# *Department of*
# CIVIL ENGINEERING

4 Years B.Tech Degree Programme

## REGULATION & SYLLABUS 2017

**Choice Based Credit System**
**Outcome Based Assessment**

**SEMESTER-V & VI**

**AUTONOMOUS**

**Accredited by NBA**

**Accredited by NAAC with 'A' Grade (3.28 out of 4.00 CGPA)**

**GANDHI INSTITUTE OF ENGINEERING AND TECHNOLOGY**

*Affiliated to UGC New Delhi &Biju Patnaik University of Technology, Odisha*

**GUNUPUR – 765022, Odisha, India**

## 5th semester

| S. No. | Course category | Subject Code | Subjects | L | T | P | Credits |
|---|---|---|---|---|---|---|---|
| 1 | PC | BCVPC5010 | Transportation Engineering-I | 3 | - | - | 3 |
| 2 | PC | BCVPC5020 | Design of Concrete Structure | 3 | 1 | - | 4 |
| 3 | PC | BCVPC5030 | Irrigation Engineering | 3 | - | - | 3 |
| 4 | PE | BCVPE5041 | Concrete Technology | 3 | - | - | 3 |
| | PE | BCVPE5042 | Remote Sensing Techniques and GIS | | | | |
| | PE | BCVPE5043 | Traffic Engineering and Transportation Planning | | | | |
| 5 | OE | BCVOE5051 | Open Electives I | 3 | - | - | 3 |
| | OE | BCVOE5052 | Open Electives I | | | | |
| | OE | BCVOE5053 | Open Electives I | | | | |
| 6 | HS | BBS**HS**5061 | Optimization in Engineering | 3 | - | - | 3 |
| | HS | BMG**HS**5062 | Organizational Behavior | | | | |
| **Sessional** | | | | | | | |
| 7 | PC | BCVPC5110 | Transportation Engineering-I Lab | - | - | 2 | 1 |
| 8 | PC | BCVPC5120 | Design of Concrete Structure Lab | - | - | 2 | 1 |
| 9 | PC | BCVPC5130 | Irrigation Engineering Lab | - | - | 2 | 1 |
| 10 | PC | BTP**PC**5140 | *Skill development project & hands on training | - | - | 2 | 1 |
| 11 | PC | BTP**PC**5150 | **Summer Internship | - | - | - | 1 |
| **Total** | | | | | | | **24** |

| Subject code | course title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVPC5010 | **TRANSPORTATION ENGINEERING-I** | | | | | |

CEO 1- To understand the importance of transportation and characteristics of road transport

CEO 2- To know about the history of highway development, surveys and classification of roads

CEO 3- To study about the geometric design of highways

CEO4- To study about traffic characteristics and design of intersections

CEO5- To know about the pavement materials and design

Pre-Requisites (If any) –

Course Outcomes

| | |
|---|---|
| CO1 | Ability to identify the current trends of transportation. |
| CO2 | Ability to determine the characteristics of pavement materials and develop the acceptance criteria. |
| CO3 | Ability to analyze and design the highway geometric elements & ability to design the pavement |
| CO4 | Ability to design traffic managing infrastructure based on given situation. |
| CO5 | Ability to design the super elevation of road for safe road |

**Unit:1** **(10 Hours)**

Modes of transportation, importance of highway transportation, history of road construction. Principle of highway planning, road development plans, highway alignments requirements, engineering surveys for highway location.

**Geometric design**- Design controls, highway cross section elements, cross slope or camber, road width, road margins, typical cross sections of roads, design speed, sight distance, design of horizontal and vertical alignments, horizontal and vertical curves.

**Unit:2** **(8 Hours)**

**Highway Materials:-**

Properties of sub grade, sub-base , base course and surface course materials , test on sub grade soil, aggregates and bituminous materials .

Traffic Engineering definition , fundamentals of traffic flow , traffic management, prevention of road accidents , elements of transport planning , highway drainage, pavement failures and maintenance , strengthening.

**Unit:3** **(6 Hours)**

Factors affecting flexible pavement and rigid pavement design. Introduction to IRC method of pavement design. Construction procedure of flexible and rigid pavements.

**Unit:4** **(7 Hours)**

Bridge site selection, economic span of bridge , bridge superstructures , foundations , sub-structures and approaches.

Teaching Method(s): Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

**1.** Highway Engineering, by S.K.Khanna and CEG Justo

**Ref. Books**

2. A course in Highway Engineering by Dr. S.P. Bindra

3. Principles and practice of Bridge Engineering by Dr. S.P. Bindra

| Subject code | course title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVPC5020 | **DESIGN OF CONCRETE STRUCTURE** | 3 | - | - | 3 | |

CEO 1- understand the design concept of various structures and detailing of reinforcements

CEO 2-To study the stress strain behaviour of steel and concrete

CEO 3-To understand the concept of working stress and limit state methods

CEO4-To gain the knowledge of limit state design for flexure, shear, torsion, bond and anchorage

CEO5-To understand the behaviour of columns subjected to eccentric load and use of interaction diagrams

Pre-Requisites (If any) –

Course Outcomes

| | |
|---|---|
| CO1 | They have acquired in-depth knowledge and critical understanding of the theory and principles of design and solution of Reinforced Concrete structures, since they could use new technologies and information systems in the design of civil Engineering structures with Reinforced concrete. |
| CO2 | Be able to perceive, design and analyze Reinforced Concrete structures (Beams, Columns, Frames). |
| CO3 | To have the ability to compose, solve and evaluate the internal forces (N, Q, M), the deformations, the stresses and reinforcements in various structures made of Reinforced Concrete. |
| CO4 | Ability to determine strength of reinforced concrete beams and slabs at various support conditions as per Limit state design |
| CO5 | Ability to design reinforced concrete beams and slabs at various support conditions for different loadings as per Limit state design |

**Unit:1** **(9 Hours)**

Properties of concrete and reinforcing steel, philosophy, concept and methods of reinforced concrete design, introduction to limit state method, limit state of collapse and limit state of serviceability, application of limit state method to rectangular beams for flexure, shear, bond and torsion

**Unit:2** **(8 Hours)**

Design of doubly reinforced beams, design of T and L beams, design of one way and two way slabs, design of staircases.

**Unit:3** **(8 Hours)**

Design of short and long columns with axial and eccentric loadings, Design of isolated and combined column footings

**Unit:4** **(8 Hours)**

Retaining walls, various forces acting on retaining wall, stability requirement, design of cantilever and counterfort retaining walls, Design of water tanks, design requirements, design of tanks on ground, underground and elevated water tanks.

**Teaching Method(s):** Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

1. Design of Reinforced Concrete Structue by N. Subramanian, Oxford University Press
2. Limit State Design by A.K.Jain, Neemchand& Bros
3. Reinforced Concrete Design by S U Pillai& D. Menon, McGraw Hill

**Ref. Books**

1. Design of concrete structures by J.N.Bandyopadhyay, PHI
2. Limit State Design of Reinforced Concrete -P.C Verghese
3. Reinforced Concrete Design by S.N.Sinha, McGraw Hill
4. RCC Design-B.C.Punmia, A.K.Jain and A.K.Jain-Laxmi Publications

| Subject Code | Course title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVPC5030 | **IRRIGATION ENGINEERING** | 3 | - | - | 3 | |

CEO 1- To build on the student's background in hydrology and hydraulics and understanding of water resources systems

CEO 2-To develop the skills in modelling of flood flows and flood routing

CEO 3-To develop skills in the ground water flow, type of aquifer and yield from the well

CEO4-To provide the knowledge of design of reservoir, operation and sedimentation

CEO5-To study the effect, causes and remedial measures of water logging

Pre-Requisites (If any) –

Course Outcomes

| | |
|---|---|
| CO1 | Ability to solve problem on flood routine and design various hydraulic structures |
| CO2 | Assess the irrigation need of crops |
| CO3 | Design weirs in previous foundations. |
| CO4 | design gravity dam and earthen dam design the canal systems |
| CO5 | Select and design canal fall |

**Unit:1** **(10 Hours)**

Introduction: Necessity of Irrigation in India, Advantages and disadvantages of Irrigation, Techniques of water distribution in firms, Quality of irrigation water.

Water requirements of Crops: Crops and crop season, Duty and Delta, Consumptive use, Irrigation requirements, Estimation of consumptive use of water by climatic approaches, Irrigation efficiencies, Soil moisture-irrigation relationship.

**Unit:2** **(9 Hours)**

Canal Irrigation: Classification of canals, Canal losses, Alignment of canals, Design of stable channels using Kennedy's and Lacey's theory, Garret's diagram, Cross section of irrigation canals Lining of Irrigation Canals: Advantages and economics of lining, Various types of lining, Design of lined canals.

**Unit:3** **(10 Hours)**

**Reclamation of Water Logged and Saline Soils**: Causes and control of water logging. Reclamation of saline and alkaline land, Surface and Sub-surface drainage.

**Types of Cross-Drainage Works**: Types of CD works, Selection of a suitable type to suite a particular condition, Design consideration for CD works.

**Diversion Head works**: Weirs and Barrages, Types of weirs and barrages, Layout of a diversion head works, Introduction to different components of a diversion head works. Design of weirs and barrages: Bligh's creep theory, Design of weir using Bligh's theory, Lane's weighted creep theory, Khosla's theory, Khosla's method of independent variables, Exit gradient.

**Canal Falls**: Necessity, Proper location, Types, Design and detailing of one type of fall

**Unit:4** **(8 Hours)**

**Gravity Dams**: Typical cross section, various forces acting on gravity dam, Combination of forces for design, Modes of failure and criteria for structural stability, High and low gravity dam, Design of high dam, typical section of low gravity dam.

**Earth Dams**: Types, Causes of failure, Preliminary section of an earth dam, Seepage control in earth dams

**Spillways**: Descriptive study of various types of spillways.

Teaching Method(s): Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

1. Irrigation Engineering and Hydraulic Structures by S. K. Garg, Khanna Publication, New Delhi
2. Irrigation Engg. By B.C. Punmia and Pande, Laxmi Publication, New Delhi

**Ref. Books**

1. Irrigation Engg. By Birdie and Das, DhanpatRai, New Delhi
2. Irrigation Engg. By Sharma and Sharma, S. Chanda and Company, New Delhi

| Subject Code | Course title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVPE5041 | **CONCRETE TECHNOLOGY** | 3 | - | - | 3 | |

CEO 1- To understand the properties of ingredients of concrete

CEO 2-To study the behaviour of concrete at its fresh and hardened state

CEO 3-To study about the concrete design mix

CEO4-To know about the procedures in concreting

CEO5-To understand special concrete and their use

Pre-Requisites (If any) –

Course Outcomes

| | |
|---|---|
| CO1 | Identify the functional role of ingredients of concrete and apply this knowledge to mix design philosophy |
| CO2 | Acquire and apply fundamental knowledge in the fresh and hardened properties of concrete |
| CO3 | Evaluate the effect of the environment on service life performance, properties and failure modes of structural concrete and demonstrate techniques of measuring the Non Destructive Testing of concrete structure |
| CO4 | Develop an awareness of the utilization of waste materials as novel innovative materials for use in concrete |
| CO5 | Design a concrete mix which fulfills the required properties for fresh and hardened concrete |

**Unit:1** **(10 Hours)**

**Cement**: Portland cement- chemical composition, Hydration, Setting of cement, Structure of hydrate cement, Test on physical properties, Different grades of cement.

**Admixtures**: Types of admixtures - mineral and chemical admixtures -properties – dosages effects - usage.

**Aggregates:** Classification of aggregate, Particle shape & texture, Bond, strength & other mechanical properties of aggregate, Specific gravity, Bulk density, porosity, adsorption & moisture content of aggregate, Bulking of sand, Deleterious substance in aggregate, Soundness of aggregate, Alkali aggregate reaction, Thermal properties, Sieve analysis, Fineness modulus , Grading curves, Grading of fine & coarse Aggregates, Gap graded aggregate, Maximum aggregate size.

**Unit:2** **(10 Hours)**

**Fresh concrete:** Workability - Factors affecting workability, Measurement of workability by different tests, Setting times of concrete, Effect of time and temperature on workability , Segregation & bleeding, Mixing and vibration of concrete, Steps in manufacture of concrete Quality of mixing water.

**Hardened concrete:** Water Cement ratio , Abram's Law, Nature of strength of concrete, Maturity concept , Strength in tension & compression, Factors affecting strength, Relation between compression & tensile strength, Curing.

**Unit:3** **(9 Hours)**

**Testing of hardened concrete**: Compression tests, tension tests, factors affecting strength , flexure tests , splitting tests , pull-out rest, non-destructive testing methods – codal provisions for NDT.

**Elasticity, creep & shrinkage** : modulus of elasticity, dynamic modulus of elasticity, posisson's ratio, creep of concrete, factors influencing creep, relation between creep & time , nature of creep, effects of creep , shrinkage , types of shrinkage.

**Unit:4** **(9 Hours)**

**Mix design** :Factors in the choice of mix proportions , Durability of concrete, Quality Control of concrete , Statistical methods , Acceptance criteria, Proportioning of concrete mixes by various methods , BIS method of mix design.

**Special concretes:** Light weight aggregates - Light weight aggregate concrete – Cellular concrete - **No-fipes concrete** - High density concrete -Fibre reinforced concrete – Polymer concrete - Types of Polymer concrete - High performance concrete - Self compacting concrete.

Teaching Method(s): Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

*1. Concrete Technology - Gambhir, M.L., , McGraw Hill*

*2. Properties of Concrete by A.M.Neville*

**Ref. Books**

*1. Concrete Technology by M.S.Shetty. - S.Chand & Co.*

*2. Concrete Technology by Santakumar A.R, Oxford University Press*

| Subject Code | Course Title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVPE5042 | **REMOTE SENSING TECHNIQUES AND GIS** | 3 | - | - | 3 | |

CEO 1- To know about the principles of remote sensing and spectral signatures

CEO 2- To know about satellites, types of remote sensing and digital image processing

CEO 3- To study about the history and components of GIS

CEO4- To study about data types and operations

CEO5- To know the applications of remote sensing and GIS

Pre-Requisites (If any) –

Course Outcomes

| | |
|---|---|
| CO1 | demonstrate the concepts of Electro Magnetic energy, spectrum and spectral signature curves |
| CO2 | apply the concepts of satellite and sensor parameters and characteristics of different platforms |
| CO3 | apply the concepts of DBMS in GIS analyze raster and vector data and modeling in GIS |
| CO4 | apply GIS in land use, disaster management, ITS and resource information system |
| CO5 | Awareness of soft wares used for remote sensing techniques |

**Unit:1** **(13 Hours)**

**Remote sensing**- introduction, physics of remote sensing- electromagnetic radiations and their characteristics, thermal emissions, multi-concept in remote sensing, remote sensing satellites and their data products, sensors and orbital characteristics, spectral reflectance curves for earth surface features, methods of remotely sensed data interpretation- visual interpretation, concept of FCC, digital image processing- digital image and its characteristics, satellite data formats, image rectification and restoration, image enhancement- contrast manipulation, spatial feature manipulation, multi-image manipulation

**Unit:2** **(10 Hours)**

**Fundamentals of GIS**: introduction, definition of GIS, evolution of GIS, roots of GIS, definition, GIS architecture, models of GIS, framework for GIS, GIS categories, map as a model, spatial referencing system, map projections, commonly used map projections, grid systems, cartographic symbolization

**Unit:3** **(12 Hours)**

Data management, models and quality issues: conceptual models, geographical data models, data primitives, data types - raster and vector approach, digital terrain modeling , approaches to digital terrain data modeling , acquisition of digital terrain data, data modeling and spatial analysis, sources of geographical data, data collectors and providers, creating digital data sets, data presentation, data updating, data storage

**Unit:4** **(11 Hours)**

GIS data processing, analysis and visualization: raster based GIS data processing, vector based GIS data processing, human computer interaction and GIS, visualization of geographic information, principles of cartographic design in GIS, generation of information product, image classification and GIS, visual image interpretation, types of pictorial data products, image interpretation strategy, image interpretation process.

**Teaching Method(s):** Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

1. Remote Sensing and GIS, BasudebBhatta, Oxford University Press
2. Remote Sensing And GIS, M.A. Reddy, B.S. Publication, Hyderabad

**Ref. Books**

1. Fundamental of Remote Sensing by G. Joseph, Universities Press
2. Introduction Of GIS, Kang-Tsung Chang, Mcgraw-Hill
3. GIS, N. Panigrahi, Universities Press

| Subject Code | Course Title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVPE5043 | **TRAFFIC ENGINEERING AND TRANSPORTATION PLANNING** | 3 | - | - | 3 | |

CEO-1- To introduce fundamental knowledge of traffic engineering so that students can understand and be able to deal with traffic issues including safety, planning, design, operation and control.

CEO-2- Students will learn and be able to use software such as Highway Capacity Software and Synchrony in traffic engineering projects

Pre-Requisites (If any) –

Course Outcomes

| | |
|---|---|
| CO1 | Understand the factors influencing road vehicle performance characteristics and design. |
| CO2 | Apply basic science principles in estimating stopping and passing sight distance requirements. |
| CO3 | Design basic traffic signal phasing and timing plan. |
| CO4 | Design of flexible pavement layers. |
| CO5 | Be familiar of the four stages of the transport planning and prediction models. |

**Unit:1** **(10 Hours)**

Organization of traffic engineering department and its importance under Indian conditions. Road user characteristics, Human factors governing road user behavior, Vehicle characteristics, Slow moving traffic characteristics in Indian conditions.

**Unit:2** **(10 Hours)**

Speed, Journey time and delay surveys, Traffic Volume and Origin-Destination survey, Traffic flow parameters, Speed, density and volume relationships.

Parking types, ill effects of parking, off street parking facilities, Traffic regulations, Traffic management measures.

**Unit:3** **(10 Hours)**

High capacity analysis, Capacity of freeways and express ways in rural areas. Design of rotary intersection and capacity of rotary intersection.

**Unit:4** **(8 Hours)**

Systems approach to transport planning, Stages in transport planning, Trip generation and distribution, Traffic assignment and modal split, Economic evaluation of transportation plans

**Teaching Method(s):** Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

Traffic Engineering and Transport Planning, L.R. Kadiyali, Khanna Publishers, New Delhi

**Ref. Books**

12. Transportation Planning, C. S. Papacostas and P. D. Prevedouros, PHI

3. Transportation Engg: An introduction, C. J. Khisty& B. K. Lall, PHI

| Subject Code | Course Title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVOE5051 | **BRIDGE STRUCTURES** | 3 | - | - | 3 | |

Pre-Requisites (If any) –

Course Outcomes

| | |
|---|---|
| CO1 | Discuss the IRC standard live loads and design the deck slab type bridges. |
| CO2 | Analyze the box culverts for the given loading and detail the box culverts. |
| CO3 | Design and detail of T-Beam bridges. |
| CO4 | Design and check the stability of piers and abutments. |
| CO5 | Discuss the bridge foundations and prepare the bar bending schedule. |

**Unit:1** **(10 hrs)**

Introduction, historical review, engineering and aesthetic requirements in bridge design. Introduction to bridge codes. Economic evaluation of a bridge project. Site investigation and planning. Bridge hydrology, economic span, Scour - factors affecting the scour and evaluation of scour.

**Unit:2** **(8 hrs)**

Standards for loadings for bridge design. IRC loadings, Bridge foundations - open, pile, well and caisson. Piers, abutments and approach structures; Superstructure - right, skew and curved slabs.

**Unit:3** **(8 hrs)**

Girder bridges - types, load distribution, Orthotropic plate analysis of bridge decks, solution of typical problems using Courbon's method of analysis

**Unit:4** **(10 hrs)**

Introduction to long span bridges - cantilever, arch, cable stayed and suspension bridges. Methods of construction of R.C Bridges, Prestressed concrete bridges and steel bridges Fabrication, Lounching & creation. construction joints (use of relevant codes of practice are permitted in the examination).

Teaching Method(s): Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

1. Principles and practice of Bridge engineering by S.P Bindra, Dhanapatrai publications

**Ref. Books**

1. Bridge Engineering – Victor Jognson, TMH Publication
3.V. K. Raina, *Concrete Bridges Practice – Analysis, Design and Economics*, Shroff Pub, New Delhi 2nd Ed. 2005.
4. Design of Concrete Bridges, Vazirani, Ratwani and Aswani, Khanna Pub. 2nd Ed.
5. B. M. Das, *Principles of Foundation Engineering,* Thomson, Indian Edition, 2003.

| Subject Code | Course Title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVOE5052 | **TOWN PLANNING** | 3 | - | - | 3 | |

Course Outcomes

Pre-Requisites (If any) –

| | |
|---|---|
| CO1 | Apply a range of key urban design, research and problem solving skills to complex real-world situations |
| CO2 | Analyze a case study site, drawing on theoretical approaches and a range of available documents including plans, photographs and written documents |
| CO3 | Create and communicate urban design ideas and proposals to a wide audience using a range of presentation skills and media, including drawings |
| CO4 | Demonstrate effective interpersonal communication and project management skills both as part of a team and independently |
| CO5 | Demonstrate creativity, critical thinking and innovation when identifying and solving urban and regional problems in diverse contexts and assessing implications of decisions and action |

**Unit:1** **(10 Hours)**

Principles of architectural design –primary elements, form, space, organization, circulation, proportion and scale, ordering principles. Functional planning of buildings: Planning, designing and construction, General building requirements, Permit and Inspection (as per the National building Code)

**Unit:2** **(10 Hours)**

Town Planning ; Evolution of towns : History and trends in town planning:-origin and growth, Historical development of town planning in ancient valley civilizations; Objects and necessary of town planning; Surveys and analysis of a town

Unit:3 (8 Hours)

New Concepts in town planning : Garden city movement, Linear city and Satellite city concepts, Neighborhood Planning.

**Unit:4** **(8 Hours)**

Planning Principles, Practice and Techniques: Elements of City plan, Estimating future needs, Planning standards, Zoning:- its definition, procedure and districts, height and bulk zoning, F.A.R., Master Plan; Concepts of urban planning , design and landscaping.

Teaching Method(s): Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

1. Town Planning, B. Charotar Publications. rangawala

**Ref. Books**

1. B. Gallion and S. Eisner, The Urban Pattern: City planning and Design - C B S publishers.
2. D. K. Francis Ching, Architectures: Form, Space and Order, John Wiley.
3. S. Eisner, A. B. Gallion and S. Eisner, The Urban Pattern: City planning and Design, JohnWiley

| Subject Code | Course Title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVOE5053 | **SYSTEM APPROACH IN CIVIL ENGINEERING** | 3 | - | - | 3 | |

Course Outcomes

Pre-Requisites (If any) –

| | |
|---|---|
| CO1 | Formulate and solve deterministic optimization models |
| CO2 | Apply deterministic optimization techniques for resource allocation, scheduling, inventory control, capacity expansion and transportation problems |
| CO3 | Students are exposed to advances in experimental and computational technologies |
| CO4 | Apply decision theory and stochastic optimization techniques for decision making under uncertainty |
| CO5 | Formulate and solve optimization models for planning and design of civil engineering systems |

**Unit:1** **(10 Hours)**

Introduction to System approach, Operations Research and Optimization Techniques, Use of systems approach in Civil Engineering, Methods, Introduction to Linear and Non linear programming methods (with reference to objective function, constraints), Local & Global optima, unimodal function, convex and concave function

**Unit:2** **(10 Hours)**

Single variable unconstrained optimization: Sequential Search Techniques-Dichotomous, Fibonacci, Golden section Multivariable optimization without constraints-The gradient vector and Hessian Matrix, Gradient techniques, steepest ascent/decent technique, Newton's Method
Multivariable optimization with equality constraints - Lagrange Multiplier Technique

**Unit:3** **(8 Hours)**

Sequencing– n jobs through 2, 3 and M machines
Queuing Theory : elements of Queuing system and its operating characteristics, waiting time and ideal time costs, Kendall's notation, classification of Queuing models, single chanel Queuing theory : Model I (Single channel Poisson Arrival with exponential services times, Infinite population (M/M/1) : (FCFS/ / ) ∞ ∞
Simulation : Monte Carlo Simulation

**Unit:4** **(8 Hours)**

Formulation of Linear optimization models for Civil engineering applications. The simplex method, Method of Big M, Two phase method, duality.

Teaching Method(s): Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

1. Engineering Optimization: Methods and Application-- A. Ravindran, K. M. Ragsdell— Wiley India
2. Engineering Optimization by S.S.Rao
3. Operations Research by Hamdy A. Taha
4. Quantitative Techniques in Management by N.D. Vohra ( McGraw Hill )
5 Operations Research by Premkumar Gupta and D.S.Hira, S. Chand Publications (2014).

**Ref. Books**

1. Topics in Management Science by Robert E. Markland( Wiley Publication)
2. An Approach to Teaching Civil Engineering System by Paul J. Ossenbruggen
3. A System Approach to Civil Engineering Planning & Design by Thomas K. Jewell (Harper Row Publishers)

## 6TH SEMESTER

| S. No. | Course category | Subject Code | Subjects | L | T | P | Credits |
|---|---|---|---|---|---|---|---|
| 1 | PC | BCVPC6010 | Design of Steel Structure | 3 | 1 | - | 4 |
| 2 | PC | BCVPC6020 | Structural Analysis II | 3 | - | - | 3 |
| 3 | PC | BCVPC6030 | Transportation Engineering-II | 3 | - | - | 3 |
| 4 | PE | BCVPE6041 | Water Supply & Sanitary Engineering | 3 | - | - | 3 |
| | PE | BCVPE6042 | Prefabricated Structures | | | | |
| | PE | BCVPE6043 | Pavement Engineering | | | | |
| 5 | **OE** | B**OE6051 | Open Electives II | | | | |
| | OE | B**OE6052 | Open Electives II | | | | |
| | OE | B**OE6053 | Open Electives II | | | | |
| 6 | HS | BBS**HS**5061 | Optimization in Engineering | 3 | - | - | 3 |
| | HS | BMG**HS**5062 | Organizational Behavior | | | | |
| **Sessional** | | | | | | | |
| 7 | PC | BCVPC6110 | Design of Steel Structure Lab | - | - | 2 | 1 |
| 8 | PC | BCVPC6120 | Structural Analysis II Lab | - | - | 2 | 1 |
| 9 | PC | BCVPC6130 | Transportation Engineering-II Lab | - | - | 2 | 2 |
| 10 | PC | BTP**PC**6140 | Soft skills & Employability skills | - | - | 2 | 1 |
| **Total** | | | | | | | **24** |

| Subject Code | Course title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVPC6010 | **DESIGN OF STEEL STRUCTURE** | 3 | - | - | 3 | |

CEO-1- To learn IS 800-2007 code of practice for the design of Compression, Tension and Flexural members using various cross-sections

CEO-2- To study the behaviour and design of compression and tension members using simple and built-up sections

CEO-3- To understand behaviour of flexural members and the design laterally restrained and unrestrained beams

CEO-4- To study the components of truss, loads on trusses, analysis and design of purlins and truss members

CEO-5- To study the design of bolted and welded connections and arranging field visit to industries

Pre-Requisites (If any) –

Course Outcomes

| | |
|---|---|
| CO1 | Identify and compute the design loads on a typical steel building. |
| CO2 | Identify the different failure modes of steel tension and compression members and beams, and compute their design strengths. |
| CO3 | Select the most suitable section shape and size for tension and compression members and beams according to specific design criteria. |
| CO4 | Apply relevant AISC provisions to ensure safety and serviceability of structural steel elements. |
| CO5 | Design bolted and welded connections for tension and compressive members and beams. |

**Unit:1** **(10 Hours)**

Introduction, advantages/disadvantages of steel, structural steel, rolled steel section, various types of loads, design philosophy.

Limit state design method; limit states of strength and serviceability, probabilistic basis for design Riveted, bolted and pinned connections, Welded connections-assumptions, types, design of fillet welds, intermittent fillet weld, plug and slot weld, failure of welded joints, welded joints vs bolted and riveted joints

**Unit:2** **(8 Hours)**

Tension members, types, net cross-sectional area, types of failure, slenderness ratio, design of tension members, gusset plate.

Compression members, effective length, slenderness ratio, types of cross-section, classification of cross section, design of axially loaded compression members, lacing, battening, design of column bases, and foundation bolts.

Unit:3 (9 Hours)

Design of beams, types of c/s, lateral stability of beams, lateral torsional buckling, bending and shear strength, web buckling and web crippling, deflection, design procedure.

**Unit:4** **(9 Hours)**

Plate girders- various elements and design of components Eccentric and moment connections, roof trusses

Teaching Method(s): Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

1. Design of Steel Structures- Limit State Method by N. Subramanian, Oxford University Press
2. Limit State Design of Steel structures by S.K. Duggal, Mc-Graw Hill

**Ref. Books**

1. Design of steel structures by S.S.Bhavikatti, I.K. International Publishing house.
2. Design of Steel Structures by K. S. Sairam, Pearson
3. Steel Design by William T. Segui, Cengage Learning

| Subject Code | Course title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVPC6020 | **STRUCTURAL ANALYSIS II** | 3 | - | - | 3 | |

CEO-1- To understand the influence line concepts for indeterminate structures

CEO-2- To understand the methods of analysis of intermediate trusses for external loads, lack of fit and thermal effect

CEO-3- To study behaviour of arches and their methods of analysis

CEO-4- To know the concept and analysis of cable stayed bridge

CEO-5- To study the multi storey frames subjected to gravity loads and lateral loads

Pre-Requisites (If any) –

Course Outcomes

| | |
|---|---|
| CO1 | An ability to apply knowledge of mathematics, science, and engineering to understand indeterminate structure |
| CO2 | An ability to identify, formulate and solve engineering problems using slope deflection method. |
| CO3 | An ability to identify, formulate and solve structural analysis problems involving analysis of two pinned arches. |
| CO4 | An ability to identify, formulate and solve structural analysis problems involving moving loads |
| CO5 | An ability to use the techniques, skills, and modern engineering tools like stiffness method necessary for engineering practice. |

**Unit:1** **(10 Hours)**

Analysis of continuous beams and plane frames by slope deflection method and moment distribution method, analysis of continuous beam and simple portals by Kani's method

**Unit:2** **(9 Hours)**

Analysis of two hinged and fixed arches for dead and live loads, Suspension cables with two hinged stiffening girders

**Unit:3** **(9 Hours)**

Matrix methods of analysis: flexibility and stiffness methods; Application to simple trusses and beams

**Unit:4** **(10 Hours)**

Plastic Analysis: Plastic modulus, shear factor, plastic moment of resistance, Load factor, Plastic analysis of continuous beam and simple rectangular portals, Application of upper bound and lower bound theorems

**Teaching Method(s):** Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

1. Structural analysis by C.S. Reddy McGraw Hill
2. Structural Analysis by T.S. Thandamoorthy, Oxford University Press
3. Structural analysis a matrix approach by Pandit& Gupta, McGraw Hill.

**Ref. Books**

1. Indeterminate Structures: J.S.Kinney
2. Indeterminate Structural Analysis: C.K.Wang ,McGraw Hill
3. Structural Analysis by D.S.PrakashRao, Universities Press

| Subject Code | Course Title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVPC6030 | **TRANSPORTATION ENGINEERING-II** | 3 | - | - | 3 | |

CEO-1- To know about the basics and design of various components of railway engineering

CEO-2- To study about the types and functions of track, junctions and railway stations

CEO-3- To learn about the aircraft characteristics, planning and components of airport

CEO-4- To study about the types and components of docks and harbours

CEO-5- To know about various urban transportation systems and Intelligent Transportation Systems

Pre-Requisites (If any) –

Course Outcomes

| | |
|---|---|
| CO1 | Differentiate the working of various transport systems and their working in different scenarios. |
| CO2 | Understanding the functions of various components in Rail, Air, Water transport systems and their importance. |
| CO3 | Have a in depth knowledge on curve sections super elevations and many other design elements |
| CO4 | Prepare master plans for Airports, harbor site considering natural phenomenon and different harbor railway airport elements |
| CO5 | Predict the upcoming trends and changes which are likely to take place in transport and travel modes. |

**Unit:1** **(10 Hours)**

History of Indian railways, component parts of railway track, problems of multi gauge system, coning of wheels, alignments and survey, permanent way track components , Type of rail sections ,creep of rails, wear and failure in rails , Ballast requirements, sleeper requirements, types of sleepers, various train resistances

**Unit:2** **(8 Hours)**

Geometric design: Gradients and grade compensation, various speeds on a railway track, super elevation, horizontal and vertical curves, Points and crossings, Design of simple turn-out, Signaling and interlocking,

**Unit:3** **(10 Hours)**

Airport site selection, Air craft characteristics, various surface of an airport, Wind rose diagram, Geometric elements of run way and taxiway , holding apron, parking configuration , terminal building , visual aids, air traffic control, airport marking and lighting.

**Unit:4** **(8 Hours)**

Harbor Engineering: Classification of Harbor basin, general layout of harbors, Docks, Different components of docks.

**Teaching Method(s):** Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

1. Air-port Engineering by S.K.Khanna and M.G.Arora

**Ref. Books**

1. A text book of railway engineering , By S.C.Saxena and M.G.Arora
2. Railway Engineering by Satish Chandra & MM Agrawal, Oxford University Press.

| Subject Code | Course title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVPE6041 | **WATER SUPPLY & SANITARY ENGINEERING** | | | | | |

CEO-1- To make the students conversant with sources and its demand of water

CEO-2- To understand the basic characteristics of water and its determination

CEO-3- To expose the students to understand the design of water supply lines

CEO-4- To provide adequate knowledge about the water treatment processes and its design

CEO-5- To have adequate knowledge on operation and maintenance of water supply

Pre-Requisites (If any) –

Course Outcomes

| | |
|---|---|
| CO1 | Select appropriate treatment toraw water useful for domestic aswell as construction purpose. |
| CO2 | Maintain the pipe-network for water supply and Sewage disposal effectively. |
| CO3 | Calculate and Estimate the impurities present in water used for domestic as well as constructionworks. |
| CO4 | Prepare lay out plan and maintain water distribution and sewer-networks. |
| CO5 | Plan and implement house plumbing work effectively. |

**Unit:1** **(10 Hours)**

General requirement for water supply, sources, quality of water, intake, pumping and transportation of water. Physical, chemical and biological characteristics of water and their significance, water quality criteria, water borne diseases, natural purification of water sources.

**Unit:2** **(9 Hours)**

Engineered systems for water treatment: aeration, sedimentation, softening coagulation, filtration, adsorption, ion exchange, and disinfection. Design of water distribution system.

**Unit:3** **(9 Hours)**

Generation and collection of waste water, sanitary, storm and combined sewerage systems, quantities of sanitary waste and storm water, design of sewerage system ,Primary, secondary and tertiary treatment of wastewater. Waste water disposal standards.

**Unit:4** **(10 Hours)**

Basic of microbiology. Biological wastewater treatment system : Aerobic processes activated sludge process and its modifications, trickling filter, RBC, Anaerobic Processes conventional anaerobic digester, High rate and hybrid anaerobic reactors, Sludge digestion and handling, Disposal of effluent and sludge, Design problems on water distribution, sewerage, water treatment units, wastewater treatment units and sludge digestion.

**Teaching Method(s):** Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**


1. Water Supply Engineering-Environmental Engineering v.1 by S.K.Garg, Khanna Publishers
2. Sewage Disposal and Air Pollution Engineering - Environmental Engineering v.2 by S.K. Garg,Khanna Publishers
3. Water Supply and Sanitary Engineering by B.S.BirdiDhanpatRai Publishing Company


**Ref. Books**


1. Water Supply Engineering by B. C. Punmia and A.K.Jain, Laxmi Publications Water and Wastewater Technology by M.J. Hammer, PHI

| Subject Code | Course title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVPE6042 | **PREFABRICATED STRUCTURES** | 3 | - | - | 3 | |

CEO-1- To impart knowledge to students on modular construction, industrialized construction and design of prefabricated elements and construction methods.

Pre-Requisites (If any) –

Course Outcomes

| | |
|---|---|
| CO1 | Student will get the knowledge about the main processes of building constructions using prefabricated technology. |
| CO2 | In particular, will have knowledge regarding the types of prefabricated buildings (flat houses) construction, and will know the classification of these types of buildings. |
| CO3 | Student will also know the basic types of construction of prefabricated reinforced concrete, timber and steel structures (skeleton systems). |
| CO4 | He will have a basic knowledge of building technology applied in bridge structures using prefabricated technology (cantilever, methods of Prestressing reinforcement), and construction of underground structures using prefabrication (secondary segmental lining). |
| CO5 | The knowledge of types and technology of construction of wood-frame buildings will be the expected results also. |

**Unit:1** **(8 Hours)**

Need for prefabrication – Principles – Materials – Modular coordination – Standardization – Systems – Production – Transportation – Erection.

**Unit:2** **(10 Hours)**

Behaviour of structural components – Large panel constructions – Construction of roof and floor slabs – Wall panels – Columns – Shear walls

**Unit:3** **(10 Hours)**

Disuniting of structures- Design of cross section based on efficiency of material used – Problems in design because of joint flexibility – Allowance for joint deformation.

**Unit:4** **(8 Hours)**

Joints for different structural connections – Dimensions and detailing – Design of expansion joints

Teaching Method(s): Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

1. CBRI, Building materials and components, India, 1990
2. Gerostiza C.Z., Hendrikson C. and Rehat D.R., "Knowledge based process planning for construction and manufacturing", Academic Press Inc., 1994

**Ref. Books**

1. Koncz T., "Manual of precast concrete construction", Vol. I, II and III, Bauverlag, GMBH, 1976.
2. "Structural design manual", Precast concrete connection details, Society for the studies in the use of precast concrete, Netherland BetorVerlag, 2009

| Subject Code | Course title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVPE6043 | **PAVEMENT ENGINEERING** | 3 | - | - | 3 | |

CEO-1- To study the behaviour of pavements under various loads

CEO-2- To design the flexible and rigid pavements using different Empirical, semi-empirical and theoretical approaches

CEO-3- To understand the concept of Pavement Management System, pavement failures and its evaluation .

Pre-Requisites (If any) –

Course Outcomes

| | |
|---|---|
| CO1 | Characterize the response characteristics of soil, aggregate, asphalt, and asphalt mixes |
| CO2 | Analyze flexible pavements |
| CO3 | Analyze rigid pavements |
| CO4 | Design a flexible pavement using IRC, Asphalt Institute, and AASHTO methods |
| CO5 | Design a rigid pavement using IRC, and AASHTO methods |

**Unit:1** **(10 Hours)**

Introduction: Classification of pavements, Difference between highway and runway pavements, Factors affecting structural design, Characteristics of traffic loading, Concept of VDF and Computation of design traffic.

**Unit:2** **(10 Hours)**

Principles of pavement design: Concepts of structural and functional failures, Performance criteria; Analysis of pavements: ESWL, Analysis of flexible and concrete pavements.

**Unit:3** **(11 Hours)**

Design of pavements: IRC, AASHTO and other important methods of design of bituminous and concrete pavements.

**Unit:4** **(8 Hours)**

Pavement evaluation techniques: Benkelman beam, Falling weight deflect meter and other equipment's, Concepts of pavement maintenance management.

Teaching Method(s): Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

1. Pavement Analysis and Design, Y. H. Huang, Prantice Hall

**Ref. Books**

1. Principles of Pavement Design, E. J. Yoder & M.W. Witzack, John Wiley and Sons, New York.
2. Principles of Transportation Engineering, P. Chakroborty& A. Das, PHI Publication

| Subject Code | Course title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVOE6051 | **HOUSING PLANNING AND MANAGEMENT** | 3 | - | - | 3 | |
| Course Outcomes | | | | | | |
| Pre-Requisites (If any) – | | | | | | |
| CO1 | To understanding require knowledge of plan drawings | | | | | |
| CO2 | This knowledge will be useful to the student to planning to the buildings, as per the law and rules and regulations. | | | | | |
| CO3 | To know the approval of house building is to be base on the national policies and state level laws. | | | | | |
| CO4 | The students should have the knowledge to analyze the slum clearance project, to prepare plan for plot map cost flow . | | | | | |
| CO5 | Ability to analyze the types of Housing | | | | | |

**Unit:1** **(8 Hours)**

Definition of Basic Terms – House, Home, Household, Apartments, Multi storied Buildings, Special Buildings, Objectives and Strategies of National Housing Policies including Slum Housing Policy, Principle of Sustainable Housing – Integrated approach on arriving holding capacity and density norms - All basic infrastructure consideration - Institutions for Housing at National, State and Local levels.

**Unit:2** **(10 Hours)**

Basic Concepts, Contents and Standards for Housing Programs - Sites and Services, Neighborhoods- Plotted land development programs, Open Development Plots, Apartments, Gated communities, Townships, Rental Housing, Co-operative Housing, Slum Housing Programs – Slum improvement – Slum redevelopment and Relocation – Use of GIS and MIS in Slum Housing Projects,, Role of Public housing agencies, and Private sector in supply , quality, infrastructure and pricing – Role of Non-Government Organizations in slum housing.

**Unit:3** **(8 Hours )**

Formulation of Housing Projects – Land Use and Soil suitability analysis -Building Byelaws and Rules and Development Control Regulations - Site Analysis, Layout Design, Design of Housing Units (Design Problems) – Housing Project Formulation.

**Unit:4** **(8 Hours)**

New Constructions Techniques – Cost Effective Modern Materials and methods of Construction- Green building concept- Building Centers – Concept, Functions and Performance Evaluation. Evaluation of Housing Projects for sustainable principles – Housing Finance, Cost Recovery – Cash Flow Analysis, Subsidy and Cross Subsidy- Public Private Partnership Projects – Viability Gap Funding - Pricing o f Housing Units (Problems).

**Teaching Method(s)**: Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

1. Meera Mehta and Dinesh Mehta, "Metropolitan Housing Markets", Sage Publications Pvt. Ltd., New Delhi, 1999.
2. Francis Cherunilam and Odeyar D Heggade, "Housing in India", Himalaya Publishing House, Bombay, 1997.

**Ref. Books**

1. Wiley- Blackwell, "Neufert Architects" Data, 4th Edition, Blackwell Publishing Ltd, 2012
2. Donald Watson and Michael J.Crosbie, "Time Saver Standards for Architectural Design", 8th Edition, Tata McGraw Hill Edition, 2011

| Subject Code | Course title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVOE6052 | **GREEN BUILDING TECHNIQUES** | 3 | - | - | 3 | |

Course Outcomes

Pre-Requisites (If any) –

| | |
|---|---|
| CO1 | Identify and compare existing energy codes, green building codes and green rating systems |
| CO2 | Identify and compare cost and performance of building materials with recycled components, non-petroleum based materials, materials with low volatile organic compounds, materials with low embodied energy and salvaged materials and incorporate them into design. |
| CO3 | Identify and use construction materials and methods that more easily allow for salvage and re-use of building materials |
| CO4 | Perform demolition in ways that allow for salvage of re-usable building materials. |
| CO5 | Identify and make use of techniques for weatherization and sustainable remodeling of existing structures. |

**Unit:1** **(10 Hours)**

Fundamental Principles of Green Building, Introduction to high-performance green buildings, Conventional versus green building delivery systems - Design and construction relationships - Green building project execution - the integrated design process - green building documentation requirements - design versus ecological design - historical perspective - contemporary ecological design - future ecological design - green design to regenerative design.

**Unit:2** **(8 Hours)**

Sustainable sites Design and landscaping – enhancing ecosystems - building envelop – selection of green materials - products and practices - passive design strategy – internal load reduction – indoor environment quality strategies - Building energy system strategies – Water cycle strategies- building water and waste management – relevance to LEED / IGBC standards.

**Unit:3** **(10 Hours)**

Site protection planning - health and safety planning - construction and demolition waste management - reducing the footprint of construction operations - maximizing the value of building commissioning in HVAC System, lighting and non mechanical Systems - costs and benefits relevance to LEED / IGBC standards.

**Unit:4** **(10 Hours)**

Methods and tools for building assessment- USGBC LEED building assessment standard - LEED certification process – Green Globes building assessment protocol- international building assessment systems - LEED-NC Platinum / gold / silver building case studies – trends in building rating systems – IGBC standards – ECBC compliances. Florida Green Building Coalition. Future directions in green high performance building technologies- Carbon accounting-Green Building specifications. Business case for high-performance green buildings - the economics of green building - benefits - managing initial costs - cost barrier in project management – long term environment benefits.

**Teaching Method(s):** Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

1. Jerry Yudelson, Green building A to Z, Understanding the buildings, 2008.
2. Green building guidelines: Meeting the demand for low-energy, resource efficient homes. Washington, D.C.: Sustainable Buildings Industry Council, 2004.

**Ref. Books**

1. Jerry Yudelson, Green Building through Integrated Design, McGraw Hill, 2008
2. Alex Wilson and Mark Peipkorn., Green Building Products: the GreenSpec guide to residential building materials, 2nd Edition, Gabriola Island, BC:

| Subject Code | Course title | L | T | P | C | QP |
|---|---|---|---|---|---|---|
| BCVOE6053 | **AIR & NOISE POLLUTION** | 3 | - | - | 3 | |

Course Outcomes

Pre-Requisites (If any) –

| | |
|---|---|
| CO1 | Identify sampling and analysis techniques for air quality assessment |
| CO2 | Describe the plume behavior for atmospheric stability conditions |
| CO3 | Apply plume dispersion modeling and assess the concentrations |
| CO4 | Design air pollution controlling devices |
| CO5 | Ability to understand the behavior of air pollution characteristics |

**Unit:1** **(8Hours)**

Classification of air pollutants – Particulates and gaseous pollutants – Sources of air pollution – Source inventory – Effects of air pollution on human beings, materials, vegetation, animals – global warming-ozone layer depletion, Sampling and Analysis – Basic Principles of Sampling – Source and ambient sampling – Analysis of pollutants – Principles.

**Unit:2** **(10 Hours)**

Elements of atmosphere – Meteorological factors – Wind roses – Lapse rate – Atmospheric stability and turbulence – Plume rise – Dispersion of pollutants – Dispersion models – Applications.

**Unit:3** **(10 Hours)**

Concepts of control – Principles and design of control measures – Particulates control by gravitational, centrifugal, filtration, scrubbing, electrostatic precipitation – Selection criteria for equipment - gaseous pollutant control by adsorption, absorption, condensation, combustion – Pollution control for specific major industries.

**Unit:4** **(8 Hours)**

Air quality standards – Air quality monitoring – Preventive measures - Air pollution control efforts – Zoning – Town planning regulation of new industries – Legislation and enforcement – Environmental Impact Assessment and Air quality .Sources of noise pollution – Effects – Assessment - Standards – Control methods – Prevention

**Teaching Method(s):** Chalk & Board/ PPT/Video Lectures/ MOOC/ Internship/Industry Guest Lecture/ Invited Guest lecture/ Demonstration. etc.(can be chosen one or many)

**Text Books**

1. Anjaneyulu, D., “Air Pollution and Control Technologies”, Allied Publishers, Mumbai, 2002.
2. Rao, C.S. Environmental Pollution Control Engineering, Wiley Eastern Ltd., New Delhi, 1996.

**Ref. Books**

1. Heumann. W.L., "Industrial Air Pollution Control Systems", McGraw Hill, New Yark, 1997.
2. Mahajan S.P., "Pollution Control in Process Industries", Tata McGraw Hill Publishing Company, New Delhi, 1991.