature of various types of natural hazards.
2. Explain the causes and impacts of natural hazards on the environment and society.
3. Analise the mechanism of earthquake, tsunami, and volcanism.
4. Identify zones vulnerable to landslides and land subsidence.
5. Evaluate and predict hydrological hazards such as drought and flood.

## MODULE 1

Basic idea of Natural hazards and disasters, Different types of natural hazards, Causes of natural hazards: endogenous and exogenous processes, Human intervention and influence on natural hazards.

[08]

## MODULE 2

Plate tectonics and its effect, Earthquakes and their causes, Ground motion and failures, Earthquake hazard zoning, Tsunami: generation and movement, Giant tsunamis, Tsunami hazard assessment, Volcanic hazard.

[08]

## MODULE 3

Landslide and their causes, Type of downslope movement, Causes and triggers, Slope stability and failure, Mohr's hypothesis, Coulomb's failure criterion, Land subsidence.

[08]

## MODULE 2

Climatological factors and meteorological hazards, Storms: Tropical Cyclone, Hurricane, Tornado, Storm damage and safety measures, Wildfires.

[08]

## MODULE 5

Hydrological hazards: brief idea, Flood - causes and impacts, Floods and human interaction, Flood frequency and recurrence interval, Flood inundation modelling, Drought - causes and types, Difference between drought and aridity, Drought and water scarcity, Drought severity assessment, Drought mitigation.

[08]

Total contact hours: **40**

**Reference Books**

Natural hazard risk assessment and public policy. Petak, W.J. and Atkinson, A.D. Springer Verlag, NY.

## (Semester: V)

# CE 301A2/A8 ENGINEERING SEISMOLOGY [3 1 0 4]

**Course Outcomes:**

**CO1**: Critical understanding of advanced seismology and causes of earthquakes.
**CO2**: Remembering the seismic hazard and a detailed understanding of wave equations and their solutions.
**CO3**: Assess the design basis ground motion parameters and its application in earthquake engineering for disaster mitigation.
**CO4**: Processing, analysis and interpretation of earthquake data, determination of magnitude, epicentral distance, focal depth, focal mechanism, seismic hazard and risk, seismic zoning.
**CO5**: Prediction of earthquake – a brief idea.

| Module no. | Description | Hours |
|---|---|---|
| **01.** | Propagation of earthquake Waves, Body & surface waves, laws of reflection, refraction and attenuation, travel times curves, internal structure of earth. | **8** |
| **02.** | Seismicity of earth, major earthquakes in the world, important Indian Earthquakes, earthquake catalogs, plate tectonics, causes of earthquakes. Magnitude, energy, intensity, acceleration, return period, frequency, Ground motion characteristics. | **12** |
| **03.** | Earthquake recording instruments, seismographs, different modes of recording analogue, digital, micro earthquake, teleseismic, local, strong motion, band width and their engineering implications. | **8** |
| **04.** | Processing, analysis and interpretation of earthquake data, determination of magnitude, epicentral distance, focal depth, focal mechanism, seismic hazard and risk, seismic zoning. | **8** |
| **05.** | Introduction to earthquake prediction– a brief idea. | **4** |
| | **Total** | **40** |

**References:**


1. Richter,C.F. Elementary Seismology,Eurasia Publishing House (Pvt)LTD,New Delhi
2. Agrawal,P.N.,Engineering Seismology,Oxford & IBH Publishing Co.Pvt.Ltd,New Delhi
3. Aki,K and Richard, P.G.Quantitative seismology, Theory and Methods,Vol.I and II,W.H. Freeman & Co.
4. Rikitake,T.,1976 Earthquake Prediction, Elsevier Science, Amsterdam
5. Oldham,1989 Report on Great Earthquake of 12th June 1897, Memoir Geological Survey of India,V29.
6. Latest Codes of IS-1893-part-I 2016.

## (Semester: VI)

# CE 305A2/A8 FLOOD AND DROUGHT [3 1 0 4]

**Course Outcomes:**
**CO1**: An understanding of flood and flood routing.
**CO2**: An understanding of the Drought and Drought management system.
**CO3**: To know the water resources scenario in India.

| Module no. | Description | Hours |
|---|---|---|
| 1 | **Introduction:** Definition and scope of the subject, Flood and drought with human Introduction | 03 |
| 2 | **Flood:** Rational Method, Empirical Formulae, Unit Hydrograph Method, Flood Frequency Method, Gumbel's Method, Log-Pearson Type III Distribution, Partial duration series, Regional Flood Frequency Analysis, Extremes of Extremes-Envelope curve, Data for frequency studies, Design Flood, Design. Storm, Risk, Reliability and safety factor | 12 |
| 3 | **Flood Routing:** Introduction, Basic equations, Level pool routing, Attenuation, Hydrologic Channel routing, Hydraulic method of flood routing, Clark's method for IUH, Nash conceptual model, Flood control, Flood control in India. | 07 |
| 4 | **Drought:** Classification, Types of drought, Aridity Index, Impact of drought, Possible modification of drought components **Drought Management: Definition**, Water Harvesting, Rain water Harvesting, Flood water harvesting, Different types of water harvesting | 12 |
| 5 | **Droughts in India:** Causes, Status, Surface water resources of India Utilizable water resources, Total water requirement and available water Resources scenario in India | 06 |
| | **Total** | 40 |

**References:**


1. Ven te Chow, Applied Hydrology, McGraw Hill.
2. Subramanya K, Engineering Hydrology, Tata McGraw Hill.
3. VP Singh, D Jhajharia, R Mirabbasi, R Kumar, Integrated Drought Management, CRC Press
4. D Wilhite and RS Pulwarty, Drought and Water Crises: Integrating Science, Management, and Policy, Second Edition, CRC Press
5. AS Schumann, Flood Risk Assessment and Management, Springer

## (Semester: VII)

# CE 401A2/A8 LANDSLIDE HAZARD [3 1 0 4]

**Course Outcomes:**
**CO1:** Students will gain a basic knowledge of landslides and factors causing landslides.
**CO2:** Students will gain a detailed knowledge of classification and mapping of landslides.
**CO3**: Students will gain a detailed understanding of landslide-hazard and stability of slopes.
**CO4:** Students will gain a detailed understanding of landslides control measures and case studies of landslides.

| Module no. | Description | Hours |
|---|---|---|
| 1 | **Introduction: Definition;** overview of Hazard assessment techniques on regional, semi detail and detailed scales and their application for planning purposes; Terrain classification and ma in methods, use of RS and GIS. | 04 |
| 2 | **Factors for landslide:** Causative factors of landslides natural including inherent factors and external factors as well as anthropogenic factors; Impacts of natural causative factors like lithology, structure, slope morphometry, relative relief, hydrogeological conditions and land use and land cover on stability of slopes Impacts of external factors like concentrated rain fall and earth quakes on slope stability; Various causes of slope instability in Himalaya; extreme hydro-meteorological conditions leading to landslide dams and Related damages | 10 |
| 3 | **Classification and Mapping:** Classification of landslides and mass movements, Landslide hazard zonation (LHZ) on regional scales in India; LHZ mapping technique suggested by Bureau of Indian Standards with exam les; Application of regional scale LHZ maps. | 06 |
| 4 | **Landslide hazard studies and stability of slopes:** Landslide hazard studies on detailed scale of 1: 1000; Mechanics of landslide; Markland test for landslide probability, Strength of slope materials; Assessment of rock mass properties; Overview of slope stability studies for slopes characterized by overburden debris and rock materials. | 06 |
| 5 | **Landslide Control Measures:** Landslide control measures – grading of slopes, retaining walls, breast walls, drainage measures, rock bolts and rock anchors, Biotechnical measures, Special toe walls and other stability Measures. **Case studies in India:** Case studies of important landslides of Himalaya and their control practices. | 14 |
| | **Total** | 40 |

**References:**


1. Mitigation of Natural hazards and Disasters: International perspective. Haque, C. Emdad, Springer, Dordrecht. Mutreja.
2. Environmental geosciences. Keller, EA. John Wiley & Sons, NY.
3. Natural hazard risk assessment and Public policy. Petak, W.J. and Atkinson, A.D. Springer Verlag, NY.
4. Subramanya K, Engineering Hydrology, Tata McGraw Hill.
5. A field manual for landslide investigations, R. Anbalagan, B. Singh, D. Chakraborthy and A. Kohli. DST Government of India, New Delhi.

## (Semester: VIII)

# CE 405A2/A8 DISASTER MANAGEMENT [ 3 1 0 4]

**SCHEME OF EXAMINATION**
Questions to be set: 05 (All Compulsory)

**Course Outcomes (CO):**

After completion of this course, students should be able to

1. Understanding of Disaster management and Risk and Vulnerability Analysis of Disaster.
2. Establishment of Disaster Preparedness and Response.
3. Categorize Rehabilitation, Reconstruction and Recovery.
4. Understand Disaster Response Plan

| Module no. | Description | Hours |
|---|---|---|
| **1** | Introduction on Disaster: Different Types of Disaster :<br>A) Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc<br>B) Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea,Rail& Road), Structural failures(Building and Bridge),War & Terrorism etc.<br><br>Causes, effects and practical examples for all disasters. | **10** |
| **2** | Risk and Vulnerability Analysis:<br>1. Risk: Its concept and analysis<br>2. Risk Reduction<br>3. Vulnerability: Its concept and analysis<br>4. Strategic Development for Vulnerability Reduction. | **08** |
| **3** | Disaster Preparedness and Response:<br>Preparedness-<br>1. Disaster Preparedness: Concept and Nature<br>2. Disaster Preparedness Plan<br>3. Prediction, Early Warnings and Safety Measures of Disaster.<br>4. Role of Information, Education, Communication, And Training.<br>5. Role of Government, International and NGO Bodies.<br>6. Role of IT in Disaster Preparedness<br>7. Role of Engineers on Disaster Management.<br>Response | **06** |

| | | |
|---|---|---|
| **4** | Disaster Response: Introduction<br>1. Disaster Response Plan<br>2. Communication, Participation, and Activation of Emergency Preparedness Plan<br>3. Search, Rescue, Evacuation and Logistic Management<br>4. Role of Government, International and NGO Bodies<br>5. Psychological Response and Management (Trauma,Stress, Rumor and Panic)<br>6. Relief and Recovery<br>8. Medical Health Response to Different Disasters | **06** |
| **5** | Rehabilitation, Reconstruction and Recovery:<br>1. Reconstruction and Rehabilitation as a Means of Development.<br>2. Damage Assessment<br>3. Post Disaster effects And Remedial Measures.<br>4. Creation of Long-term Job Opportunities and Livelihood Options,<br>5. Disaster Resistant House Construction<br>6. Sanitation and Hygiene<br>7. Education and Awareness,<br>8. Dealing with Victims' Psychology.<br>9. Long-term Counter Disaster Planning<br>10. Role of Educational Institute. | **08** |
| | **Total** | **38** |

**References:**


1. Dr. Mrinalini Pandey. Disaster Management. Wiley India Pvt. Ltd.
2. Jagbir Singh. Disaster Management: Future Challenges and Opportunities. Publishers Pvt. Ltd.
3. J. P. Singhal. Disaster Management. Laxmi Publications.
4. Shailesh Shukla, Shamna. Biodiversity, Environment and Disaster Management. Unique Publications.

# EARTHQUAKE ENGINEERING

## (Semester: III)

# CE 201A2/A8 ENGINEERING GEOLOGY [ 3 0 1 4 ]

**SCHEME OF EXAMINATION**
Questions to be set: 05 (All Compulsory)

**Course Outcomes (CO):**

After completion of this course, students should be able to

6. Remembering the properties of minerals and rocks, processes of their formation, and their relevance in Civil Engineering.
7. Interpretation of various geological structures, their roles and influences on Civil Engineering planning and construction.
8. Applying the concept of hydrogeology for assessment and management of water resources
9. Analysing the geological set-up to evaluate suitability of sites and stability of Civil Engineering structures.
10. Understanding the working principles and applications of various geophysical techniques for interpretation of subsurface geology.

## MODULE 1

### Introduction
Geology and Civil Engineering, earth as a planet, its structure and composition.

[01]

### Mineralogy and Petrology
Sources of rocks and minerals, important rock forming and ore minerals, Rock types (Igneous, Sedimentary, Metamorphic), texture and structure in rocks, Rock cycle, Engineering properties of rocks.

[06]

## MODULE 2

### Physical Geology
Weathering of rocks, kinds of weathering, agencies, causes and products of weathering. Geological works of wind, rivers, glaciers, and groundwater on rocks.

[04]

### Structural Geology
Outcrop, dip and strike, clinometer, compass. Folds, faults, joints and unconformity and their recognition in the field and their importance in Civil Engineering projects.

[04]

## MODULE 3

### Engineering Geology

Geological consideration in selection of sites for dams and reservoirs, tunnels, bridges and highways, landslides – their causes and prevention. Earthquake waves, seismic zones of India and world, earthquakes in India, causes and effects, micro-seismic zoning, engineering consideration against earthquakes.

[08]

## MODULE 4

### Engineering Properties of Rocks

Test for engineering properties of rocks, Tests for rocks used as foundation sites of construction, Tests for rocks used as building stones, Tests for rocks used as aggregates.

[03]

### Rock Mechanics

Introduction to rock mechanics and rock engineering, simple failure criteria, Rock masses: strength, deformability, failure criteria, Rock mass classification schemes: Q and RMR, Foundations and slope stability: foundations on discontinuous rock, slope instability basic mechanisms and static equilibrium solutions, Q and RMR.

[06]

## MODULE 5

### Geophysical Techniques

Different types of geophysical techniques: gravity, magnetic, electrical resistivity, electromagnetic, seismic methods; Theories, working principles, instruments, advantages and disadvantages; Various applications.

[04]

### Hydrogeology

Occurrence of ground water, types of aquifers, aquifer properties, factors controlling aquifer recharge and yield, geo-hydrological zones in India, groundwater development in India, fracture characterisation, well site selection, hydrogeological investigations.

[04]

Total contact hours: **40**

### Reference Books:


1. Mukherjee P K, **A Text Book of Geology**.
2. Breth F G H and De Freitas, **Geology for Engineering**.
3. Krayrine and Judd, **Principles of Engineering Geology and Geotechnics**.
4. Gokhale W, **Manual of Geological Maps** (1987) CBS Publishers, New Delhi.
5. Fetter C W, **Applied Hydrogeology** (2000), Prentice Hall; 4 edition
6. Singhal BBS and Gupta RP, **Applied Hydrogeology of Fractured Rocks** (1999), Springer
7. Goodman R E, **Introduction to Rock Mechanics** (1989), Wiley, 2nd edition.
8. N Chenna Kesavulu, **Textbook of Engineering Geology** (2020), Trinity Press, 3rd edition.

## (Semester: IV)

# CE 205A2/A8 NUMERICAL METHODS AND STATISTICS
# [ 3 1 0 4 ]

**SCHEME OF EXAMINATION**

Questions to be set: 05 (All Compulsory)

**Course Outcomes (CO):**

After completion of this course, students should be able to

1. Understanding and remembering the important formulae and equations for numerical analysis.
2. Executing various numerical techniques and methods for problem solving.
3. Applying the differential techniques, interpolation and integration for determining response of beams.
4. Evaluating the various solution of non-linear and differential equations.
5. Analysing and justifying solutions based on curve fittings techniques.

## Module – 1:

**i) Linear Algebraic Equations**

(a) Gauss Elimination method
(b) Gauss Jordan Elimination Method
(c) Cholоskey Decomposition method
(d) Gauss Siedal and Jacobi Iterative methods.

**ii) Solution of Non-linear Equations**

(a) Bisection method
(b) Newton - Raphson method

[08]

## Module – 2:

### i) Numerical Integration

(a) Trapezoidal rule
(b) Simpsons rule

[04]

**ii)Numerical Differentiation**

(a) Forward Difference
(b) Backward Difference
(c) Central Difference
(d) Taylor Series

[04]

**iii) Solution of Differential Equations**

(a) Runga-Kutta method
(b) Adams – Bashforth method

[03]

## Module – 3:

**i) Descriptive Statistics**

Measures of Central Tendency
Measures of Dispersion
Measures of Skewness
Measures of Relationship [06]

**ii) Testing of Hypothesis**

Basic concepts concerning Testing of Hypothesis
Procedure of Hypothesis Testing [03]

## Module – 4:

**Analysis of Variance**

Basic principle of ANOVA
One Way ANOVA
Two Way ANOVA
Analysis of Co-variance (ANOCOVA) [06]

## Module – 5:

**Linear Regression Analysis**

Dependent and Independent variables
Simple Linear Regression Model
Multiple Linear Regression Model [06]

Total contact hours: **40**

## Reference Books:


1. Dr. P. Kandasamy, **Numerical Methods**, S.Chand, New Delhi.
2. Krishnaraju N and Muthu K U, **Numerical Methods for Engineering Problems**, Macmilan India, New Delhi.
3. Sastry S S, **Introductory Methods of numerical Analysis**, Prentice Hall of India
4. Rajasekaran S, **Numerical Methods for Science and Engineering**, Wheeler and Co.Pvt Ltd.
5. C.R. Kothari and Gaurav Garg, **Research Methodology, New Age International (P) Limited, Publishers.**

## (Semester: V)

# CE 301A2/A8 ENGINEERING SEISMOLOGY [3 1 0 4]

**Course Outcomes:**

**CO1**: Critical understanding of advanced seismology and causes of earthquakes.
**CO2**: Remembering the seismic hazard and a detailed understanding of wave equations and their solutions.
**CO3**: Assess the design basis ground motion parameters and its application in earthquake engineering for disaster mitigation.
**CO4**: Processing, analysis and interpretation of earthquake data, determination of magnitude, epicentral distance, focal depth, focal mechanism, seismic hazard and risk, seismic zoning.
**CO5**: Prediction of earthquake – a brief idea.

| Module no. | Description | Hours |
|---|---|---|
| **01.** | Propagation of earthquake Waves, Body & surface waves, laws of reflection, refraction and attenuation, travel times curves, internal structure of earth. | **8** |
| **02.** | Seismicity of earth, major earthquakes in the world, important Indian Earthquakes, earthquake catalogs, plate tectonics, causes of earthquakes. Magnitude, energy, intensity, acceleration, return period, frequency, Ground motion characteristics. | **12** |
| **03.** | Earthquake recording instruments, seismographs, different modes of recording analogue, digital, micro earthquake, teleseismic, local, strong motion, band width and their engineering implications. | **8** |
| **04.** | Processing, analysis and interpretation of earthquake data, determination of magnitude, epicentral distance, focal depth, focal mechanism, seismic hazard and risk, seismic zoning. | **8** |
| **05.** | Introduction to earthquake prediction– a brief idea. | **4** |
| | **Total** | **40** |

**References:**


1. Richter,C.F. Elementary Seismology,Eurasia Publishing House (Pvt)LTD,New Delhi
2. Agrawal,P.N.,Engineering Seismology,Oxford & IBH Publishing Co.Pvt.Ltd,New Delhi
3. Aki,K and Richard, P.G.Quantitative seismology, Theory and Methods,Vol.I and II,W.H. Freeman & Co.
4. Rikitake,T.,1976 Earthquake Prediction, Elsevier Science, Amsterdam
5. Oldham,1989 Report on Great Earthquake of 12th June 1897, Memoir Geological Survey of India,V29.
6. Latest Codes of IS-1893-part-I 2016.

**(Semester: VI)**

# CE 306A2/A8 INTRODUCTION TO STRUCTURAL DYNAMICS
# [3 1 0 4]

**Course Outcomes:**
**CO1**: Understanding the basic knowledge of structural dynamics.
**CO2**: Remembering and understanding the Single degree of freedom system.
**CO3**: Application of Multi degree of freedom system in earthquake engineering.
**CO4**: Analysis of the analysis of multi-degree of freedom un-damped systems – Raleigh method, Power Method
**CO5**: Analysis of static and dynamic structures.

| Module no. | Description | Hours |
|---|---|---|
| **01.** | **Introduction:** Objectives, dynamic loading, types of dynamic problems. Formulation of equations of motion: a) D'Alembert's principle, b) Principle of virtual work c) Variational approach. | **04** |
| **02.** | **Single Degree of Freedom Systems:** Components of the system, un-damped and damped free vibrations, logarithmic decrement, forced vibrations due to harmonic excitation – steady state and transient response, transmissibility, vibration isolation, Forced vibrations due to general dynamic loading. | **14** |
| **03.** | **Multi-Degree of Freedom Systems:** Equations of motion, un-damped and damped free vibration, eigenvalues and eigen vectors, orthogonality conditions. | **08** |
| **04.** | **Damping**: Free vibration of shear buildings with and without damping, Approximate methods for the analysis of multi-degree of freedom un-damped systems – Raleigh method, Power Method. | **04** |
| **05.** | **Static and dynamic Analysis of structures:** Static and Response spectrum and Time history method. | **08** |
| | Total | **38** |

**References:**


1. Rao, S.D., (1995), 'Mechanical Vibrations',3rd ed., Addison Wesely, New York, 19.
2. Chopra A.K., (2001), 'Dynamics of structures– Theory and application to Earthquake Engg.' Prentice - Hall of India Pvt. Ltd. New Delhi.
3. Seto, (1964), 'Mechanical vibrations, Schuam's Outline Series', McGraw Hill, New York.
4. Jai Krishna, Chandrasekaran, A.R. and Brijesh Chandra, (1994), 'Elements of Earthquake Engg'., 2nd ed., South Asian Publishers, New Delhi,
5. Thansi by W.T, (1988), 'Theory of vibration – with Applications', C.B.S. Publishers and Distributors, New Delhi.
6. Paz. M, (2004), 'Structural Dynamics', 2nd ed., C.B.S. Publishers, New Delhi.
7. Mukhopadhay., (2000), 'Vibrations of structures and structural systems' Oxford and IBH, New Delhi.
8. Biggs J.M., 'Introduction to structural dynamics', McGraw Hill publications.
9. Clough and Penzien, (1993), 'Dynamics of structures' – McGraw Hill publications.

## (Semester: VII)

# CE 406A2/A8 DISASTER MANAGEMENT [3 1 0 4]

**Course Outcomes:**
**CO1:** Students who take this course will gain a thorough, critical understanding of Disaster management and Risk and Vulnerability Analysis of Disaster.
**CO2**: Students will gain a detailed understanding of Disaster Preparedness and Response.
**CO3:** Students will gain a detailed understanding of Rehabilitation, Reconstruction and Recovery.

| Module no. | Description | | Hours |
|---|---|---|---|
| **1** | Introduction on Disaster: Different Types of Disaster :<br>C) Natural Disaster: such as Flood, Cyclone, Earthquakes, Landslides etc<br>D) Man-made Disaster: such as Fire, Industrial Pollution, Nuclear Disaster, Biological Disasters, Accidents (Air, Sea, Rail & Road), Structural failures (Building and Bridge), War & Terrorism etc.<br>Causes, effects and practical examples for all disasters. | | **10** |
| **2** | Risk and Vulnerability Analysis:<br>1. Risk: Its concept and analysis<br>2. Risk Reduction<br>3. Vulnerability: Its concept and analysis<br>4. Strategic Development for Vulnerability Reduction. | | **10** |
| **3** | Disaster Preparedness and Response:<br>Preparedness-<br>1. Disaster Preparedness: Concept and Nature<br>2. Disaster Preparedness Plan<br>3. Prediction, Early Warnings and Safety Measures of Disaster.<br>4. Role of Information, Education, Communication, And Training.<br>5. Role of Government, International and NGO Bodies.<br>6. Role of IT in Disaster Preparedness<br>7. Role of Engineers on Disaster Management.<br>Response<br>8. Disaster Response: Introduction<br>9. Disaster Response Plan<br>10. Communication, Participation, and Activation of Emergency Preparedness Plan | | **12** |

| | | | |
|---|---|---|---|
| | 11. Search, Rescue, Evacuation and Logistic Management<br>12. Role of Government, International and NGO Bodies<br>13. Psychological Response and Management (Trauma, Stress, Rumor and Panic)<br>14. Relief and Recovery<br>15. Medical Health Response to Different Disasters | | |
| **4** | Rehabilitation, Reconstruction and Recovery:<br>1. Reconstruction and Rehabilitation as a Means of Development.<br>2. Damage Assessment<br>3. Post Disaster effects And Remedial Measures.<br>4. Creation of Long-term Job Opportunities and Livelihood Options,<br>5. Disaster Resistant House Construction<br>6. Sanitation and Hygiene<br>7. Education and Awareness,<br>8. Dealing with Victims' Psychology.<br>9. Long-term Counter Disaster Planning<br>10. Role of Educational Institute. | | **08** |
| | **Total** | | **40** |

**References:**


1. Dr. Mrinalini Pandey. Disaster Management. Wiley India Pvt. Ltd.
2. Jagbir Singh. Disaster Management: Future Challenges and Opportunities. Publishers Pvt. Ltd.
3. J. P. Singhal. Disaster Management. Laxmi Publications.
4. Shailesh Shukla, Shamna. Biodiversity, Environment and Disaster Management. Unique Publications.

# GEOINFORMATICS

## (Semester: III)

# CE 202A2/A8 REMOTE SENSING [3 1 0 4]

**SCHEME OF EXAMINATION**

Questions to be set: 05 (All Compulsory)

**Course Outcomes (CO):**

**CO1:** Remembering the basic principles of Aerial Photography and Satellite Remote Sensing
**CO2:** Understanding the physics and fundamental concepts of Remote Sensing
**CO3:** Applying the techniques of digital image processing for feature extraction and mapping
**CO4:** Analysing and interpreting satellite images for identification of features and events
**CO5:** Evaluating and modelling scenarios for decision making on resource assessment and planning

**MODULE - 1**

**Introduction to Remote Sensing**
Definition; Objectives; Basic principle; Process; Spectral signatures; Platforms; Software; Sensor resolutions; Advantages and limitations; Brief history of remote sensing.
[03]

**Physics of Remote Sensing**
Physics of remote sensing; Electromagnetic spectrum; Black body concept; Atmospheric windows; Electromagnetic radiation: wave model and particle model, Stephen Boltzmann Law, Wein's Displacement Law; Energy interaction: Scattering - absorption – reflection.
[03]

**MODULE - 2**

**Aerial Photography and Photogrammetry**
Basic principles; Photographic systems; Advantage and Disadvantages; Vertical aerial photography; Scale of photography; Relief displacement; Stereoscopy; Vertical exaggeration; Elements of image interpretation.
[06]

**MODULE - 3**

**Satellite Sensors**
Imagining systems; Working principle; Geometry of scanners; CCD arrays and platforms; Satellite orbits; History of space imaging; Satellite missions - LANDSAT, SPOT, IRS etc.; Characteristics of sensors: MSS, TM, LISS – I to IV, Outputs from various sensors.
[03]

**Image Visualisation**
Image geometric distortions; Digital image data formats; Image types; Colour theory, False Colour Composites, Band combinations; Band ratio, NDVI.

[03]

**MODULE - 4**

**Digital Image Processing**
Geometric and radiometric corrections of images; Ground Control Points, Root Mean Square Error; Image resampling; Image contrast enhancement; Image filtering, Linear edge detection and enhancement; Principal Component Analysis; Intensity-Hue-Saturation; Image fusion and resolution merge.

[06]

**Digital Image Classification**
Classification techniques: Parametric, non-parametric, non-metric, hard rule and fuzzy rule based, Supervised and unsupervised, per-pixel and object-oriented classification; Clustering techniques; Accuracy assessment; Linear mixture modelling; ANN based classification; Digital change detection; Change detection techniques; Spectral change vector analysis; Error matrix.

[08]

**MODULE - 5**

**Beyond Optical Remote Sensing**
Thermal Infra-Red remote sensing; Heat energy budget; Brightness temperature and Emissivity; Hyperspectral remote sensing; Microwave remote sensing: passive and active sensing; Imagining RADAR, LIDAR and SONAR; Applications.

[08]

Total contact hours: **40**

**Textbooks and Reference Books**:

1. Paul R Wolf, Elements of Photogrammetry, McGraw Hill.
2. Lillesand and Kiefer, Remote sensing and Image Interpretation, John Wiley and Sons.
3. Ravi R Gupta, Remote Sensing Geology, Springer
4. Floyd F Sabins, Remote Sensing Principles and Interpretation, WH Freeman and Co.
5. John R Jenson, Introductory Digital Image Processing, Prentice Hall.
6. Burrough P A, Principles of Geographical Information System for Land Resource Assessment, Oxford University Press.
7. Bonham-Carter G F, Geographic information systems for geoscientists modelling with GIS (1995), Pergamon.
9. Hall M K, Schaller C J, Walker C S, and Kendal L P, Exploring Water Resources: GIS Investigations for the Earth Sciences (2002), Brooks Cole

## (Semester: IV)

# CE 206A2/A8 GEOGRAPHIC INFORMATION SYSTEMS [3 1 0 4]

**SCHEME OF EXAMINATION**
Questions to be set: 05 (All Compulsory)

**Course Outcomes (CO):**

**CO1:** Remembering the basic principles of Geographic Information Systems (GIS)
**CO2:** Understanding the capabilities, advantages, and limitations of GIS
**CO3:** Applying the techniques of GIS for spatial mapping
**CO4:** Analysis the real-world scenarios through integration of remote sensing and GIS
**CO5:** Modelling scenarios for decision making on resource assessment and planning using GIS

**MODULE - 1**

**Introduction to GIS**
Definition; Salient features; History; Components; Elements of GIS; Data types; Measurement scales of attribute data; Why GIS?

[03]

**Map projections and Coordinate systems**
Map projections; Coordinate systems and geo-referencing; Coordinate transformations; Resampling; Raster and Vector models.

[03]

**MODULE - 2**

**GIS Measurements**
GIS measurements: Raster versus Vector; Distance measurements; Proximity analysis.

[03]

**Data and Database in GIS**
Data structures and models; Continuous versus Discrete data; Database management system; Database structures; Database creation; Data analysis functions.

[03]

**MODULE - 3**

**Spatial Analysis and Mapping**
Interpolation techniques; Spatial analysis; Spatial statistics; GIS queries; Reclassification; Digitization; Buffering; Raster GIS filtering; Boolean operations; Map overlay; Site suitability analysis and zoning.

[04]

**Terrain Analysis**
Terrain Analysis: rater versus vector; Topology concept; DTM and TIN models; Extraction of terrain parameters: slope, aspect, curvature, hill shading, view shed analysis, contouring; volumetric estimation.

[04]

**Network Analysis**
Definition and concept of network; Client-server Network web GISl; Types of network analysis examples: shortest path problem, travelling salesperson's problem, location-allocation modelling, route tracing; Geocoding; Path analysis.

[04]

**MODULE - 4**

**GIS Modelling**
Process modelling in GIS (natural and scale analogue models, conceptual models, mathematical models); multi-criteria evaluation; criteria weighting: rating, ranking, and pair-wise comparison; Analytic Hierarchic Process (AHP); Advanced spatial modelling.

[06]

**MODULE - 5**

**Integrated Remote Sensing and GIS Applications**
Geology and Geohazards: geological structures, landforms, topography, rocks. Identification of minerals and ore deposits; Zoning and micro-zoning for landslide, earthquake, avalanche, beach erosion, land subsidence etc.
Hydrological hazards: flood forecasting, flood inundation mapping, flood-risk zoning; reservoir sedimentation; fluvial geomorphology and environmental appraisal, snow melt initiation; drought and water-scarcity; groundwater potential modelling; groundwater quality; aquifer vulnerability; soil moisture.
Urban and regional planning: mapping and monitoring urban growth and changes; land use/land cover mapping; land degradation; deforestation; desertification; basin erosion; sedimentation; hazard and risk assessment, forecasting etc.

[10]

Total contact hours: **40**

**Textbooks and Reference Books:**


1. Burrough P A, Principles of Geographical Information System for Land Resource Assessment, Oxford University Press.

2. Bonham-Carter G F, Geographic information systems for geoscientists modelling with GIS (1995) Pergamon.

3. Kang-Tsung Chang, Introduction to Geographic Information Systems, 9th Edition, McGraw Hill

4. Paul A. Longley, Michael F. Goodchild, David J. Maguire, David W. Rhind, Geographic Information Science and Systems. 4th Edition, Wiley

## (Semester: V)

# CE 303A2/A8 DIGITAL IMAGE PROCESSING [3 1 0 4]

**SCHEME OF EXAMINATION**
Questions to be set: 05 (All Compulsory)

**Course Outcomes (CO):**

**CO1:** Remembering the basic principles of Aerial Photography and Satellite Remote Sensing
**CO2:** Understanding the physics and fundamental concepts of Remote Sensing
**CO3:** Applying the techniques of digital image processing for feature extraction and mapping
**CO4:** Analysing and interpreting satellite images for identification of features and events
**CO5:** Evaluating and modelling scenarios for decision making on resource assessment and planning

**MODULE - 1**

**Remote Sensing and Digital Image Pre-processing**
Remote sensing – an overview; Advantages and limitations; Data requirements and resolutions; Processing of digital images.

[04]

**Remote Sensing Data Collection**
Analogue image digitization; Digital remote sensor data collection; Multiple imagining; Imagining spectrometry; Airborne and satellite-borne digital cameras; Digital image data formats.

[04]

**MODULE - 2**

**Image Quality Assessment and Statistical Evaluation**
Overview; Image processing mathematical notation; Sampling theory; The histogram and its significance; Metadata; Pixel values visualisation; Univariate descriptive image statistics; Multivariate image statistics; Feature space plots; Geostatistical analysis; Autocorrelation and kriging.

[04]

**Image Display and Visualization**
Overview; Image display considerations; Black-and-white hard-copy image display; Image colours and display; Merging of remote sensing data; False Colour Composite; Image Fusion; Dimension measurement in image – length, perimeter, area, shape.

[04]

**MODULE - 3**

**Image Radiometric Correction**

Overview; Electromagnetic energy interactions; Conduction, convection, and radiation; Electromagnetic radiation models; Atmospheric energy–matter interactions; Terrain energy–matter interactions; Energy-matter interactions at the sensor system; Correction for remote sensing detector error; Remote sensing atmospheric correction; Correction for slope and aspect effects.

[06]

**Geometric Correction**

Internal and external geometric error; Types of geometric correction; Ground control points; Image-to-map geometric rectification; RMS error; Mosaicking.

[02]

**MODULE - 4**

**Image Enhancement**

Overview; Image reduction and magnification; Transects (spatial profiles); Spectral profiles; Contrast enhancement; Band ratioing; Neighbourhood raster operations; Spatial filtering; Principal components analysis (PCA); Vegetation indices; Texture transformations; Landscape ecology metrics.

[08]

**MODULE - 5**

**Information Extraction Using Imaging Spectroscopy**

Overview; Panchromatic, Multispectral and Hyperspectral data collection; Hyperspectral image quality assessment; Radiometric calibration; Geometric correction; Dimensionality reduction; Endmember (Purest pixels) determination; Mapping and matching; Selected indices useful for hyperspectral data analysis; Derivative spectroscopy.

[08]

Total contact hours: **40**

**Textbooks and Reference Books:**


1. **John R Jenson**, Introductory Digital Image Processing, Prentice Hall
2. **Lillesand and Kiefer**, Remote sensing and Image Interpretation, John Wiley and Sons.
3. Paul Mather, Computer Processing of Remotely sensed Images, 5th Editon, Wiley Blackwell
4. Michael J De Smith, Michael F Goodchild, Paul a Longley, Geospatial Analysis: A Comprehensive Guide, 6th Edition,
5. Andy Mitchell & Lauren Scott Griffin, The Esri Guide: Spatial Measurements and Statistics, 2nd Edition, Esri Press
6. Jensen, J. R., Guptill, S., and D. Cowen, 2012, Change Detection Technology Evaluation, Bethesda: U.S. Bureau of the Census, Task 2007, FY2012 Report.

## (Semester: VI)

# CE 307A2/A8 PATTERN RECOGNITION [3 1 0 4]

**SCHEME OF EXAMINATION**
Questions to be set: 05 (All Compulsory)

**Course Outcome (CO):**

**CO1:** Identifying the elements of image interpretation
**CO2:** Understanding the basic principles of pattern recognition process
**CO3:** Applying the techniques of pattern recognition in pixel clustering
**CO4:** Classifying digital images for feature identification and mapping
**CO5:** Implementing advanced techniques of image classification at complex situations

**MODULE - 1**

**Elements of Image Interpretation**
Introduction: Definition of digital image; Elements of image interpretation; Development of interpretation keys; Image Restoration, Image Reduction and Magnification; Ground Truthing: Ground Truth Collection; Spectral Signature; Data Calibration; Interpretation of target Properties; Training; Verification.
[08]

**MODULE - 2**

**Pattern Recognition**
Concept of Pattern Recognition; Multi-spectral pattern recognition; Spectral pattern recognition; Spatial pattern recognition; Temporal pattern recognition; Spectral discrimination; Signature bank.
[06]

**Spatial Patterns, Processes and Uncertainty Modelling**
Kriging and Spatial Autocorrelation, Points and Pattern Analysis: Nearest Neighbour Analysis, Quadrat Analysis, Poisson Processes, Uncertainty, Spatial resolution induced error, Positional Uncertainty, Attributed Uncertainty, Error Propagation Analysis, Taylor Series Approximation.
[06]

**MODULE - 3**

**Clustering**
Basics of Clustering; Clustering criteria, Different distance functions and Similarity / dissimilarity measures; Within cluster distance criterion; K-means algorithm; Single linkage and complete linkage algorithms; MST; K-medoids; DBSCAN; Data sets - Visualization; Unique clustering.
[08]

**MODULE - 4**

**Digital Image Classification**

Thematic Image Classification: Parametric and Non-parametric classifiers, Hard and Soft classification, Advantage and disadvantages of different classifiers, Unsupervised classification: ISODATA, RGB, and K-mean classifiers, Supervised classification system: Minimum distance to mean, Parallelepiped, Maximum likelihood, Mahalanobis Distance classifiers; Limitations of standard classifiers; Object based classification; Accuracy assessment: Reference data, Sampling techniques; Error of Commission and Omission; Error matrix; Kappa statistics and Change detection analysis.

[07]

**MODULE - 5**

**Advanced Classification Techniques and Modelling**

Advanced Classification Techniques: Hybrid classification; ANN; Spectral mixture analysis; Fuzzy classifiers; Fuzzy C-means Classifier; Soft-computing and Neuro-fuzzy techniques; Structural pattern recognition; Spectral angle mapper; Decision tree; Support vector machine; Real-life examples.

[05]

Total contact hours: **40**

TEXTBOOKS

1. Duda, Hart and Stork, Pattern Classification, Second Edition, Wiley, 2001.
2. S. Theodoridis, K. Koutroumbas, Pattern recognition, Academic Press, 1999.

REFERENCE BOOKS

1. T.M. Mitchell, Machine learning, Mc Graw-Hill, New York, 1997.
2. Joseph, George and Jeganathan, C. (2017). “Fundamentals of Remote Sensing”, 3rd Edition, Universities press (India) Pvt. Ltd., Hyderabad.

## (Semester: VII)

# CE 403A2/A8 ADVANCED REMOTE SENSING TECHNIQUES
# [3 1 0 4]

**SCHEME OF EXAMINATION**
Questions to be set: 05 (All Compulsory)

**Course Outcome (CO):**

**CO1:** Understanding the basic principles of Thermal Remote Sensing
**CO2:** Realising the principles and concept of Hyperspectral Remote Sensing
**CO3:** Exploring Microwave Remote Sensing and related advanced technologies
**CO4:** Analysing the data and information obtained by gravity sensing from space (GRACE)
**CO5:** Applying the advanced recent UAV Based and underground remote sensing technologies

**MODULE 1**

**Thermal Remote Sensing**
Overview, Thermal energy interaction and transfer, Thermal infrared (TIR) radiation principles, Heat energy budget, TIR scanners, TIR missions, Kinetic heat and temperature, Radiant energy and Radiant flux, Emissivity, Factors affecting thermal data, Temperature estimation from LANDSAT data, Applications of thermal remote sensing data.
[06]

**MODULE 2**

**Hyperspectral Remote Sensing**
Hyperspectral sensing – an overview; Hyperspectral Data Collection; Dimensionality Reduction; Endmember (Purest Pixels) Determination; Mapping and Matching; Selected Indices Useful for Hyperspectral Data Analysis; Derivative Spectroscopy.
[04]

**MODULE 3**

**Microwave Remote Sensing**
Microwave Remote Sensing – an Overview; Passive versus Active Sensing; Active Microwave Sensing – Imagining RADAR; Primary and Secondary Advantages; Applications.
[04]

**SAR Interferometry**
Introduction to SAR and InSAR; SAR Sensors and Platforms; SAR and InSAR Theory; SAR Image Processing; SAR Interferometry; SAR Polarimetry; SAR Altimetry; DInSAR and PSInSAR; Applications.
[06]

**LIDAR and SONAR**
LIDAR – an Overview, Working principle, Applications, Advantages.
SONAR – an Overview, Working principle, Applications, Advantages.
[04]

**MODULE 4**

**GRACE**
The GRACE mission, Concept and working principle, Data format, variables, and resolution, Sensor models, Real data processing and analysis, GRACE follow-on (GRACE-FO), Groundwater assessments using GRACE and InSAR, Other applications of GRACE.
[06]

**MODULE 5**

**UAV based Remote Sensing**
Overview; Working principle; Platforms and Sensors; Advantages and Limitations; Optimal scale and resolution; Operations: pre-flight, during flight, post-flight; Time-series analysis; Errors; Applications; Ethics and Laws.
[06]

**Underground Remote Sensing**
Underground LiDAR, Fixed LiDAR (GeoLidar) and simultaneous location and mapping (SLAM), Applications in mining.
[04]

Total class hours: **40**

## (Semester: VIII)

# CE 408A2/A8 ADVANCED GEOSPATIAL MODELLING [3 1 0 4]

**SCHEME OF EXAMINATION**
Questions to be set: 05 (All Compulsory)

**Course Outcome (CO):**

**CO1:** Recapitulating the basic principles of geospatial technology
**CO2:** Learning the techniques of geospatial data management and spatial statistics
**CO3:** Exploring the technology of real-time analysis through web GIS
**CO4:** Applying artificial intelligence in GIS for geospatial analysis and mapping
**CO5:** Modelling, prediction, and forecasting of events based on artificial intelligence

**MODULE 1**

**Geospatial Analysis - Preliminary Concepts**
Introduction to Geospatial data, Data Types and sources, Remote Sensing data products and formats, Data analysis tools, Datums, Map projections and Coordinate systems, Understanding maps, Map reading.
[06]

**MODULE 2**

**Geospatial Data and Spatial Statistics**
Attribute-based Spatial SQL, Spatial-criteria-based data query, Geodata transformation, Root Mean Square (RMS) Error, Resampling of pixel values, Spatial interpolation methods, Kriging, Spatial autocorrelation, Spatial factor analysis, Spatial regression, Buffering and overlay analysis. DEM and TIN data, their derivatives.
[08]

**MODULE 3**

**Web GIS and Real-time Analysis**
Google Earth, Google Earth Engine, GEE editor and cloud computing, GEE-based Time-series and forecasting.
[06]

**MODULE 4**

**Application of Machine Learning, and Deep Learning in Geoinformation**
Supervised and unsupervised learning, Logistic learning, Support Vector Machine Learning, Decision tree learning, Ensemble learning, Neural network learning, Data preprocessing and validation, Convolutional neural network.
[06]

**MODULE 5**

**Modelling, Prediction, Forecasting, and Decision Making**
Weight of evidence, Analytic Hierarchy Process, Spatial data reclassification, Binary models, Indexed models, Regression models, Logistic Regression Models, Process models, Time-series and Forecasting models, GeoAI-aided models.
[08]

Total class hours: **40**

**Textbooks and Reference Books**


1. T.M. Mitchell, Machine Learning, Mc Graw-Hill, New York, 1997.
2. Eugene Charniak, Introduction to Deep Learning. The MIT Press, Cambridge, Massachusetts, London, England, 2018.

# ENVIRONMENTAL ENGINEERING

## (Semester: III)

# CE203A2/A8 ENVIRONMENT MANAGEMENT [ 3 1 0 4]

Course Outcomes:

CO1: This course will introduce students to the various EM system standards.
CO2: Students will understand the concepts and will then take up the issues and techniques relating to EM.
CO3: Students will also discuss environmental design and economics.

NPTEL Link: https://nptel.ac.in/courses/120108004

| Module no. | Description | Hours |
|---|---|---|
| 1 | Principles of Environmental Management.<br>Ecosystem Concepts.<br>Environmental Concerns in India.<br>Policy and Legal Aspects of EM.<br>Introduction to Environmental Policies.<br>Environmental Laws and Legislations.<br>Environmental Legislations in India.<br>Environmental Impact Assessment (EIA).<br>Impact Prediction, Evaluation and Mitigation.<br>Forecasting Environmental Changes | **05** |
| 2 | Strategic Environmental Assessment (SEA).<br>Environmental Clearance Procedure in India.<br>EIA Documentation and Processes.<br>EIA Monitoring and Auditing.<br>Environmental Auditing.<br>Elements of Audit Process.<br>Waste Audits and Pollution Prevention Assessments.<br>EA in Industrial Projects.<br>Liability Audits and Site Assessment.<br>Auditing of EM | **12** |
| **3** | Life Cycle Assessment (LCA).<br>Stages in LCA of a Product.<br>Procedures for LCA.<br>Different Applications of LCA.<br>Environmental Management System Standards.<br>EMS Standards: ISO 14000.<br>Implementation of EMS Conforming to ISO 14001.<br>Environmental management techniques.<br>Application of Remote Sensing and GIS in EM | **08** |

| | | |
|---|---|---|
| **4** | Ecosystem approach to risk assessment.<br>Environmental Design (ED)<br>ED for Manufactured Products.<br>ED for Buildings.<br>ED for Developmental Planning.<br>Environmental Economics.<br>Economics and the Environment.<br>Environmental Valuation.<br>Economics of Natural Resources.<br>Environmental and Regional Economics.<br>Ecological Economics. | **12** |
| | **Total** | **38** |

**References:**


1. Vijay Kulkarni and Ramachandra T.V., 2006. Environmental Management,
2. Commonwealth Of Learning, Canada and Indian Institute of Science, Bangalore.

## (Semester: IV)

# CE 207A2/A8 SOLID WASTE MANAGEMENT [3 1 0 4]

**Course Outcomes:**

**CO1:** Students will understand the functional element of solid waste management which is important because it helps in evaluating the impacts of projected changes and technological developments

**CO2**: Students will understand generation, collection and transportation of MSW.

**CO3:** Students will have in depth understanding about various treatment methods

**CO4:** Students will have an insight into various legislation in the area of MSW.

| Module no. | Description | Hours |
|---|---|---|
| **1** | 1. Evolution of Solid Waste Management<br>2. Sources/Types and Characteristics of Solid Waste<br>3. Generation of Solid Waste | 7 |
| **2** | 1. Waste Handling, Separation, storage, and Processing<br>2. Collection of Solid Waste<br>3. Transfer and Transport | **15** |
| **4** | 1. Separation and processing of Solid Waste<br>2. Chemical Transformation (combustion/incineration)<br>3. Biological Treatment (Composting) | **8** |
| **5** | 1. Biological Treatment (Anaerobic Digestion)<br>2. Disposal of Solid Waste<br>3. ISWM and legislation | **10** |
| | TOTAL | **38** |

## References:


• Christensen, H. T., Solid Waste Technology & Management, Wiley, 2010, Volume 1 & 2

• Haug, T. R., The Practical Handbook of COMPOST ENGINEERING, Lewis Publishers, 1993

• Reinhart, R. D. and Townsend, G. T., Landfill Bioreactor Design & Operation, CRC Press, 1997, 1st Edition

• Tchobanoglous, G. and Kreith, F., HANDBOOK OF SOLID WASTE MANAGEMENT, McGraw Hill, 2002, 2nd Edition

• Tchobanoglous, G., Theisen and Vigil, Integrated Solid Waste Management: Engineering Principles and Management Issues, McGraw Hill, 1993.

## (Semester: V)

# CE 304A2/A8 AIR POLLUTION AND CONTROL
# [3 1 0 4]

**Course Outcomes:**

CO1: Students who take this course will gain a thorough, critical understanding of air pollution and various mechanism and concepts

CO2: Students will gain a detailed understanding of Air pollution control devices.

CO3: Students will gain a detailed understanding of Air pollution standards, laws and understanding of emerging technologies.

| Module no. | Description | Hours |
|---|---|---|
| **1** | **1** : Air Pollution: Introduction and Impacts of air pollution on human health, vegetation, animals, building materials, structures, and atmosphere, soil and water bodies.<br>**2 :** Sources, classification and formation/transformation of air pollutants: Meteorology and Atmospheric Stability.<br>**3** : Lapse Rate, Plume Behaviour, and Air Quality Monitoring, Air Quality Index (AQI) | **10** |
| **2** | **1** : Air Quality Modelling, Gaussian dispersion models: point, line and area source models<br>**2**: Emissions Inventory: Transport, Industrial, Agricultural, Residential and Commercial sectors | **09** |
| **3** | 1: Indoor air pollution: sources, types and health impacts. Sampling, assessment and evaluation of Indoor air quality.<br>**2 :** Global and regional environmental issues of air pollution: Ozone depletion, Climate change, Global warming, Acid rain.<br>**3** : Air pollution control devices, equipment and their design. | **12** |
| **4** | **1** : Air pollution emission standards, National and international policies, acts, rules and regulations.<br>**2** : Emerging technologies and strategies to mitigate air pollution, Current challenges and way forward.<br>**3** : Lab-based measurements of air pollutants. | **09** |
| | **Total** | **40** |

**References:**


1. Wark, K., Warner, C.F., and Davis, W.T., "Air Pollution: Its Origin and Control", Addison Wesley Longman. 1998.
2. Boubel, R.W., Fox, D.L., Turner, D.B., Stern, A.C., "Fundamentals of Air Pollution", Academic Press. 2005.
3. Seinfeld, J.H., Pandis, S.N., "Atmospheric Chemistry and Physics", John Wiley. 2006.
4. Lodge, J.P. (Ed.), "Methods of Air Sampling and Analysis", CRC Press. 1988.
5. Gurjar, B.R., Molina, L., Ojha, C.S.P. (Eds.), "Air Pollution: Health and Environmental Impacts", CRC Press. 2010.

**(Semester: VI)**

# CE 308A2/A8 HAZARDOUS WASTE MANAGEMENT [3 1 0 4]

## Course Outcomes:

**CO1:** This course provides an in depth understanding of solid and hazardous waste characteristics and management..

**CO2:** Students will gain a detailed knowledge, Hazardous waste Characterization Environmental legislation for solid and hazardous waste disposal and transport Risk Assessment.

**CO3**: Students will gain a detailed understanding of Waste stabilization techniques, Chemical, physical and biological treatment Landfill design for Sanitary and Hazardous Wastes.

NPTEL Course : https://archive.nptel.ac.in/courses/105/106/105106056/#

| Module no. | Description | Hours |
|---|---|---|
| 1 | Relevant Regulations Municipal solid waste (management and handling) rules; hazardous waste (management and handling) rules; biomedical waste handling rules; flyash rules;recycled plastics usage rules; batteries (management and handling) rules | 04 |
| 2 | Hazardous Waste Management – Fundamentals Characterization of waste; compatibility and flammability of chemicals; fate and transport of chemicals; health effects | 10 |
| 3 | Radioactive Waste Management – Fundamentals Sources, measures and health effects; nuclear power plants and fuel production; waste generation from nuclear power plants; disposal options | 04 |
| 4 | Environmental Risk Assessment Defining risk and environmental risk; methods of risk assessment; case studies<br>Physicochemical Treatment of Solid and Hazardous Waste Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); ground water contamination and remediation | 06 |
| 5 | Biological Treatment of Solid and Hazardous Waste Composting; bioreactors; anaerobic decomposition of solid waste; principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation<br>Landfill design Landfill design for solid and hazardous wastes; leachate collection and removal; landfill covers; incineration | 14 |
| | **Total** | **38** |

## References:


1. John Pichtel Waste Management Practices CRC Press, Taylor and Francis Group 2005.
2. 2. LaGrega, M.D.Buckingham,P.L. and Evans, J.C. Hazardous Waste Management, McGraw Hill International Editions, New York, 1994.
3. Richard J. Watts, Hazardous Wastes - Sources, Pathways, Receptors John Wiley and Sons, New York, 1997

## (Semester: VII)

# CE 404A2/A8 ENVIRONMENTAL IMPACT ASSESSMENT [3 1 0 4]

**Course Outcomes:**

**CO1**: An understanding of EIA tool so as to assess the positive and negative environmental, economic and social impacts of a project

**CO2**: In this course students will develop basic understanding of the history, need, structure, process, involved methods and challenges.

**CO3**: Students will also learn criteria for selecting method for impact assessment, overview of methods, parameters for public participation ad technique for writing reports.

NPTEL Link: https://archive.nptel.ac.in/courses/124/107/124107160/

| Module no. | Description | Hours |
|---|---|---|
| 1 | 1: Introduction to Environment Management & EIA<br>2: Legal, Policy & Regulatory Framework<br>3: EIA Procedure - Scoping & Screening and Establishing Baseline Conditions | 05 |
| 2 | 1: EIA Methodologies<br>2: Connectedness: connected spaces and subspaces, Connectedness of the real line, Intermediate value theorem<br>3. EIA Methods, Tools and Techniques | 12 |
| 3 | 1: Public Involvement in EIA<br>2.: Impact Management - Mitigation & Preparation of Environment Management Plans (EMP)<br>3.: EIA Reporting & Review of EIA Quality | 10 |
| 4 | 1: Decision Making & Project Management<br>2: Implementation & Follow up<br>3: EIA Case Examples | 12 |
| | **Total** | 40 |

**References:**

1) Wathern P., “Environmental Impact Assessment: Theory and Practice”,Routledge Publishers,1990

2) Marriott B., “Environmental Impact Assessment: A Practical Guide”,McGraw-Hill Publication,1997

3) Shrivastava A.K., Baxter Nicola, Grimm Jacob, “Environmental Impact Assessment”, APH Publishers, 2003

4) Anjaneyulu Y., Manickam Valli, “Environmental Impact Assessment Methodologies”, CRC Press 2011

5) Glasson J., Therivel Riki, Chadwick Andrew, “Introduction to Environmental Impact Assessment”, Oxford Brookes University 2012/ 4th edition

## (Semester: VIII)

# CE 408A2/A8 SUSTAINABLE ENGINEERING CONCEPTS AND LIFE CYCLE ANALYSIS [3 1 0 4]

**Course Outcomes:**

**CO1**: This course will introduce students to the fundamental concepts related to interaction of industrial and environmental/ecological systems, sustainability challenges facing the current generation, and systems-based approaches required to create sustainable solutions for society.

**CO2**: Students will understand the concepts and the scientific method as it applies to a systems-based, trans-disciplinary approach to sustainability, and will be prepared to identify problems in sustainability and formulate appropriate solutions based on scientific research, applied science, social and economic issues.

**CO3**: Students will also learn about the basic concepts of life cycle assessment (LCA), along with life cycle inventory (LCI) and life cycle impact assessment (LCIA) including the social and economic dimensions.

NPTEL Link: https://archive.nptel.ac.in/courses/105/105/105105157/

| Module no. | Description | Hours |
|---|---|---|
| 1 | An Introduction to Sustainability Concepts and Life Cycle Analysis (Introduction, Material flow and waste management, What it all means for an engineer? Water energy and food nexus)<br><br>Risk and Life Cycle Framework for Sustainability (Introduction, Risk, Environmental Risk Assess-ment, Example Chemicals and Health Effects, Character of Environmental Problems) | 05 |
| 2 | Environmental Data Collection and LCA Methodology (Environmental Data Collection Issues, Sta-tistical Analysis of Environmental Data, Common Analytical Instruments, Overview of LCA Methodology - Goal Definition, Life Cycle Inventory, Life Cycle Impact Assessment, Life Cycle Interpretation, LCA Software tools)<br><br>Life Cycle Assessment – Detailed Methodology and ISO Framework (Detailed Example on LCA Comparisons, LCA Benefits and Drawbacks, Historical Development and LCA Steps from ISO Framework) | 12 |

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| **3** | Life Cycle Inventory and Impact Assessments (Unit Processes and System Boundary Data Qual-ity, Procedure for Life Cycle Impact Assessment, LCIA in Practice with Examples, Interpretation of LCIA Results)<br><br>Factors for Good LCA Study (ISO Terminologies, LCA Steps Recap, Chemical Release and Fate and Transport, and Green Sustainable Materials) | **08** |
| **4** | Design for Sustainability (Environmental Design for Sustainability: Economic, Environmental Indicators, Social Performance Indicators, Sustainable Engineering Design Principles and Environmental Cost Analysis)<br><br>Case Studies (e.g., Odour Removal for Organics Treatment Plant, Comparison of Hand Drying Methods, Biofuels for Transportation, Kerosene Lamp vs. Solar Lamp, Bioplastic etc.). | **12** |
| | **Total** | **38** |

## References:

Allen, D., & Shonnard, D. R. (2011). Sustainable engineering: Concepts, design and case studies. Prentice Hall.