B.E. (Civil Engineering)

Curriculum Syllabus

2015 – 19 Batch

(2015-16 Admission)

3rd Semester

Course Title: Building Technology and Services		**Course Code: 15ECVC201**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Building Materials

Introduction. Properties of building stones, Clay products, Bricks and tiles; Timber, Plywood, Allied products, Plastics and glass, Paints, Steel, Gypsum and Allied products, Adhesives. **08 hrs**

2. Types of Foundations

Preliminary investigations of soil, Presumptive bearing capacity of soils, Masonry footings, Isolated footings, Grillage footings, Strap footings, Raft foundations, Pile foundations. **05 hrs**

Unit II

3. Stone and Brick Masonry

Rubble masonry, Ashlar masonry, Bonds in brick work (English and Flemish bond). Load bearing and partition walls. Damp proof construction. **03 hrs**

4. Floors and Roofs **03 hrs**

Types of flooring (Materials and method of laying), Granolithic, Mosaic, Ceramic, Marble, Polished Granite, Industrial flooring. Flat Roof (R.C.C.), Sloped roof (R.C.C. and Tile roof), Lean to roof, Steel trusses, Water and Weather proof course.

6. Stairs, Doors and Windows **05 hrs**

Types (Classifications) and Technical terms in stairs, Requirements of a good stair. Geometric Design of RCC Dog Legged and open well stairs. (Plan and sectional elevation of stairs) Paneled doors, Glazed doors, Flush doors, Collapsible and rolling shutters, Louvered doors, Revolving, sliding and swing doors, Windows, Types, Paneled, Glazed, Bat window, Dormer window, Louvered and corner window, Ventilators

Unit III

7. Plastering and Painting

Purpose of Plastering, Materials of plastering, Lime mortar, Cement Mortar, Methods of plastering, Stucco plastering, Lath plastering, Purpose of Painting, Distemper, Plastic emulsion, Enamel, Powder coated painting to walls and iron and steel surfaces, Polishing of wood surface. **03 hrs**

8. Introduction to cost effective construction and services

Necessity, Advantages, Pre fabrication techniques, Pre cast doors and windows (Pre cast frames and shutters), Alternative Building Materials, Hollow concrete blocks, Stabilized mud blocks, Micro concrete tiles, Precast roofing elements. Water supply and sanitation. Electricity illuminated. Modern services & Air condition **03 hrs**

Text Books

1. Bhavikatti S.S., *Materials of Construction, Vol-1*, I.K. International Pvt. Ltd., New Delhi, 2013
2. Bhavikatti S.S., *Materials of Construction, Vol-II*, I.K. International Pvt. Ltd., New Delhi, 2014.
3. Punmia, B.C., Jain A.K., *Building Construction*, 10ed., Lakshmi Publications, New Delhi, 2008.
4. Rai, M. and Jai Sing, *Advanced Building Materials and Construction*, CBRI Publications, Roorkee, 2014
5. Rangwala, S.C., *Building Construction*, 31st Edition Charotar Publishing House, Anand, India, 2014.
6. Sushilkumar, *Building Construction*, 20ed., Standard Publisher and Distributors, Delhi, 2014.

Reference Books:

1. Arora, S.P. and Bindra, S.P., *A Text Book of Building Construction Technology*, Dhanapat Rai Publications (P) Ltd., New Delhi, 2014.
2. Bhavikatti S.S., Chitawadagi M.V., *Building Planning and Drawing*, IK International Publishing House Pvt. Ltd., New Delhi., 2014
3. Jagadeesh, K.S., Venkatarama Reddy B.V. and Nanjunda Rao K.S., *Alternative Building Materials and Technologies*, New Age International (P) Ltd., New Delhi, 2007.

Course Title: Surveying		**Course Code: 15ECVC202**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4 Hrs / week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Overview and Measurement of directions **05 hrs**

Basic principle of surveying, classification of surveys Measurement of distance: chain surveying Methods of measurements: Direct and indirect chain and their types, tapes and their types, Ranging – direct and indirect, errors in chain surveying and tape corrections.

Compass surveying prismatic and surveyor's compass, bearing and their types. Calculation of included angles from bearings. Corrections to measured bearings – local attraction. Plottng a traverse, closing error and its adjustment by Bowditch's rule. Traverse computations – Latitude and departure (omitted measurements).

2. Measurement of elevations and contouring **09 hrs**

Levelling terms used in levelling, Types of levelling instruments viz Dumpy level, Auto level, electronic or digital level and their temporary adjustments, taking observations.

Methods of calculating reduced levels – HI method and rise and fall method.

Types of leveling curvature and refraction correction, sensitiveness of bubble tube.

Contours and contouring, characteristics of contours, contour interval, Contouring methods – Direct and indirect. Interpolation of contours. Preparation of contour maps. Uses of contour maps.

Plane table surveying: Methods of plane tabling, Two point problem, Three point problem. Merits and demerits of plane tabling.

3. Theodolite surveying and Trigonometric levelling 06 hrs

Theodolite surveying, terminologies used in theodolite, parts of a vernier theodolite, temporary adjustments. Measurement of horizontal angle, vertical angle and other theodolite applications. Theodolite traversing, locating landscape details. Fundamental lines of a theodolite and their desired relationships, errors, precision, upkeep and maintenance of theodolites.

Basic principles, calculation of heights and distances when instrument stations and object in SAME vertical plane (single plane method) and when instrument stations and object NOT in same vertical plane (double plane method).

Unit II

4. Tacheometric Surveying **04 hrs**

Basic principle of stadia tacheometry; tacheometric equations for horizontal line of sight, inclined line of sight (LOS), when staff vertical to LOS and when staff normal to LOS; Anallactic lens, tangential method of tacheometry, subtense bar, and Beaman's stadia arc; determination of tacheometric constants.

5. Curve surveying **08 hrs**

Types of curves, circular curve-terminologies, elements of a simple curve, methods of setting out simple curve- linear method, angular method; compound curves- elements of a compound curve, setting out of compound curve; Reverse curve-element of elements of a reverse curve, setting out of reverse curve; Transition curve- requirements of a transition curve, elements of transition curve, setting out of transition and composite curve;

6. Modern Surveying Instruments: Theodolite, EDM and Total Station **08 hrs**

Modern theodolites- micro-optic theodolites, electronic theodolites, digital theodolites

Electromagnetic spectrum radar, electromagnetic distance measurement (EDM), EDM equipment- geodimeter, tellurometer, mekenometer, distomat. Corrections to measurements; Total station- principles and working, temporary adjustments, application- angle measurement, distance measurement (horizontal, vertical and slope); major function performed with total station, various types of total station (viz. Sokkia, Leica, Pentax, Nikon, South, etc)

Unit III

7. Areas and Volumes **03 hrs**

Computation of areas: Area from co-ordinates, latitude and departures, Mid-ordinate method, average ordinate method, Trapezodial rule, Simpson's rule, Area from digital planimeter.

Computation of volumes: Volumes from cross sections, Prismoidal formula, and Trapezoidal formula capacity of reservoirs volume of borrow pits, Mass-Haul diagram.

8. Construction surveying / setting out works: **03 hrs**

Prerequisites, instruments and methods.

Laying out buildings

Settingout of culverts

Settingout bridges – locating the centre line – locating bridge piers

Settingout tunnels – Transferring alignment, Transferring bench marks or levels

Setting out Sewer lines

9. Modern methods of Surveying **04 hrs**

Satellite based positioning system, Global Positioning System (GPS), basic principals of GPS, satellite configuration, positioning using satellite signals, GPS receivers;Functions of GPS- determining position, navigation, tracking, mapping,

precise time determination; Application in survey- surveying with GPS, surveying with hand held GPS; Introduction to GIS- Geographic Information System, definition of GIS, component of GIS, hardware for GIS, software for GIS, data, users, features of GIS, GIS subsystems, data acquisition, data processing and analysis, communication, management of GIS, GIS capabilities, operations of GIS, Applications of GIS. Introduction and applications of LIDAR.

Text Books

1. Alak, D., *Plane Surveying*, S. Chand & Co., 2000.
2. Bhavikatti S.S., *Surveying and Leveling Vol-I & II,* I.K. International Publishers, 2008.
3. Chandra, A.M., *Higher Surveying*, 3ed. New Age India Ltd. 2015.
4. Chandra, A.M., *Plane Surveying*, 3ed. New Age India Ltd. 2015.
5. Punmia, B.C., Jain, Ashok.K. Jain, Arun.K. *Surveying Vol. 1*, 11ed., Lakshmi Publishers, 2015.
6. Punmia, B.C., Jain, Ashok.K. Jain, Arun.K. *Surveying Vol. 2*, 15ed., Lakshmi Publishers, 2012.
7. Punmia, B.C., Jain, Ashok.K. Jain, Arun.K., *Surveying Vol. 3*, 15ed., Lakshmi Publishers, 2005.

Reference Books:

1. Anderson, J. M. and Mikhail E. M., *Introduction to Surveying, TMH, New York, 1985*
2. Basak, *Text Book of Surveying*, 2010
3. Duggal, S.K., *Text Book of Surveying*, 2013
4. Roy, S.K., *Fundamentals of Surveying*, Prentice Hall of India, 2010.

Course Title: Mechanics of Fluids **Course Code: 15ECVF201**

L-T-P: 4-0-0 **Credits: 4** **Contact Hours: 4 Hrs/ week**

ISA Marks: 50 **ESA Marks: 50** **Total Marks: 100**

Teaching Hours: 50 Hrs **Examination Duration: 3 Hrs**

Unit I

1. Fluid Properties and Classification of Fluid

Introduction, to fluid mechanics; Systems of units; Properties of fluid; Mass density; Specific Volume, Specific Weight, Relative density; Viscosity, Newton's law of viscosity, Newtonian and Non-Newtonian Fluids; Ideal and Real fluids; Compressibility; Vapour pressure; Surface tension; capillarity; Problems on above topics. **05 hrs**

2. Fluid Pressure and its Measurement

Definition of pressure, units and dimensions, pressure at a point, Pascal's law, Hydrostatic pressure law, Different types of pressures, Measurement of pressure- Classification- Simple manometers, Differential manometer and Micro Manometer **05 hrs**

3. Hydrostatics

05 hrs

Definition of total pressure, Center of pressure, Centroid; Centroidal depth, depth of center of pressure, Hydrostatic force on plane surface submerged horizontally, vertically and inclined inside a liquid; Hydrostatic force on submerged curved surface. Archimedes principle and centre of buoyancy

4. Kinematics of Fluids

05 hrs

Description of fluid flow, Lagrangian and Eulerian approaches. Classification of flow; Definition of path line, streamline, streak line, stream tube; Acceleration of flow in one dimensional flow; Derivation of continuity equation in differential form; Definition of velocity potential, stream functions, stream line, equipotential line; Relation between velocity potential and stream function; Laplace equation. Problem on above.

Unit II

5. Dynamics of Fluid Flow

Definitions, concept of inertia force and other forces causing motion; Derivation of Euler's equation and Bernoulli's equation with assumption and limitation; Problems on applications of Bernoulli's equation (with and without losses); Application of Bernoulli's equation on Venturimeter, Orificemeter, Pitot tube. Impulse- Momentum equation and its application on direct and oblique impact of a jet on a stationary flat plate, Direct impact on a moving plate. **10 hrs**

6. Flow through Pipes and open Channels **10 hrs**

Introduction; Reynolds number; Classification of flow; Definition of hydraulic gradient. energy gradient; Major and minor losses in pipe flow, Equation for head loss due to friction (Darcy's-Weishbach equation).Moody's diagram. Uniform flow in open channels, Geometric properties of Rectangular, Triangular, Trapezoidal and Circular channels. Chezy's equation, Manning's equation (theory and problems). Most economical open channels. Specific energy of flowing liquid and critical depth of flow, type of flows, hydraulic jump.

Unit III

7. Dimensional Analysis and Model Studies

Introduction, Systems of units, Dimensions of quantities, Dimensional Homogeneity of an equation. Analysis- Raleigh's method, Buckingham's Π theorem- problems. Model Studies, Similitude, Non-dimensional numbers: Froude models-Undistorted and Distorted models. Reynold's models **05 hrs**

8. Discharge Measurements

Flow through orifices; classification, hydraulic coefficients and their relationship, Flow through mouthpieces: classification, classification of notches and weirs, derivation of discharge equation for rectangular, triangular and trapezoidal notches or weirs, Cipolletti notch or weir, discharge over a broad crested weir, Ogee weir and submerged weir. **05 hrs**

Text Books

1. Arora, K. R., *Fluid Mechanics, Hydraulic and Hydraulics*, Standard Book House, New Delhi, 1993.
2. Bansal, R. K., *Fluid Mechanics and Hydraulic Machines*, 9ed. Lakshmi Publications, New Delhi, 2005.
3. Jain, A. K., *Fluid Mechanics*, Khanna Publications, New Delhi, 1998.
4. Modi, P.N. and Seth S.M., *Hydraulics and fluid mechanics*, 2ed., Standard book house, New Delhi, 2010.
5. Streeter, V.L. and Wylie, E. B., *Fluid Mechanics* , McGraw-Hill, London, 1998.
6. Ven Te Chow,Open Channel Hydraulics McGraw Hill,New York 1959.

Reference Books:

1. Daugherthy, R.L., Franzini, J.B., Finnemore, E.J. *Fluid Mechanics with Engineering Applications*, McGraw Hill, New York, 1985.
2. John, F. D., *Fluid Mechanics*, Pearson Education, India, 2002.
3. Modi, P.N. and Seth S.M., *Hydraulics and fluid mechanics*, 2ed., Standard book house, New Delhi, 2002.
4. Shames, I.H., *Mechanics of Fluids*, McGraw Hill, New York, 1992.

Course Title: Mechanics of Materials		**Course Code: 15ECVF202**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 3 Hrs**	

Unit I

1. Simple Stress and Strain **06 hrs**

Introduction, Properties of Materials, Stress, Strain, Hooke's law, Poisson's Ratio, Stress – Strain Diagram for structural steel and non ferrous materials, Principles of superposition, Total elongation of tapering bars of circular and rectangular cross sections. Elongation due to self – weight

2. Simple Stress and Strain continued… **06 hrs**

Composite section, Volumetric strain, expression for volumetric strain, Elastic constants, relationship among elastic constants, Thermal stresses (including thermal stresses in compound bars).

3. Bending moment and shear force in beams **06 hrs**

Introduction, Types of beams loadings and supports, Shearing force in beam, Bending moment, Sign convention, Relationship between loading, shear force and bending moment, Shear force and bending moment equations, SFD and BMD with salient values for cantilever beams, simply supported beams and overhanging beams considering point loads, UDL, UVL and Couple.

Unit II

4. Bending stress, shear stress in beams **06 hrs**

Introduction – Bending stress in beam, Assumptions in simple bending theory, Pure bending derivation of Bernoulli's equation, Modulus of rupture, section modulus, Flexural rigidity, Expression for horizontal shear stress in beam, Shear stress diagram for rectangular, symmetrical 'I' and 'T' section.

5. Deflection of beams **06 hrs**

Introduction – Definitions of slope, deflection, Elastic curve derivation of differential equation of flexure, Sign convention, Slope and deflection for standard loading classes using Macaulay's method for prismatic beams and overhanging beams subjected to point loads, UDL and Couple.

6. Columns and struts

Introduction – Short and long columns, Euler's theory on columns, Effective length, slenderness ration, radius of gyration, buckling load, Assumptions, derivations of Euler's Buckling load for different end conditions, Limitations of Euler's theory, Rankine's formula and problems. **06 hrs**

Analysis and sketching of various stresses in beams (2-D and 3-D) **02 hrs**

Unit III

7. Torsion of circular shafts **05 hrs**

Introduction – Pure torsion-torsion equation of circular shafts, Strength and stiffness, Torsional rigidity and polar modulus, Power transmitted by shaft of solid and hollow circular sections, Torsion of Rectangular shaft (only Explanar)

8. Compound stresses **07 hrs**

Introduction, Stress components on inclined planes, General two dimensional stress system, Principal planes and stresses, Mohr Circle, thin cylinders subjected to pressure, change in length, diameter and volume, Thick cylinders - Lame's equations (excluding compound cylinders).

Text Books:

1. Basavarajaiah, B.S. and Mahadevappa, P., *Strength of Materials*, 3ed., CBS Publishers, New Delhi, 2010.
2. Beer, F. and Johnston, R., *Mechanics of Materials*, 5ed., Tata Mac Graw Hill – 2007.
3. Bhavikatti, S.S., *Strength of Materials*, 3ed., Vikas Publishers, 2009
4. Hibbeler, R.C., *Mechanics of Materials*, 9ed., Pearson Education Ltd., 2014.
5. Punmia, B.C., Jain, A. and Jain, A., *Mechanics of Materials*, 10ed., Lakshmi Publications, New Delhi, 2013.
6. Stephen Crandall, Thomas Lardner, *An Introduction to the Mechanics of Solids* 3rd Ed., with SI Units, Tata McGraw Hill, 2007.

Reference Books:

1. Beer and Johnson, *Strength of Materials,* Tata McGraw-Hill Education, 2004.
2. James, M. Gere, *Mechanics of Materials*, 8ed., Thomson Learning, 2012.
3. Nash W.A., *Strength of Materials*, 4ed., Schaum's Outline Series, 2007
4. Popov E.P., *Engineering Mechanics of Solids,* PHI, 2012.
5. Singer Harper, *Strength of Materials*, Row Publications, 2007.

Course Title: Survey Practice - I **Course Code: 15ECVP201**

L-T-P: 0-0-1 **Credits: 1** **Contact Hours: 2 Hrs / Week**

ISA Marks: 80 **ESA Marks: 20** **Total Marks: 100**

Teaching Hours: 30 **Examination Duration: 3 Hrs**

1. a)To measure distance between two points using direct ranging

   b) To set out perpendiculars at various points on given line using cross staff, optical square and tape.
2. Setting out of rectangle, pentagon, hexagon using chain and tape only
3. To set out rectangle, hexagon, pentagon using chain, tape and compass.
4. To determine the distance between two inaccessible points using chain & compass.
5. To locate points using radiation & intersection method of plane tabling
6. To determine difference in elevation between two points using fly leveling technique & to conduct fly back leveling using HI & Rise & Fall methods.
7. To determine difference in elevation between two points using reciprocal leveling & determine the collimination error.
8. To conduct profile leveling for water supply / sewage line & to draw the longitudinal section to determine the depth of cut & depth of filling for a given formation level.
9. To solve 3-point problem in plane tabling using Bessel's graphical solution
10. To locate the Contours by Direct contouring
11. To locate the Contours by Indirect contouring
12. Use of planimeter and demonstration of minor instruments like clinometer, hand level, box sextant.

Text Books

Reference Books:

1. Bhavikatti S.S., *Surveying and Leveling Vol-I & II,* I.K. International Publishers, 2008.
2. Punmia, B.C., Jain, Ashok.K., Jain, Arun.K., *Surveying Vol. l & 2*, 15ed., Lakshmi Publishers, 2005.

Course Title: Building Engineering Drawing		**Course Code: 15ECVP202**
L-T-P: 0-0-2	**Credits: 2**	**Contact Hours: 4 Hrs/ week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 40 Hrs	**Examination Duration: 3 Hrs**	

Unit I

1. To prepare working drawing of components of building i) Stepped wall footing and isolated RCC column footing, ii) Fully paneled and flush doors, iii) Half paneled and half-glazed window, iv) RCC dog legged and open well stairs, v) Steel truss **10 hrs**

2. Functional design of building (Residential, Public and Industrial), positioning of various components of building, orientation of building, building standards, bye laws, set back distances and calculation of carpet area, plinth area and floor area ratio. **03 hrs**

3. Development of plan, elevation, section and schedule of openings from the given line diagram of residential buildings, i) Two bed room building, ii) G +1 storey buildings (Two Drawings will be done by using ZWCAD) **18 hrs**

Unit II

4. Functional design of building using inter connectivity diagrams, development of line diagram only for Residential and Office building (One Drawing will be done by using ZWCAD) **05 hrs**

5. Line diagram of water supply, sanitary and electrical layouts (One Drawing will be done by using ZWCAD) **04 hrs**

Text Books

1. Bethune, J. D., *Engineering Graphics with Auto CAD* 3ed., Pearson Education Publishers, 1998.
2. Chandra, A.M and Chandra, S., *Engineering Graphics with Auto CAD*, 2ed., Pearson Education Publishers, 2004.
3. Gurcharan Singh., *Civil Engineering Drawing*, 5ed., Standard Publishers Distributors Nai Sarak, Delhi, 1998.
4. National Building Code of India 2005, Bureau of Indian Standards, Manak Bhavan, 9 Bahadur Shah Zafar Marg, Newdelhi-110028
5. Shah, M.H and Kale, C.M, *Building Drawing*, Tata Mc Graw Hill Publishing Co. Ltd., New Delhi, 2002.

4th Semester

Course Title: Structural Analysis-I **Course Code: 15ECVC203**

L-T-P: 3-0-0 **Credits: 3** **Contact Hours: 3 Hrs/ week**

ISA Marks: 50 **ESA Marks: 50** **Total Marks: 100**

Teaching Hours: 40 Hrs **Examination Duration: 3 Hrs**

Unit I

1. Structural Systems

Forms of structures, Conditions of equilibrium, Degree of freedom, Linear and Non linear structures, one, two, three dimensional structural systems, Static and Kinematics determinate and indeterminate structures. Structural Symmetry **04 hrs**

2. Plane Trusses

Introduction, Assumptions, Analysis by method of joints, Analysis by method of sections. **06 hrs**

3. Deflection of Beams **07 hrs**

Moment area method, Conjugate beam method, Deflection of beams.

Unit II

4. Strain Energy

Strain energy and complimentary strain energy, Strain energy due to axial load, bending and shear, Principle of virtual work, The first theorem of Castigliano, Betti's law, Clarke - Maxwell's theorem of reciprocal deflection, Problems on beams and trusses. **08 hrs**

5. Arches and cables **07 hrs**

Three hinged circular and parabolic arches with supports at same levels and different levels. Determination of thrust, shear and bending moment, Analysis of cables under point loads and UDL, length of cables - Supports at same levels and at different levels.

Unit III

6. Influence Lines Diagrams

Influence line diagrams for simply supported, cantilever and over hanging beams, Influence line diagrams for girders supporting floor beams, Use of Influence line diagrams, Maximum S.F. and B.M. values due to moving loads. **08 hrs**

Text Books

1. Bhavikatti, S. S., *Structural Analysis-I*, Vikas Publishing House Pvt. Ltd., New Delhi, 2003.
2. Punmia, B. C. and Jain, A. K., *Strength of Materials and Theory of Structures*,

Vol. I & II, Laxmi Publication, New Delhi, 2000.

3. Reddy, C. S., *Basic Structural Analysis*, 2ed., Tata McGraw- Hill Publishing Company, New Delhi, 2007.

Reference Books:

1. Noris, C.H. and Wilber, J., *Elementary Structural Analysis*, 4ed., McGraw- Hill Book Company, 2003.
2. Pandit, G. S., Gupta, S. P. and Gupta, R., *Theory of Structures*, Vol. I, Tata McGraw- Hill Publishing Company, New Delhi, 1999.
3. Prakash Rao D. S., *Structural Analysis, A unified approach*, 1ed., University Press Limited, Hyderabad, 1996.
4. Ramamruthum, S. and Narayan, R., *Theory of Structures*, Dhanpat Rai Publishing Company, New Delhi, 1998.
5. Timoshenko, S. P. and Young, D. H., *Theory of Structures*, McGraw- Hill Book Company, New York, 1965.

Course Title: Environmental Engineering **Course Code: 15ECVC204**

L-T-P: 4-0-0 **Credits: 4** **Contact Hours: 4 Hrs/ week**

ISA Marks: 50 **ESA Marks: 50** **Total Marks: 100**

Teaching Hours: 50 Hrs **Examination Duration: 3 Hrs**

Unit I

1. Demand and conveyance of water

Human activities and environmental pollution need for protected water supply. Types of water demands, population forecasting- arithmetical, geometrical, incremental increase and simple graphical method. Surface and subsurface sources Intake structures. Design of the economical diameter of the rising main, **06 hrs**

2. Quality of Water

Concept of safe wholesome and palatability of water, Sampling of water, Examination of Water–Physical, chemical and Biological Examinations. Drinking water standards BIS & WHO guidelines. Health significance of Fluoride, Nitrates and heavy metals like Mercury, Cadmium, Arsenic etc **04hrs**

3.Water Treatment

Treatment flow-charts. Aeration- Principles, types of Aerators. Sedimentation aided Coagulant, design, jar test, Theory of filtration, slow sand, rapid sand and pressure filters, design – excluding under drainage system .Theory of disinfection, types of disinfection. **10 hrs**

Unit II

4.Miscellaneous Treatment and Distribution of Water

Softening methods of removal of hardness by lime soda process and zeolite process. Adsorption technique, reverse osmosis technique, fluoridation and defluoridation. **05 hrs**

System of supply, service reservoirs and their capacity determination, methods of layout of distribution systems. Valves in pipe network and type of fire hydrants.

5. Sewerage systems

Types of sewerage systems. DWF, estimation of storm flow, design of storm water drain. Design of sewers - self cleansing and non-scouring velocities. Design of hydraulic elements for circular sewers flowing full and flowing partially full **05 hrs**

6. Sewage characteristics **03 hrs**

Physical, Chemical and Biological characteristics, CNS cycle. BOD and COD their significance

7. Disposal of Sewage **03 hrs**

Self-purification phenomenon, Zones of purification, Oxygen sag curve. Sewage sickness Sewage farming. Numerical Problems on Disposal of Effluents using Streeter Phelps equation.

8. Sewage Treatment **03 hrs**

Flow diagram of municipal waste water treatment plant. Preliminary & Primary treatment: Screening, grit chambers, primary sedimentation tanks – Design.

Unit III

9.Secondary treatment **09 hrs**

Theory and design of biological unit operation- Trickling filter and Activated sludge process and its modifications.
Miscellaneous treatment – Oxidation pond – design, concepts of UASB, RBC and sequential batch reactor.

10.Sludge Disposal **02 hrs**

Digestion of sludge, Sludge drying beds.

Text Books

1. Birdie, G.S., *Water Supply and Sanitary Engineering*, Dhanpath Rai and Son Publishers, New Delhi, 2003
2. *CPHEEO: Manual on water supply and treatment*, Ministry of Urban Development
3. Garg, S.K., *Sewage disposal and Air Pollution Engg*., Khanna Publishers, 2003.
4. Garg, S.K., *Water supply Engineering*, 7ed., Khanna Publishers, New Delhi, 2005.
5. Modi, P.N., *Sewage Treatment and Disposal Engg.,* 15ed., Std. Book House, New Delhi, 2015.
6. Punima, B. C., and Jain Ashok, *Environmental Engineering-I,* 2ed., Laxmi Publications, New Delhi., 2008
7. Punmia, B. C., Jain Ashok K and Arun Kumar Jain, *Wastewater Engineering*, Laxmi Publications, New Delhi, 2016.

Reference Books:

1. AWWA, *Standard Methods Examination of Water and Wastewater*, Water Environment Federation, 2004
2. Clair N. Sawyer and L. Perry McCarty, Parkin, G. F., *Chemistry for Environmental Engineers*, McGraw-Hill, 2004
3. Davis, M.L. and Cornwell, D.A., *Introduction to Environmental Engineering*, Tata McGraw Hill. 2010
4. Fair, G.M., Geyer J.C., Okan D.A., *Elements of Water Supply and Wastewater Disposal*, John Wiley and Sons Inc. 2000
5. Hammer M.J., *Water and Waste Water Technology*, John Wiley and Sons, New York , 2000

6. Howard S. Peavy, Donald R. Rowe, George Techno Bano Glous, *Environmental Engineering*, McGraw Hill International, 1995.
7. IS:10500-2012,Drinking water- Specification
8. Metcalf & Eddy, *Wastewater Treatment Engg. & Reuse*, Tata McGraw Hill Publications, 2003.
9. *Ministry of Urban Development, Manual on Waste Water Treatment - CPHEEO*, New Delhi.
10. Srinivasan, D., *Environmental Engineering*, PHI Learning Pvt. Ltd., New Delhi, 2008.
11. W.K. Berry, *Water Pollution*, CBS Publishers Pvt. Ltd ,New Delhi, 2016

Course Title: Concrete Technology **Course Code: 15ECVC205**

L-T-P: 3-0-0 **Credits: 3** **Contact Hours: 3 Hrs /Week**

ISA Marks: 50 **ESA Marks: 50** **Total Marks: 100**

Teaching Hours: 40 Hrs **Examination Duration: 3 Hrs**

Unit I

1. Concrete Ingredients

08 hrs

Cement, Chemical composition, hydration of cement, Types of cement, manufacture of OPC by wet and dry process. Testing of cement - Field testing, Fineness by sieve test and Blame's air permeability test, Normal consistency, setting time, soundness. Compression strength of cement and grades of cement, quality of mixing water. Fine aggregate - grading, analysis, Specific gravity, bulking, moisture content, deleterious materials. Coarse aggregate - Importance of size, shape and texture. Grading of aggregates - Sieve analysis, specific gravity. Flakiness and elongation index, crushing, impact and abrasion tests.

2. Fresh concrete

08 hrs

Workability - factors affecting workability, Measurement of workability - slump, flow tests. Compaction factor and vee-bee consistometer tests. Segregation and bleeding. Process of manufacture of concrete: Batching, Mixing, Transporting, Placing, Compaction, Curing. Chemical admixtures-plasticizers, accelerators, retarders and air entraining agents. Mineral admixtures - Fly ash, Silica fume and rice husk ash.

Unit II

3. Hardened concrete

10 hrs

Factors affecting strength, w/c ratio, gel/space ratio, maturity concept. Effect of aggregate properties, relation between and compressive strength, and tensile strength, bond strength, modulus of rupture. Accelerated curing. Elasticity - Relation between modulus of elasticity and strength, factors affecting modulus of elasticity, Poisson ratio. Shrinkage - plastic shrinkage and drying shrinkage, factors affecting shrinkage, Creep - Measurement of creep, factors affecting creep, effect of creep. Durability - definition, significance, permeability, sulphate attack. Chloride attack, carbonation, freezing and thawing. Factors contributing to cracks in concrete settlement cracks, construction joints. Thermal expansion, Testing of hardened concrete - compressive strength, split tensile strength. Flexural strength, factors influencing strength test results

4. Concrete Mix design **06 hrs**

Concept of Mix design, variables in proportioning exposure conditions. Procedure of mix design as per IS 10262-2009,Numerical examples of Mix design

Unit III

5. Special concretes and concreting methods

Constituents, properties and applications: of Light weight concrete, High density concrete, High strength and high performance concrete, Self Compacting Concrete, Fiber reinforced concrete and Ready mixed concrete. Ferro cement - Constituents, properties and applications. Guniting and shotcreting **04 hrs**

6. Non destructive testing of concrete

Principles, applications and limitation of Rebound hammer lest and Ultrasonic pulse velocity test, interpretation of test values. Profometer - Principles, applications and limitations **04 hrs**

Text Books

1. Shetty M.S., Concrete technology - Theory and practice, 1ed., S.Chand and company, New Delhi, 2008

Reference Books:

1. Gambhir, M.L, Concrete manual, 4ed , Dhanpat Rai & Sons, 2005
2. IS-10262-2007, Recommend guidelines for concrete mix.
3. IS-383:1970, specifications for Concrete mix aggregates from natural resources for concrete (second revision).
4. P. Kumar Mehta, Paulo J. M. Monteiro,- Concrete: Microstructure, Properties, and Material McGraw Hill publications, 2013

Course Title: Construction Project Management		**Course Code: 15ECVC206**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3Hrs / Week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40 Hrs	**Examination Duration: 3 Hrs**	

Unit I

1 Introduction to Construction Project Management

Phases of construction project, importance of construction and construction industry, Indian construction Industry, Construction project management and its relevance, stakeholders of a construction project. **04 hrs**

2 Drawings and Specifications **05 hrs**

Types of Drawings-Architectural and Structural, Study of Scales Used, sequence of dimensioning, dimension lines and figures, Importance of Specifications, General specifications of 1st, 2nd, 3rd and 4th Class building, Detailed specifications of a typical building. Scope definition using drawings and specifications.

3 Work Breakdown Structure

Concept of WBS, Common usage of terms, Preparing a WBS, Factors to be considered, WBS measurement considerations, Challenges to be considered, WBS level of Detail, WBS life-cycle considerations, Project risk and the WBS, Resource planning and management with WBS, Problems – Detailed WBS of a residential building. **06 hrs**

Unit II

4 Project Management through Networks

Introduction, project feasibility, planning methods of projects– Objectives, planning stages. Scheduling, Bar charts and mile stone charts. Introduction, Terms & definitions, Elements of network, types of network, drawing the network. CPM – Event times, Activity times, floats, critical activity and critical path. Problems. PERT – Introduction, time estimates, expected time, earliest expected time, latest allowable occurrence time, slack, critical path. Probability of completing the project. Problems. Updating of network. Problems. Contraction of network. Problems. Resource Allocation. Problems (Resource smoothening and resource levelling). **11 hrs**

5 Construction Safety Management **06 hrs**

Introduction, evolution of safety, Accident causation theories, unsafe conditions and acts, health and safety act and regulations, role of safety personal, causes of accidents, principles of safety, safety and health management system.

Unit III

6 Construction Equipment

Introduction, standard and special equipment, factor for selecting equipment, cost of owning and operating, economic life of an equipment. Earth moving equipment (Bull Dozers, Scrapers, Loaders and Excavators). Hoisting equipment, concrete mixer and plants, conveyors and rollers, trenching machines, equipment for highway construction. Live projects for course project. **08 hrs**

Text Books

1. Kumar Neeraj Jha, Construction Project Management: Theory and Practice, 2nd Edition, Pearson Publications, 2015.

Reference Books:

1. Robert. L Peurifoy and William B. Ledbetter, Construction planning and Equipment& methods, Mc. Graw Hill Publication, 3rd edition, 2010.
2. Verma Mahesh, Construction planning and Management, Metropolitan Book co. Delhi, 1982.

Course Title: Hydrology & Irrigation Engineering **Course Code: 15ECVC207**

L-T-P: 3-0-0 **Credits: 3** **Contact Hours: 3Hrs / Week**

ISA Marks: 50 **ESA Marks: 50** **Total Marks: 100**

Teaching Hours: 40 Hrs **Examination Duration: 3 Hrs**

Unit I

1. Introduction & Precipitation

Introduction, Hydrologic cycle (Horton's representation). Water budget equation Precipitation: introduction, forms of precipitation, types of precipitation, measurement of precipitation (Simon's gauge & Syphon gauge only), selection of rain gauge station. Adequacy of rain gauges, methods of computing average rainfall ,interpolation of missing data, adjustment of missing data by double mass curve method. Hyetograph and mass curve of rainfall. **05 hrs**

2. Losses From Precipitation

Evaporation: Definition, factors affecting, measurement (Class A pan). Estimation using empirical methods (Meyer's and Rohwer's equation). Evapo-transpiration: Definition, factors affecting, measurement, estimation (Blaney criddle method) Infiltration: Definition, factors affecting, measurement (double ring infiltrometer), infiltration indices, Horton's equation of infiltration. Runoff and its estimation **04 hrs**

3.Hydrographs **04 hrs**

Definition. Components of Hydrograph. Base flow separation, Unit hydrograph and its derivation from simple storm hydrographs, S – curve and its computation.

4. Reservoirs **03 hrs**

Definitions. Investigation for reservoir sites. Storage zones. Determination of storage capacity and yield of a reservoir using mass curve.

Unit II

5. Introduction

Definition. Benefits and ill effects of irrigation. Sources of water for irrigation. Systems of irrigation: Surface and ground water, flow irrigation, Lift irrigation, Bhandhara irrigation. Methods of applying water to crops in India – Potential and development **04 hrs**

6. Irrigation and Water Requirements of Crops **04 hrs**

Definition of duty, Delta and Base period, Relationship between Duty, Delta and Base period, Factors affecting duty of water. Crops and crop seasons in India, Crops Grown in Karnataka, their seasons, Irrigation efficiency, Frequency of irrigation, Definition of gross commanded area,

culturable commanded area, culturable cultivated area, etc.

7. Canals: **04 hrs**

Definition, Types of canals, Alignment of canals and Canal regulator. Design of canals by and Kennedy's and Lacey's methods- Problems. Cross drainage works: Classifications. Diversion Works definition, layout, types of weirs and Barrages. Design of Impermeable floors – Bligh's and Lane's theories – Simple design problems. Khosla's theory

8. Gravity Dams

Definition, Forces acting on a Gravity dam, Modes of failures, Elementary and practical profile, Low and high gravity dams, Stability analysis problems, Principle stresses, Drainage **04 Hrs**

9. Earthen Dams

Introduction. Types of earthen dams. Failure of earthen dams. Preliminary design. Drainage arrangements. Determination of Phreatic line.

04 hrs

9. Spillways

Definition. Types of Spillways. Design Principles for an Ogee Spillway. Energy dissipaters: Types and introduction to IS Stilling basins (No design problems). **04 hrs**

Text Books

1. H.M. Raghunath, *Hydrology*, New Age International (P) Ltd., Publication, New Delhi, 2004.
2. Jayarami Reddy, *A Text Book of Hydrology*, Lakshmi Publications, New Delhi, 2007.
3. Modi, P.N., *Irrigation, Water Resources, and Water Power Engineering*, Standard Book House, New Delhi, 2004.
4. Punmia, B.C. and Pande Lal, *Irrigation and Water Power Engineering*, Laxhmi Publications, New Delhi, 2000
5. Sharma, R.K., *Text Book of Irrigation Engineering and Hydraulic Structures*, S. Chand, New Delhi, 2002.
6. Subramanya K, *Engineering Hydrology*, 2ed., Tata McGraw Hill, New Delhi, 2005.

Reference Books:

1. Garg, S.K., Irrigation Engineering and Hydraulic Structures, Khanna Publications, New Delhi, 2005.
2. Linsley, Kohler and Paulhus, Applied Hydrology, Wiley Eastern Publication, New Delhi, 1988
3. Michael, A.M., Irrigation Theory and Practices, Vikas Publications, New Delhi, 2004.

4. R.K. Sharma and Sharma, Hydrology and Water Resources Engineering, Oxford and IBH, New Delhi, 2000.
5. Sahasra Budhe, Irrigation Engineering and Hydraulic Structures, Dhanpath Rai Publications, New Delh
6. Ven Te Chow, Hand Book of Hydrology, Tata McGraw Hill, New Delhi, 1964.

Course Title: Survey Practice - II **Course Code: 15ECVP204**

L-T-P: 0-0-1 **Credits: 1** **Contact Hours: 2 hr / week**

ISA Marks: 80 **ESA Marks: 20** **Total Marks: 100**

Teaching Hours: 30 **Examination Duration: 3Hrs**

1. Measurement of horizontal angles with method of repetition and reiteration using theodolite. Measurement of vertical angles using theodolite.
2. To determine the elevation of an object using single plane method when base is accessible and inaccessible.
3. To determine the distance and difference in elevation between two inaccessible points using double plane method.
4. To determine the tachometric constants a) using horizontal line of sight. b) Inclined line of sight.
5. To set out simple curves using linear methods perpendicular offsets from long chord.
6. To set out simple curves using linear methods by offsets from chords produced.
7. To set out simple curves using Rankine's deflection angles method.
8. To set out compound curve with angular methods with suing theodolite only
9. To set out reverse curve between two parallel line with angular methods with using theodolite only.
10. To set out the center line of a simple rectangular room using offset from base line
11. To set out the center line of columns of a building using two base lines at right angles
12. To determine height of a remote object, horizontal distance and coordinates of points using Total Station Instruments
13. Introduction to GPS

Text Books

Reference Books:

1. Bhavikatti S.S., *Surveying and Leveling Vol-I & II,* I.K. International Publishers, 2008.
2. BVB Lab Manual.
3. Punmia, B.C., Jain, Ashok.K., Jain, Arun.K., *Surveying Vol. l & 2*, 15ed., Lakshmi Publishers, 2005.

Course Title: Material Testing Lab **Course Code: 15ECVP205**

L-T-P: 0-0-2 **Credits: 2** **Contact Hours: 4 Hrs/ Week**

ISA Marks: 80 **ESA Marks: 20** **Total Marks: 100**

Teaching Hours: 40 Hrs **Examination Duration: 3 Hrs**

Unit I

Tests on cement and concrete

1. Standard consistency (Normal consistency) for different cements.
2. Setting times: for different cements.
3. Specific gravity of cement
4. Specific surface of cement by Blaine's air permeability apparatus: for different cements.
5. Compressive strength of cement: for different cements.
6. Soundness of cement
7. Durability of Concrete
8. Permeability of Concrete

Tests on green concrete

9. Workability of concrete by slump test, compaction factor test and Vee-Bee test.

Open end experiment - Concrete mix design

Mechanical properties of materials

1. Test on Bricks
2. Tension test on Mild steel and HYSD bars.
3. Compression test of Mild Steel, Cast Iron and HYSD.
4. Impact test on Mild Steel (Charpy & Izod)
5. Shear Test on Mild steel.
6. Hardness tests on ferrous and non-ferrous metals – Brinell's and Rockwell
7. Torsion test on Mild Steel circular sections
8. Bending Test on Wood Under two point loading
9. Non destructive Testing - Demonstration

Tests on hardened concrete

1. Compressive strength of cement concrete for mix 1:2:4 and 1:1.5:3.
2. Split tensile strength of cement concrete for mix 1:2:4 and 1:1.5:3
3. Modulus of rupture – 2 pt loading method

Note:

1. Casting of concrete cubes, cylinders and beams shall be done in

concrete lab and testing will be done in strength of material testing lab

2. All tests to be carried out as per relevant BIS Codes

Text Books

Reference Books:

For Concrete Lab:

1. For PPC - IS 1489:91 – I
1. For OPC 33 Grade cement - IS 269:1989 Soundness of cement
2. IS 4031-1996 (Part-I)
3. For OPC 43 Grade cement - IS 8112: 1989
4. For OPC 53 Grade cement - IS 12269 :1987
5. For PBSC cement - IS 455: 1989
6. For SRC cement - IS 12330 :1988
7. For Concrete Mix Design – IS 10262 – 1984(Reaffirmed)
8. SP:23 – 1982, A hand book on Concrete Mixes based on IS.

For Material testing lab

1. Davis, Troxell and Hawk, *Testing of Engineering Materials*, International Student Edition – McGraw Hill Book Co. New Delhi.
2. Fenner, *Mechanical Testing of Materials*, George Newnes Ltd. London.
3. Holes, K. A., *Experimental Strength of Materials*, English Universities Press Ltd. London.
4. IS Codes ; IS : 432 - 1982 (Part-I) , IS : 1608 – 1960 , IS : 1500 – 1968, IS : 5652 – 1981.
5. Kukreja, C. B., Kishore K. Ravi Chawla, *Material Testing Laboratory Manual* Standard Publishers & Distributors 1996
6. Suryanarayana, A.. K., *Testing of Metallic Materials*, Prentice Hall of India Pvt. Ltd. New Delhi

5th Semester

Course Title: Structural Analysis-II		**Course Code: 15ECVC301**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Slope Deflection Method

Introduction, Assumptions, Sign conventions, Derivation of slope deflection equation, Analysis of continuous beams, Analysis of portal frames with and without lateral sway. **15 hrs**

Unit II

2. Stiffness Method

Degree of kinematic indeterminacy of one and two dimensional structures, Generalized coordinates, Analysis of continuous beams with and without sinking of supports and portal frames. **15 hrs**

Unit III

3. Plastic Analysis

Introduction, plastic hinge and plastic moment capacity, Assumptions, Shape factor for general sections, Collapse load, Basic theorems for finding collapse loads, Methods of plastic analysis, Kinematic method applied to beams and frames, Beam mechanism, Sway mechanism, Combined mechanism. Push over analysis. **10 hrs**

Text Books

7. Bhavikatti S.S., *Structural Analysis-Vol. II* , 4ed , Vikas Publishers, 2013
8. Pandit, G.S. and Gupta, R., *Structural Analysis-A Matrix Approach*, Tata McGraw Hill Publishing Co Ltd, 2013

Reference Books:

2. Leet, E.M.and Uang, C. M., *Fundamentals of Structural Analysis*, Tata McGraw Hill Publishing Company, New Delhi, 2003.
3. Noris, C.H. and Wilbur, J., *Elementary Structural Analysis,* 4ed., Tata McGraw Hill Publishing Company, New Delhi, 2003
4. Reddy, C.S., *Basic Structural Analysis*, 3ed., Tata McGraw Hill Publishing Company, New Delhi, 2010.
5. Timoshenko, S.P., and Young, D.H., *Theory of Structures*, McGraw Hill

Company, New York, 1965.

Course Title: Geotechnical Engineering **Course Code: 15ECVC302**

L-T-P: 3-0-0 **Credits: 3** **Contact Hours: 3 Hrs/ week**

ISA Marks: 50 **ESA Marks: 50** **Total Marks: 100**

Teaching Hours: 40 **Examination Duration: 3 Hrs**

Unit I

1. Introduction

Introduction to soil mechanics, Phase Diagram, Voids ratio, Porosity, Percentage air voids, Degree of saturation, Moisture content, Specific gravity , Bulk density, Dry density, Saturated density, Submerged density and their inter relationships. **04 hrs**

2. Index Properties of Soils

Index Properties of soils- Water content, Specific Gravity, Particle size distribution, Relative density, Consistency limits and indices, insitu density, Activity of Clay, Laboratory methods of determination of index properties of soils: Moisture content, Specific gravity, Particle size distribution, Liquid limit- Casagrande and cone penetration methods, Plastic limit and shrinkage limit determination. **05 hrs**

3. Classification of Soils

Purpose of soil classification, basis for soil classification, Particle size classification – MIT classification and IS classification, Unified soil classification and IS classification - Plasticity chart and its importance, Field identification of soils. **03 hrs**

4. Clay Mineralogy and Soil Structure

Single grained, honey combed, flocculent and dispersed structures, Valence bonds Soil-Water system, Electrical diffuse double layer, adsorbed water, base-exchange capacity, Isomorphus substitution. Common clay minerals in soil and their structures- Kaolinite, Illite and Montmorillonite. **03 hrs**

Unit II

5. Flow of Water through Soils

Darcy's law- assumption and validity, coefficient of permeability and its determination, factors affecting permeability, permeability of stratified soils, Seepage velocity, Superficial velocity and coefficient of percolation, effective stress concept-total stress and effective stress, quick sand phenomena, Capillary Phenomena. Laplace equation- assumptions and limitations, Characteristics and uses of flownets, Methods of drawing flownets for Dams and sheet piles. Estimating quantity of seepage and Exit gradient. Determination of phreatic line in earth dams with and without filter. Piping and protective filter, graded filter **06 hrs**

6. Compaction of Soils

Definition, Principle of compaction, Standard and Modified proctor's compaction tests, factors affecting compaction, effect of compaction on soil properties, Field compaction control, Proctor needle. Compacting equipments. **04 hrs**

7. Shear Strength of Soils

Concept of shear strength, Mohr's strength theory, Mohr-coulomb theory, conventional and modified failure envelops, Total and effective shear strength parameters, Concept of pore pressure, factors affecting shear strength of soils, Sensitivity and Thixotropy of clay. Measurement of shear parameters- Direct shear test, unconfined compression test, Triaxial compression test and vane shear test, Test under different drainage conditions. **06 hrs**

Unit III

8. Stresses in Soils

Boussinesq's and Westergaard's theories for concentrated, circular, rectangular, line and strip loads. Comparison of Boussinesq's and Westergaard's analysis. Pressure distribution diagrams, contact pressure, Newmark's chart. **04 hrs**

9. Consolidation of Soils

Definition, Mass-spring analogy, Terzaghi's one dimensional consolidation theory-assumption and limitations. Normally consolidated, under consolidated and over consolidated soils, pre-consolidation pressure and its determination by Casagrande's method. Consolidation characteristics of soil, Time rate of consolidation. Laboratory one dimensional consolidation test, Determination of consolidation characteristics of soils-compression index, and coefficient of consolidation, determination of coefficient of consolidation by square root of time fitting method, logarithmic time fitting method. **05 hrs**

Text Books

a. Alam Singh and Chowdhary G.R, *Soil Engineering in Theory and Practice,* CBS Publishers and Distributors Ltd., New Delhi, 1994.

b. Braja M Das, *Principles of Geotechnical Engineering*, 8ed., Cenage Learning India (P) Ltd., India, 2014.

c. Punmia B C., *Soil Mechanics and Foundation Engineering.*, 17ed., Laxmi Publications Co., New Delhi, 2005.

Reference Books:

1. Craig, R.F., *Soil Mechanics*, Spon Press Publishers, New York ,2004.
2. Gopal Ranjan and Rao A.S.R., *Basic and Applied Soil Mechanics*, New Age International (P) Ltd., New Delhi, 2000.
3. Murthy V.N.S., *Soil Mechanics and Foundation Engineering*, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2016.
4. Venkatrahmaiah C., *Geotechnical Engineering,* 3ed., New Age International (P) Ltd., New Delhi, 2006.

Course Title: Design of RCC Structures		**Course Code: 15ECVC303**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 4 Hrs**	

Unit I

1. General Features of Reinforced Concrete

Introduction, Philosophies of design (Brief on Working Stress method). Limit State Method of Design: Design Loads, Materials for Reinforced Concrete, Codal provisions, Concept of Safety. Design Philosophy – Limit State Design principles. Principles of limit states, Factor of Safety, Characteristic design loads, and Characteristic design strength. **05 hrs**

2. Ultimate Strength of R.C. Sections

General aspects of Ultimate strength, Stress block parameters for limit state of collapse, Ultimate flexural strength of singly reinforced and doubly reinforced rectangular sections, Ultimate flexural strength of flanged sections, Ultimate shear strength of RC sections, Concept of development length and anchorage. **11 hrs**

3. Flexure and Serviceability Limit States

General Specifications for design of beams for flexure -practical requirements, size of beam, cover to reinforcement-spacing of bars. General aspects of serviceability-Deflection limits in IS: 456 – 2000-Calculation of deflection, Cracking in structural concrete members, Calculation of deflections and crack width. **04 hrs**

Unit II

4. Design of Slabs

General consideration of design of slabs, Rectangular slabs spanning one direction, Rectangular slabs spanning in two directions for various boundary conditions. Design of simply supported, cantilever slabs. **08 hrs**

5. Design of Beams

Design procedures for critical sections for moment and shear. Anchorages of bars, check for development length, Reinforcement requirements, Slenderness limits for beams to ensure lateral stability, Design examples for Simply supported and Cantilever beams for rectangular and flanged sections. **10 hrs**

Unit III

6. Design of Columns

General aspects, effective length of column, loads on columns, slenderness ratio for columns, minimum eccentricity, design of short axially loaded columns, design of column subject to combined axial load and uniaxial moment using SP – 16 charts. **07 hrs**

7. Design of Staircase

General features, types of staircase, loads on stairs, effective span as per IS codal provisions, distribution of loading on different types of stairs, Design of stairs. **05 hrs**

Text Books

1. Jain, A.K., *Limit State method of design*, 7ed., Nemichand and Bros., Roorkee, 2012.
2. Krishnaraju, N., *Design of Reinforced concrete structures (IS: 456 – 2000)*, 3ed., CBS Publishers, New Delhi, 2016.

Reference Books:

1. Bhavikatti, S. S., *Design of RCC Structural Elements Vol-I,* New Age International Publications, New Delhi, 2016.
2. Robert Park & Thomson, *Reinforced Concrete*, John Wiley & Bros, 1975
3. M. L Gambhir, '*Fundamentals of Reinforced Concrete Design'*, PHI Learning Pvt. Ltd., 2009, 1st ed.
4. Punmia, B.C., Ashok Kumar Jain & Arun Kumar Jain, *Limit State design of Reinforced concrete*, Laxmi Publication, New Delhi, 2007.

IS Codes

1. IS:456-2000, Plain and Reinforced Concrete – Code of Practice, BIS, New Delhi, 2000
2. IS:875 (Part 1 & 2) - 1987, Code of Practice for Design Loads (Other than earthquake) for building and structures, BIS, 1987
3. SP 16: Design Aids for Reinforced Concrete to IS 456:2000.

Course Title: Transportation Engineering		**Course Code: 15ECVC304**
L-T-P: 4-0-0	**Credits: 4**	**Contact Hours: 4 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 50	**Examination Duration: 3 Hrs**	

Unit I

1. Introduction to Transportation Engineering

Importance of Transportation systems, Different modes, characteristics, their integration and comparison, Road types and classification, road patterns, phasing road development in India, salient features of 3rd and 4th twenty-year road development plans, Present scenario of road development in India and in Karnataka. **04 hrs**

2. Highway Alignment and Surveys

Guidelines for selection of alignment, engineering surveys, steps involved in alignment of new highway and realignment of highway. Design features of Rural / low volume roads, Expressways and Urban Roads. **04 hrs**

3. Geometric Design of Highways

Functional design of highways, cross section elements- camber, width of carriageway, shoulder width, formation width, right of way, typical cross section of roads in embankment and cutting, sight distance, design of horizontal and vertical curves-features involved in highway safety and traffic efficiency. **08 hrs**

4. Traffic Engineering

Sampling in Traffic Studies, Objectives, methods of traffic study, equipment, data collection, analysis and interpretation of (i) Spot speed (ii) Speed and delay (iii) Volume (iv) Origin - Destination (v) Parking (vi) Accident studies. Traffic flow, Roadway capacities. **05 hrs**

Unit II

5. Pavement Materials

Basic road construction materials such as soils, aggregates, bitumen-tar-emulsion-cutback and Portland cement, bituminous mixes – types, source, functions, requirements, properties, tests and specifications for use in various components of road. **04 hrs**

6. Pavement design

Flexible pavement design: Empirical, semi empirical and theoretical design approaches, principle, advantages and application. Design as per IRC guidelines, outline of other common design methods such as **09 hrs**

AASHTO and Asphalt Institute methods

Rigid pavement design: Determination of ESWL, Axle load distribution studies, Stresses due to wheel loads and temperature variations, Design of cement concrete pavements as per IRC guidelines.

7. Highway Construction

Steps for the construction of road formation in embankment and cut, construction steps for subgrade (preparation of subgrade) in cutting, filling and at grade, Different types of granular base course- WBM, WMM, CRM - specifications, construction method and quality control tests, Different types of bituminous layers for binder and surface courses-specifications construction method and quality control tests, Different types of sub-base and base course for cement concrete pavement and construction method. **08 hrs**

Unit III

8. Introduction to Intelligent Transportation Systems (ITS)

Definition, Objectives, Historical Background, Benefits of ITS -ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection. **08 hrs**

Text Books

1. Khanna, S.K., and C.E.G. Justo, & A. Veeraragavan, *Highway Engineering,* 10ed., Nem Chand and Bros. Publishers, Roorkee, 2015.
2. Kadiyali, L.R., *Traffic Engineering and Transportation Planning*, 7ed., Khanna Publishers, New Delhi, 2011.
3. Kadiyali L.R.., *Principles and Practices* of *Highway Engineering*, Khanna Publishers, New Delhi, 2005.
4. Papacostas, C.S. and Prevedourous, P.D., *Transportation Engineering and Planning*, 3 ed., Prentice-Hall India, New Delhi, 2002.

Reference Books:

1. Eldon J. Yoder and Mathew W., Witczak, *Principles of Pavement Design*, 2ed. Tata McGraw Hill Publishing Co Ltd., Delhi, 1975.
2. Huang, Yang, H., *Pavement Analysis and Design*, 2ed., Prentice-Hall, 1993.
3. M A Chowdhary and A Sadek. *Fundamentals of Intelligent Transportation systems planning*. Artech House Inc., US, 2003.
4. *IRC: 37-2012, Guidelines for the Design of Flexible Pavements (Third Revision)*, Indian Roads Congress, New Delhi.
5. IRC: 58-2015*, 'Guidelines for the Design of Plain jointed Rigid pavements for highway'*, Indian Roads Congress, New Delhi.
6. IRC-SP-72-2007, '*Guidelines for the Design of Flexible Pavements for Low Volume*

Rural Roads', Indian Roads Congress, New Delhi.

7. MORTH Specifications for Road and Bridge Works, IRC Publication.

Course Title: Advanced Project Management		**Course Code: 15ECVC305**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Introduction to Advanced Project Management

Introduction, Importance of advanced project management, the project management institute and PMBOK, the role of a project manager, project management in India. **05 hrs**

2. Work Breakdown Structure

Concept of WBS, Common usage of terms, Preparing a WBS, Factors to be considered, WBS measurement considerations, Challenges to be considered, WBS level of Detail, WBS life-cycle considerations, Project risk and the WBS, Resource planning and management with WBS, Problems – Detailed WBS of residential, commercial, industrial and Highway Road etc. CPM and PERT. **12 hrs**

Unit II

3. Cost Loaded Scheduling and Project Controls

Determination of unit costs and total cost of a typical construction project. Project Controls - Introduction, Project life cycle, Overview of project life cycle, earned value management, Cost performance Index, Schedule performance index, forecasting methods and problems, resource utilization and cumulative curves, Cost loaded Schedules. **10 hrs**

5. Contractor's Estimation of cost and Bidding Strategy

Pre-qualification process, study of tender documents, preparation of construction schedule, determination of bid price. **06 hrs**

Bidding and Estimation practices in Indian Construction Industry.

Unit III

6. Risk analysis and Project Close out

Risks involved in projects – determination and mitigation. Closing out of project, Lessons learned, historical data - creation and uses. **03 hrs**

7. Labour Laws and Quality Control

Need for inspection and Quality Control, principles of inspection, Stages of inspection and quality control. Status of construction labour, wages of construction workers, unions, different labour acts. **04 hrs**

Text Books

1. James Lewis, *Project Planning, Scheduling, and Control*, 3ed.,2009.

Reference Books:

1. P. Harris, *Planning and Scheduling Using MS Project* 2010.
2. Ursula Kuehn, *Integrated Cost and Schedule Control in Project Management,* 2ed.,2011.

Course Title: Highway Engineering Laboratory		**Course Code: 15ECVP301**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 2 Hrs/ week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 30	**Examination Duration: 3 Hrs**	

Unit I

Test on coarse aggregate:

1. Impact test
2. Crushing test
3. Los Angeles Abrasion test
4. Shape test (Flakiness & elongation index and Angularity number)
5. Specific gravity and water absorption test
6. Gradation test
7. Bulk density and voids ratio test

Tests on Bitumen:

1. Penetration test
2. Specific gravity test
3. Ductility test
4. Softening point test
5. Viscosity test
6. Flash and fire point test
7. Stripping value test
8. Marshall stability test

Test on subgrade soil:

1. CBR Test – soaked

Traffic and pavement performance studies:

1. Traffic studies
2. Intersection studies
3. Bump indicator studies

Reference Books:

1. Khanna, S.K., Justo, C.E.G., and Veeraragavan, A., *Highway Materials and Pavement Testing*, Nem Chand and Bros, Roorkee
2. IS : 2386 (part 4) (Reaffirmed 2011)- Impact & Crushing test.
3. IS : 2386 (part 5)-Los Angeles abrasion test
4. IS : 2386 (part 5)-Shape Test
5. IS : 2386 (Part 3)-Specific gravity and Porosity
6. IS 2720 (Part 16)-1997, Laboratory Determination of CBR, Rev.2. Indian standard method of test for soils
7. IS : 6241-1971- Stripping value of aggregate
8. IS 383-1997 'Indian standard specifications for coarse and fine aggregates from natural sources'.

9. IS: 73-2013, Rev.3. Indian standard specifications for paving bitumen'.

Course Title: Environmental Engineering Laboratory **Course Code: 15ECVP302**

L-T-P: 0-0-1 **Credits: 1** **Contact Hours: 2 Hrs/ week**

ISA Marks: 50 **ESA Marks: 50** **Total Marks: 100**

Teaching Hours: 30 **Examination Duration: 3 Hrs**

1. Determination of Solids in Sewage: Total Solids, Suspended Solids, Dissolved Solids, Volatile Solids, Fixed Solids, Settleable Solids.
2. Electrical conductivity and pH.
3. Determination of Calcium, Magnesium and Total Hardness
4. Determination of Alkalinity, Acidity
5. Determination of Sulphates, Chlorides
6. Determination of Dissolved Oxygen and BOD.
7. Determination of COD.
8. Determination of Residual Chlorine.
9. Jar Test for Optimum Dosage of Alum, Turbidity determination
10. Determination of Iron.
11. Determination of Fluorides.
12. Determination of MPN

Reference Books:

1. *Standard Methods for Examination of Water and Wastewater*, 22nd American Publication – Association, Water Pollution Control Federation, American Water Works Association, Washington DC., 2012
2. IS 10500:2012, Drinking Water Specification, BIS, New Delhi
3. IS 3025 (Part 62) : 2006 Methods of Sampling and Test (Physical & Chemical) for water and waste water, BIS, New Delhi
4. IS 3307:1977, Tolerance Limits For Industrial Effluents Discharged on Land and Irrigation Purpose, BIS, New Delhi

Course Title: Engineering Computation Laboratory		**Course Code: 15ECVP303**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 2 Hrs/ week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 30	**Examination Duration: 3 Hrs**	

Students must be able to write coding in python, compile it and run as applied to the elemental numerical on engineering mathematics and civil engineering subjects like Mechanics of materials, Surveying, transportation, Fluid Mechanics, Structural Dynamics, etc. They should be able to document the lab work in the form of Flow-charts, Algorithms, coding output of results in tabular/graphical formats.

Following is the list of experiments:

1. Introduction to Python programming language: Data types, Operators, Program flow control, User defined functions
2. Working with Arrays, Array operators, Array indexing and slicing, and Plotting graphs
3. Developing and testing a Python function to find the roots of polynomial equations using Newton Gregory forward and backward interpolation.
4. Developing and testing a Python function to solve systems of linear equations using Gauss Elimination method.
5. Developing and testing a Python function to solve linear system of equations using Gauss Seidel iterative method.
6. Developing and testing a Python function to implement Power method for the computation of the largest eigenvalue and corresponding eigenvector.
7. Developing the equations for reactions, shear force and bending moment for a simply supported beam.
8. Finding out the principal stress in the three dimensional state of stress at a point.
9. Using Power method, obtain the smallest natural frequency and the corresponding mode shape.
10. Estimating the population for a given year by extrapolation using first, second, third and fourth order interpolating polynomials and comparing the prediction with actual results.

Text Book

1. Mark Lutz, Programming python, O'Reilly Media, 2010.
2. Alex Martelli, Python in a nutshell, O'Reilly Media, 2003.
3. M.K.Jain, S.R.K.Iyengar, R.K.Jain, 'Numerical Methods for scientific and engineering computation', New Age International Publishers, 2003.

Course Title: Mini Project		**Course Code: 15ECVW301**
L-T-P: 0-0-3	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

(To be conducted in the beginning of 5th Semester for a period of 7 days, Viva voce conducted along with 5th semester exams)

An extensive survey training involving investigation and design of the following projects is to be conducted for 7 days. The student shall submit a project report consisting of designs and drawings.

1. General instructions

Reconnaissance of the sites and fly leveling to establish bench marks.

2. Water Supply and Sanitary Project

Examination of sources of water supply, Calculation of quantity of water required based on existing and projected population. Preparation of village map by any suitable method of surveying (like plane tabling), location of sites for ground level and overhead tanks underground drainage system surveys for laying the sewers.

3. Highway Project

Preliminary and detailed investigations to align a new road (min. 1 to 1.5 km stretch) between two obligatory points. The investigations shall consist of topographic surveying of strip of land for considering alternate routes and for final alignment. Report should justify the selected alignment with details of all geometric designs for traffic and design speed assumed. Drawing shall include key plan initial alignment, final alignment, longitudinal section along final alignment, typical cross sections of road.

NOTE:

A) For the above works to Total Station should also be used along with conventional instruments.

B) All relevant drawings to be prepared using ZW CAD.

Reference Books:

1. Basak, *Text Book of Surveying*, 2010
2. Bhavikatti S.S., *Surveying and Leveling Vol-I & II,* I.K. International Publishers, 2008.
3. *CPHEEO: Manual on water supply and treatment*, Ministry of Urban Development.
4. Duggal, S.K., *Text Book of Surveying*, 2013
5. Garg, S.K., *Water supply Engineering*, 7ed., Khanna Publishers, New Delhi, 2005.
6. Kadiyali, L.R., Traffic Engineering and Transportation Planning, 7ed., Khanna

Publishers, New Delhi, 2011.

7. Khanna, S.K., and C.E.G. Justo, & A. Veeraragavan, Highway Engineering, 10ed., Nem Chand and Bros. Publishers, Roorkee, 2015.
8. Modi, P.N., *Sewage Treatment and Disposal Engg.,* 15ed., Std. Book House, New Delhi, 2015.
9. Punmia, B.C., Jain, Ashok.K. Jain, Arun.K. *Surveying Vol. 1 and Vol-2*, Lakshmi Publishers, 2015.
10. *IRC: 37-2012, Guidelines for the Design of Flexible Pavements (Third Revision)*, Indian Roads Congress, New Delhi.
11. *IRC:15-2011, Construction of Concrete Roads,* Indian Roads Congress, New Delhi.
12. *IRC: 58-2015,Guidelines for the Design of Plain jointed Rigid pavements for highway*, Indian Roads Congress, New Delhi.

6th Semester

Course Title: Advanced Geotechnical Engineering		**Course Code: 15ECVC306**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Subsurface Exploration

Importance of exploration program, Methods of soil exploration: Boring, sounding tests, geophysical Methods-Electrical resistivity and Seismic refraction methods. Types of soil samples- disturbed, undisturbed, and representative samples. Stabilization of boreholes - Typical bore log. Number and depth of borings for various civil engineering structures. Location of ground water table in fine and coarse grained soils. **03 hrs**

2. Lateral Earth Pressure

Active and Passive earth pressures, Earth pressure at rest, Earth pressure coefficients. Earth pressure theories- Rankine's and Coulomb's – assumptions and limitations, Graphical solutions for active earth pressure Cullman's and Rebhann's methods, Lateral earth pressure in cohesive and cohesionless soils, Earth pressure distribution. **06 hrs**

3. Stability of Slopes

Types of slopes, causes and type of failure of slopes. Definition of factor of safety, Stability of finite and infinite slopes- Method of slices, Friction Circle method, Fellineous method, Taylor's stability number. **06 hrs**

Unit II

4. Shallow Foundations

Definitions of ultimate, net and safe bearing capacities, Allowable bearing pressure. Terzaghi's and Brinch Hansen's bearing capacity equations-assumptions and limitations. Bearing capacity of footing subjected to eccentric loading. Effect of ground water table on bearing capacity. Plate load test, Standard penetration test, cone penetration test. **06 hrs**

5. Deep Foundations

Types of Deep foundation. Piles, Drilled Piers and Cassons. Load carrying capacity of pile**.** Design of pile and pile groups. Batter piles and under reamed piles. Design of pile cap. Design aspects of Well foundations. **06 hrs**

6. Foundation Settlement

Settlement Analysis, Data for settlement analysis, computation of settlement, Concept of immediate, consolidation and secondary settlements. Tolerance BIS specifications for total and differential settlements of footings and rafts. **03 hrs**

Unit III

7. Soil Stabilization and Reinforced soil

Introduction Methods of soil stabilization Reinforced soil**,** basic mechanism, choice of soil and reinforcement, Strength characteristics of reinforced soil, Design of Reinforced earth retaining walls, Wall with reinforced backfill, Reinforced earth slab. **06 hrs**

8. Containment of solid waste in landfills

Waste containment, Landfills, Shapes and size of landfills, Types of landfills, Impervious barriers for liners and covers, Stability of landfills, Landfill construction and operation **04 hrs**

Text Books

1. Alam Singh and Chowdhary, G.R., *Soil Engineering in Theory and Practice,* 2ed., CBS Publishers and Distributors Ltd., New Delhi, 2009.
2. Punmia, B.C., *Soil Mechanics and Foundation Engg.*, 16ed., Laxmi Publications Co., New Delhi, 2005.
3. B.M. Das, *Principles of Foundation Engineering*, 6ed., Thomson Business Information India (P) Ltd., India, 2007.

Reference Books:

1. Braja M. Das, *Principles of Geotechnical Engineering*, 8ed., Cenage Learning India (P) Ltd., India, 2014.
2. Gopal Ranjan and A.S.R Rao., *Basic and Applied Soil Mechanics*, New Age International (P) Ltd., New Delhi, 2000.
3. Knappett J.A and R.F Craig, *Soil Mechanics*, 8ed., Van Nostrand Reinhold Co. Ltd., 2012.
4. Murthy V.N.S., *Principle and Practices Soil Mechanics and Foundation Engineering*, 4ed., UBS Publishers and Distributors, New Delhi, 2002.
5. N.N.Som and S.C.Das, *Theory and practice of foundation engineering*, PHI learning Pvt Ltd
6. Sashi K Gulhati and Manoj data, *Geotechnical Engineering*, Tata Mcgraw Hill
7. Sivakumar Babu, G. L., *Introduction to Soil Reinforcement and Geosynthetics*, Universities Press, Hyderabad, 2006.
8. Swami saran, *Analysis and Design of Substructures: Limit State Design,* 2ed

oxford and IBH publishing co. pvt. ltd

9. Venkatrahmaiah, C., *Geotechnical Engineering,* 3ed., New Age International (P) Ltd., New Delhi, 2006.

IS Codes

10. IS 8403 : 1981 (Reaffirmed 2002) Code of practice for Determination of Brearing Capacity of Shallow Foundations.
11. IS 2911:1985 Part I to IV (Reaffirmed 1995) Code of Practice for Design and Construction of Pile Foundations.
12. IRC-SP-102-2014-Guidelines for design and construction of reinforced soil walls.

Course Title: Estimation and Costing		**Course Code: 15ECVC307**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Introduction

Different type of estimates, study of various drawing attached with estimates, important terms, units of measurement, abstract, approximate methods of estimating buildings, cost from materials and labour equations recommended by CBRI –examples. **04 hrs**

2. Methods of Estimation

Methods of taking out quantities and cost -center line method, long and short wall method or crossing method. **04 hrs**

3. Preparation of Estimates for Building Components

Preparation of detailed and abstract estimates for the following Civil Engineering works -Buildings -Masonry structures and framed structures with flat, sloped RCC roofs. Building components (Beams, Columns and Column Footings, RCC Roof Slabs etc) **08 hrs**

Unit II

3. Preparation of Estimates for Truss & Culverts

Wooden and Steel truss, RCC slab culverts, Manhole and Septic tanks. **04 hrs**

4. Specifications

Definition of specifications,- objective of writing specifications, essentials in specifications, general and detail specifications of item of works in buildings, specifications of aluminum and wooden partitions, false ceiling, aluminum and fiber doors and windows, various types of claddings. **04 hrs**

5. Rate Analysis

Definition and purpose. Working out quantities and rates for the following standard items of works -earth work in different types of soils, cement concrete of different mixes, bricks and stone masonry, flooring, plastering, RCC works, centering and form work for different RCC items, wood and steel works for doors, windows and ventilators. **08 hrs**

Unit III

6. Measurement of Earthwork for Roads

Methods for computation of earthwork -cross sections -mid section formula, trapezoidal or average end area or mean sectional area formula, prismoidal formula, for different terrains. **04 hrs**

7. Department (PWD) Procedures / Processes

Types of contract -essentials of contract agreement - legal aspects, penal provisions on breach of contract. Definition of the terms -Tender, earnest money deposit, security deposit, tender forms, documents and types. Comparative statements, acceptance of contract documents and issue of work orders. Duties and liabilities, termination of contract, completion certificate, quality control, right of contractor, refund of deposit. Administrative approval -Technical sanction. Nominal muster roll, measurement books -procedure for recording and checking measurements - preparation of bills, Arbitration. **04 hrs**

Text Books

1. Chakraborti, N., *Estimating, Costing, specification and valuation in Civil Engg.*, Calcutta, 2007.
2. Dutta, B.N., *Estimating and Costing in Civil Engineering: Theory and Practice Including Specifications and Valuation*, Sangam Books, 2002

Reference Books:

1. Birde, G.S., Text book of Estimating & Costing, Dhanpath Rai and Sons. New Delhi, 2014.
2. Kohli, D.D. and Kohli, R.C., Text Book of: Estimating and Costing (Civil), Ed.12, S. Chand Co. New Delhi, 2012.
3. Public Works Department Schedule of Rates 2016-17.
4. Rangwala S.C., *Estimating, Costing and Valuation,* Charotar Publishing House, Anand, 2009.

Open Elective -1

Course Title: Nano Composite Materials		**Course Code: 15ECVE301**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Introduction

Introduction to materials, traditional materials, development, properties, strength of and mechanical properties of materials , introduction, definition, classification and characteristics of composite materials - fibrous composites, laminated composites, particulate composites **06 hrs**

2. Fiber and matrices

Carbon fibers, glass fibers, silicon carbide and organic fibers. Polymer matrices, metal matrices and ceramic matrices. **05 hrs**

3. Fabrication and application

Polymer composites, metal composites and ceramic composites Application of composites: Automobile, Aircrafts, missiles, Space hardware, Electrical and electronics, marine, recreational and Sports equipment, future potential of composites. **05 hrs**

Unit II

4. An overview of Nanoscience & Nanotechnology

Historical background – nature, scope and content of the subject – multidisciplinary aspects – industrial, economic and societal implications. **06 hrs**

5. Experimental Techniques and Methods

For investigating and manipulating materials in the nano scale – electron microscope – scanning probe microscope – optical and other microscopes **05 hrs**

6. Introduction to Nanomaterials

Carbon Nanotubes , synthesis and purification – filling of nanotubes – mechanism of growth – electronic structure – transport properties – mechanical and physical properties – applications **05 hrs**

Unit III

7. Introduction to nano-composite

Nano composite polymer matrix, nano composite ceramic matrix, nano composite metal matrix Applications in engineering , future scope of nano-composite, research , training in development of nano-composite materials. **05 hrs**

8. Safety and environmental aspects

Safety and environmental aspects of nano-materials, future challenge, cost optimization and fabrication process of nano composite materials **03 hrs**

Text Book:

1. Hull and Clyne, *Introduction to composite materials*, Cambridge University Press, 2nd edition, 1990.
2. NANO: The Essentials – Understanding Nanoscience and Nanotechnology; T Pradeep; Tata McGraw-Hill India (2007)

References:

1. Di Ventra, et al (Ed), *Introduction to Nanoscale Science and Technology [Series: Nanostructure Science andTechnology]*; Springer (2004).
2. K.K.Chawla, *Composite Science and Engineering*, Springer Verlag 1998.
3. Nanotechnology Demystified: Linda Williams & Wade Adams; McGraw-Hill (2007)
4. Richard Booker & Earl Boysen; Wiley , Nanotechnology, (2005).
5. Richard Booker & Earl Boysen; Wiley, *Nanotechnology,* (2005).
6. Robert M. Jones, *Mechanics of Composite Materials*, McGraw Hill Kogakusha Ltd. 1998

Program Elective -1

Course Title: Pavement Engineering		**Course Code: 15ECVE303**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Introduction to pavement system

Desirable characteristics of pavement, types and components, Difference between Highway pavement and Air field pavement, Functions of sub-grade, sub base – Base course – surface course, comparison between Rigid and flexible pavement. **04 hrs**

2. Stresses and Deflections in Flexible Pavements

Factors affecting design and performance of flexible and rigid pavements – Pavement design factors, loads – axle load distribution, ESWL, EWL,VDF due to varying loads and CSA. Application of elastic theory, stresses, deflections / strains in single, two and three layer system, Applications in pavement design. **08 hrs**

3. Pavement Design Approach

Flexible pavement design: Empirical, semi- empirical and theoretical design approaches, principle, advantages and application. Determination of ESWL, EWL for dual and dual tandem wheel loads in Rigid pavements **03 hrs**

Unit II

4. Flexible Pavement Design

Design steps by CBR method as per IRC, outline of other common design methods such as AASHTO and Asphalt Institute methods. **07 hrs**

5. Rigid Pavement Design

General design principle, Stresses in rigid pavements, stresses due to wheel loads and temperature variations, design of cement concrete pavements as per IRC guidelines. Design features of CRCP, SFRC and ICBP. **08 hrs**

Unit III

6. Flexible Pavement Failures, Maintenance and Evaluation

Types of failures, causes, remedial/maintenance measures in flexible pavements – Functional Evaluation by visual inspection and unevenness measurement by using different techniques - Structural Evaluation by Benkelman Beam Deflection Method, Falling weight deflectometer. **05 hrs**

7. Rigid Pavement Failures, Maintenance and Evaluation

Types of failures, causes, remedial/maintenance measures in rigid pavements. Definition and concepts of condition and evaluation surveys, Present serviceability index, methods of measuring condition. **05 hrs**

Text Books

7. Khanna, S.K., and C.E.G. Justo, & A. Veeraragavan, *Highway Engineering,* 10ed., Nem Chand and Bros. Publishers, Roorkee, 2014.
8. Yoder E.J. and Witczak, Principles of pavement design, 2ed., John Wiley and Sons, 1975.

Reference Books:.

1. IRC 101-1988- Guidelines for Design of Continuously Reinforced Concrete Pavement with Elastic Joints, Indian Roads Congress, New Delhi.
2. IRC 59 – 1976- Tentative Guidelines for Design of Gap Graded Cement Concrete Mixes for Road Pavement, Indian Roads Congress, New Delhi.
3. IRC 81-1997- Guidelines for strengthening of flexible road pavements using Benkelman beam deflection technique, Indian Roads Congress, New Delhi.
4. IRC: 37-2012 -Guidelines for the Design of Flexible Pavements (Third Revision), Indian Roads Congress, New Delhi.
5. IRC: 58-2015- Guidelines for the Design of Plain jointed Rigid pavements for highway, Indian Roads Congress, New Delhi.
6. T. Fwa, '*The Handbook of Highway Engineering'*, Taylor & Francis Group, Newyork, 2006.

Course Title: Design of Hydraulic Structures		**Course Code: 15ECVE304**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Reservoir sedimentation

Introduction, the process of erosion, factors affecting erosion. Trap efficiency and numerical problems. Reservoir sedimentation, life of a reservoir . **06 hrs**

2. Gravity Dams

Introduction, forces acting on a gravity dam, types of joints. Stress analysis in gravity dam, Elementary & practical profiles of a gravity dam, stability analysis and drainage galleries in gravity dams **10 hrs**

Unit II

3. Earth Dams

Introduction, types of Earth dams, Design criteria for Earth dams, causes of failure of earth dams, section of dam, preliminary design criteria and problems on it, control of seepage through earth dams, Safety measures. **08 hrs**

4. Cross Drainage works and Spillways

Types of cross drainage works. Features of design of cross drainage works. Design of siphon aqueduct. Introduction, essentials of a spillway, spillway components, factors affecting type & design of spillways. Ogee spillway. Energy dissipation below spillways. **08 hrs**

Unit III

5. Diversion Head Works

Introduction, Khosla's theory, method of independent variables, elements of design for surface flow. Design of vertical drop weir on Bligh's theory. Function of canal head regulator. **08 hrs**

Text Books

1. Modi, P.N., *Irrigation, Water Resources, and Water Power Engineering*, Standard Book House, New Delhi, 2004.
2. Punmia, B.C. and Pande Lal, *Irrigation and Water Power Engineering*, 16ed., Laxhmi Publications, New Delhi, 2009.
3. Sharma, R.K., *Text Book of Irrigation Engineering and Hydraulic Structures*, S. Chand, New Delhi, 2002.

Reference Books:

1. Garg, S.K., *Irrigation Engineering and Hydraulic Structures*, Khanna Publications, New Delhi, 2005.
2. Madan Mohan Das & Mimi Das Saikia, *Irrigation and Water Power Engineering,* PHI Learning Pvt. Ltd., New Delhi, 2009.
3. N. Balasubramanya, *Hydraulic Structures & Irrigation Design Drawing* Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2015
4. Sathya C, Narayana Murthy, *Design of Minor Irrigation and Canal Structures* Wiley eastern limited, New Delhi, 1990.

Course Title: Geotechnical Engineering Laboratory		**Course Code: 15ECVP304**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 2 Hrs/ week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 30	**Examination Duration: 3 Hrs**	

List Of Experiments

1. Tests for determination of specific gravity and moisture content.
2. Grain size analysis of soil sample (sieve analysis).
3. In situ density by core cutter and sand replacement methods.
4. Consistency Limits – Liquid Limit (Casagrande and Cone Penetration Methods), plastic limit and shrinkage limit.
5. Standard Proctor Compaction Test and Modified Proctor Compaction Test.
6. Coefficient of permeability by constant head and variable head methods.
7. Strength Tests

a) Unconfined Compression Test.
b) Direct Shear Test**.**
c) Triaxial Compression Test (undrained)**.**

8. Consolidation Test- Determination of compression index and coefficient of consolidation.
9. a) Demonstration of miscellaneous equipments such as Augers, Samplers, Rapid Moisture meter, Proctor's needle.
   b) Demonstration of Hydrometer Test.
   c) Demonstration of Free Swell Index and Swell Pressure Test
   d) Demonstration of determination of relative density of sands.
   e) Laboratory vane shear
10. Open ended experiments to use soil as foundation material and construction material.

Reference Books:

1. Braja M. Das., *Soil Mechanics Laboratory Manual*, 9ed., Oxford University Press, 2016.
2. Lambe T.W., Soil *Testing for Engineers*, Wiley Eastern Ltd., New Delhi.
3. Shamsher Prakash and P.K.Jain, *Engineering soil testing*, NEM Chand and Bros, Roorkee.
4. SP-36-1987-Compendium of Indian standard on soil engineering.

Course Title: Computer Aided Design Laboratory		**Course Code: 15ECVP305**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 30	**Examination Duration: 3 Hrs**	

Students should be able to write coding in MS Excel, compile the same and run, for simple numerical in various civil engineering fields. They should be able to document the laboratory work in the forms of Flow charts, Algorithms, coding, output of results in tabular/graphical formats.

Also they should be able to use the available software (SAP) to analyse a simple structures and present the results in tabular/ graphical formats and generate reports.

Using MS Excel to solve Civil Engineering Problems

Structural Engineering

1. Calculating and plotting shear force and bending moment diagrams for cantilever, simply supported and fixed beams subjected to a combination of loads.
2. Calculation of deflection diagrams for cantilever and simply supported beams subjected to single point loads and UDL.
3. Design of singly and doubly reinforced rectangular sections subjected to bending moment and shear force.
4. Stability of dams.

Surveying

5. Balancing of closed traverse using transit rule
6. Computation of volume of earthwork in cutting and filling.
7. Setting out a horizontal curve by different methods – (i) Offset from long chord (ii) Perpendicular offset from tangents (iii) Radial offsets from tangents

Transportation Engineering

8. Design of super elevation
9. Design of horizontal and vertical alignment

Geotechnical Engineering

10. Grain size distribution and grading of soil
11. Calculation of shear parameters

Fluid Mechanics

12. Most economical section for a canal

13. Water hammer analysis
14. Head over Ogee weir

Use of Structural Analysis Software

The student shall analyse the following structures in SAP:

15. Plane truss subjected to dead loads, live loads and wind loads
16. Continuous beam with at least three spans subjected to dead loads and live loads
17. Plane frame subjected to dead loads, live loads and lateral loads.
18. Analysis of two bay two storey structure under static loading conditions (concrete frame).
19. Analysis of long span steel truss bridge.

Text Book

1. Microsoft Excel 2010 Formulas, John Walkenbach, Wiley-India pvt. Ltd.

Course Title: Construction Engineering & Management Laboratory		**Course Code: 15ECVP306**
L-T-P: 0-0-1	**Credits: 1**	**Contact Hours: 2 Hrs/ week**
ISA Marks: 80	**ESA Marks: 20**	**Total Marks: 100**
Teaching Hours: 30	**Examination Duration: 3 Hrs**	

1. Introduction to Primavera P6
2. Develop a Work Break-down Structure (WBS) for a residential building of 3 storey.
3. Create and add activities to the WBS and assign relationships as per the logic of the precedence diagram for the residential building. Determine the duration of the project.
4. Apply constraints and filters to the developed activities to develop two-week, one-month and three-month look-ahead schedule.
5. Develop different roles and resources in the resource library and assign to the various activities along with their unit rates.
6. Develop the cost-loaded schedule and create baseline of the project.
7. Perform earned value analysis to track and monitor the project.
8. Conduct simulations in Microsoft Visio process simulator to determine most efficient excavation cycles on large scale projects.
9. Conduct Monte-Carlo simulation in Microsoft Excel to perform risk analysis for the project.

Reference Books:

1. Kim Heldman & William Heldman, *Microsoft Excel for Project managers 2007*.
2. P. Harris, *Planning and Scheduling Using Primavera P6 2010.*

Course Title: Minor Project		**Course Code: 15ECVW302**
L-T-P: 0-0-6	**Credits: 6**	**Contact Hours: 6 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Functional and architectural design of a building from, but not restricted to one of the following category: Educational institutions, Administration buildings, Industrial buildings, Commercial buildings, Public facilities such as bus terminus, rail station, hospitals, cinema halls, auditorium etc.

The students shall identify a building and collect requirements for the building, carry out functional design through bubble diagrams and circulation diagrams and consider aspects such as orientation, aspect, best use of site conditions. The project shall include calculation of loads and analysis and design of components including foundations, columns, beams and slab. Simplified computer aided analysis should be performed.

The student shall submit the following:

- Identification of Project.
- Bubble diagrams and Circulation diagrams
- Logic used to arrive at room dimensions based on ergonomics, furniture sizes and placement, equipment etc.
- Architectural plans, elevations, sections and building services fit for submission to approving authorities
- Preliminary soil investigation.
- Results of structural analysis and design of selected components
- Drawings showing structural details of components designed
- Develop WBS, calculate productivity, create precedence diagram, develop cost-loaded schedule and create a baseline.
- Collection of progress data, update the schedule, perform earned value analysis.

Expected Deliverables:

Identified project details, bubble diagrams and circulation diagrams, complete architectural plans, Soil investigation report, Final structural design drawings and calculations, detailed WBS, productivity calculations, precedence diagram, Initial cost-loaded schedule (Primary Baseline), 1st progress report and earned value report.

Reference Books:

1. IS 1172 – 1971 Code of Basic Requirements for Water Supply, Drainage and Sanitation (Second Rev.), BIS.
2. IS 1642 – 1960 Code of Practice for Fire Safety in Buildings (General): Materials and Constructions in Buildings, BIS.
3. IS 1648 – 1961 Code of Practice for Fire Safety in Buildings (General): Fire fighting Equipment and its maintenance, BIS.
4. IS 1742 – 1972 Code of Practice for Building Drainage, BIS.
5. IS 2065 – 1972 Code of Practice for Water Supply in Buildings (First Rev.) BIS.
6. IS 3861 – 1975 Method of Measurement of Plinth, Carpet and Rentable Area of Buildings(First Rev.) BIS.
7. IS 4326 – 1993 Earthquake Resistant Design and Construction of Buildings – Code of Practice (Second Rev.)
8. IS 7564 – 1974 Recommendations for Co-ordination of Dimensions in Buildings – Arrangement of Building Components.
9. IS:456-2000, Plain and Reinforced Concrete – Code of Practice, BIS, New Delhi, 2000
10. IS:875 (Part 1) - 1987, Code of Practice for Design Loads (Other than Buildings and Structures – Dead Loads, BIS, 1987
11. IS:875 (Part 2) - 1987, Code of Practice for Design Loads (Other than r Buildings and Structures – Live Loads, BIS, 1987.
12. Kraners, Sieverts and Partners. 1977. Open – Plan Offices, UK: McGraw Hill. (English Translation Ritchie, J.L.)
13. Leonard, M. and Cunliffe, R. 1962. Office Buildings, New York: Reinhold
14. National Building Code of India 2005 (NBC 2005), Bureau of Indian Standards, New Delhi
15. SP:1983 National Building Code of India (First Rev.) BIS.
16. Subramaniyam, T.N. (edited by) n.d. Architects, Engineers and Builders Handbook, Madras: Fairhaven Printers.

7th and 8th Semester

Course Title: Design of Steel Structures		**Course Code: 15ECVC401**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Introduction

Advantages and disadvantages of Steel structures, Loads and load combinations. Structural forms, Design concepts. IS code provisions. Fire resistance and ductility of steel. Introduction to working stress method. **03 hrs**

2. Structural Fasteners

Bolted and welded connections, Strength of bolt and bolted joint. Design of bolted connections. Bracket connections. Welded connections, fillet and Butt welds, strength of a weld, Bracket connections. **07 hrs**

3.Design of Tension Members

Axially loaded tension members and their connections, design of lug angles, Design of truss ties and joints. **05 hrs**

Unit II

4. Design of Compression Members

Angle struts, Columns including built up sections, Laced and Battened systems. Column splicing, column bases- simple slab base, gusseted base. **09 hrs**

5. Design of Flexural Members

Simple and built up sections. Laterally supported and unsupported compression flange. Web crippling and web buckling, **06 hrs**

Unit III

6. Design of Truss

Wind load, dead load and other loads wind pressure, calculation of loads on nodes, design of members of the roof Truss (Forces in the members to be given), Design of purlins **05 hrs**

7. Design of Welded Plate Girders

Introduction, Design of Plate Girders (without intermediate stiffeners) **05 hrs**

Text Book

1. Bhavikatti, S.S, *Design of Steel Structures*, 5ed., New Age International , 2017
2. Duggal S.K , *Design of Steel Structures*, 2ed., Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2014.

References

1. Subramanian, N., *Design of Steel Structures*, 1ed., Oxford University Press, New Delhi, 2014.
2. IS: 800: 2007 *Guidelines for Design of Structural Steel*.
3. IS: 875 (Part 3) 1987 *Code of Practice for Design Loads (Other than Earthquake) for Buildings and Structures : Wind Loads.*

Course Title: Design of Sub-structures **Course Code: 15ECVE401**

L-T-P: 3-0-0 **Credits: 3** **Contact Hours: 3 Hrs/ week**

ISA Marks: 50 **ESA Marks: 50** **Total Marks: 100**

Teaching Hours: 40 **Examination Duration: 3 Hrs**

Unit I

1. Soil Exploration

Subsurface exploration programme for civil engineering projects. Interpretation of soil parameters. Tests on disturbed and undisturbed soil samples, Soil exploration report. **02 hrs**

2. Shallow Foundations

Design Criteria. Types of shallow foundations. Bearing capacity theories. Bearing capacity from field tests. Use of different foundation models. Design of individual and combined footings. Design of raft foundations - Conventional methods. Modulus of subgrade reaction. Beams on elastic foundations. Analysis of footings by Finite Difference. **07 hrs**

3. Pile Foundations **06 hrs**

Load carrying capacity of pile. Design of pile and pile groups. Batter piles and under reamed piles. Design of pile cap. Design of axially and laterally loaded piles.

Unit II

3. Drilled Piers and Caissons

Construction, advantages and disadvantages of drilled piers. Design of open, pneumatic and floating caissons. Advantages and disadvantages of floating caissons. **06 hrs**

4. Well Foundation

Different shapes and characteristics of wells. Components of well foundation. Forces acting on well foundation. Sinking of wells. Causes and remedies of tilts and shifts. **05 hrs**

5. Foundations on Expansive Soils **05 hrs**

Definition, Identification, Structure, Index properties of expansive soils, Swell potential and Swell pressure, Free swell, CNS layer, foundation treatment for structures in expansive soil.

Unit III

6. Machine Foundations **05 hrs**

Basic terminologies. Design criteria for machine foundations. Vibration analysis. Methods of analysis. Determination of soil parameters. Foundations for reciprocating machines. Foundations for impact type of machines. Vibration isolation.

7. Foundations for Special Structures **04 hrs**

Foundations for tall structures - Water tanks, Chimneys, Antenna towers and Radar units.

Text Books

9. Bowles. J. E, *Foundation analysis and design*, 5ed, McGraw-Hill Company, Inc, New York, 2012.
10. Das. B.M, *Principles of Foundation Engineering*, 8ed., Thomson Business Information India (P) Ltd., India, 2014.
11. Murthy V.N.S., *Soil Mechanics and Foundation Engineering*, 4ed., UBS Publishers and Distributors, New Delhi, 2016.
12. Swami Saran, *Analysis and Design of Substructures: Limit State Design*, 2ed, oxford and IBH publishing co. Pvt. Ltd., 2006.

Reference Books:

6. Ghosh K.M., *Foundation Design in Practice*, PHI Learning Pvt. Ltd., New Delhi, 2009.
7. Nainan Kurian., *Modern Foundations: An Introduction to Advanced Techniques*, Tata McGraw Hill Education Pvt. Ltd, New Dehli, 1982.
8. Som N. N., Das S. C., *Theory and Practice of Foundation Design*, PHI Learning Private Limited, New Delhi, 2009.
9. Srinivasulu, P. and Vaidyanathan, C.V., *Hand Book of Machine Foundations*, 1ed, Tata McGraw Hill Education Pvt. Ltd, New Dehli , 2002.
10. Tomlinson, M.J., *Pile Design and Construction Practice*, 6ed, CRC Press, 2014.
11. Winterkorn, H. F. and Fang H. Y., *Foundation Engineering Hand Book*, 2ed, Van Nostrand Reinhold Company, 1991.

IS Codes:

1. IS 2911 (Part 1/Sec 3) : 2010 **-** *Design And Construction Of Pile Foundations*

2. IS: 2950 (Part I) -1981 (Reaffirmed 2008) - *Code Of Practice For Design And Construction Of Raft Foundations*

Course Title: Advanced RCC Structures **Course Code: 15ECVE402**

L-T-P: 3-0-0 **Credits: 3** **Contact Hours: 3 Hrs/ week**

ISA Marks: 50 **ESA Marks: 50** **Total Marks: 100**

Teaching Hours: 40 **Examination Duration: 3 Hrs**

Unit I

1. Design of Footings

Introduction, load for footing, Design of isolated rectangular footing for axial load and uniaxial moment, design of pedestal. **05 hrs**

2. Design of Combined Footing

Design of strap footing, Design of Combined footings: Rectangular and trapezoidal Combined Footings. **05 hrs**

3. Design of Raft Footing **05 hrs**

Design of raft footing as per IS:456:2000 Guidelines

Unit II

4. Retaining Walls

Design of Cantilever and Counter-fort type of retaining walls. **08 hrs**

5. Design of Portal Frame **07 hrs**

Design of RCC Portal Frame, Design of beam, column, footing for the given bending moment, shear force and torsion as per IS: 456: 2000 Guidelines

Unit III

6.Design of continuous beams **05 hrs**

Bending moment envelops moment redistribution as per IS Code provisions

7. Design of Water tanks **05 hrs**

Design of circular and rectangular water tanks, resting on ground and over head water tanks and design of Intz tank.

Text Books

1. Jain, A.K., *Limit State Method of Design*, 7ed., Nemichand and Bros., Roorkee, 2012.
2. Punmia B.C., Ashok Kumar Jain, and Arun Kumar Jain, *Limit State Design of Reinforced Concrete*, Laxmi Publications Pvt. Ltd., New-Delhi-2016.

Reference Books:

1. Bhavikatti S.S, *Advanced RCC Design (RCC Vol-II)*, New Age International Publishers, New Delhi, 2008.
2. Krishnaraju, N., *Design of Reinforced Concrete Structures (IS: 456 – 2000)*, 3ed., CBS Publishers, New Delhi, 2016.
3. Robert Park & Thomson, *Reinforced Concrete*, John Wiley & Bros Pvt. Ltd, 1975
4. Unnikrishnan Pillai S. and Devdas Menon, *Reinforced Concrete Design Third*

Edition, Tata McGraw Hill Education Pvt Ltd., New-Delhi-2017.

5. IS:456-2000, *Plain and Reinforced Concrete – Code of Practice (Fourth Revision)*, BIS, New Delhi, 2000
6. SP 16: *Design Aids for Reinforced Concrete to IS 456:1978.*

Course Title: Design Studio – Steel and RC Structures		**Course Code: 15ECVP401**
L-T-P: 1-0-1	**Credits: 2**	**Contact Hours: 6 Hrs/ week**
ISA Marks: 20	**ESA Marks: 80**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit – I

1. RCC Detailing **20 hrs**

   a. Drawing and detailing of beams (Simply supported and Continuous beam), slab (One way and two way), column, footing (Isolated and combined) and stairs (Dog legged)

   b. Retaining walls – cantilever and counter fort retaining walls

   c. Water tanks – Over head (Intz tank)

   d. Portal frame – Single bay

Unit – II

2. Drawings to be prepared for given structural details **12 hrs**

   a. Connections: Bolted and welded, beam-beam, Beam-column, seated, stiffened and un-stiffened.

   b. Columns: Splices, Column-column of same and different sections. Lacing and battens

   c. Column Bases: Slab base and gusseted base.

   d. Roof Trusses: At supports and different nodes.

Text Books

2. Bhavikatti, S.S., *Design of Steel Structures by Limit State of Method – As per IS 800-2007*, I.K. International Publishing House Pvt. Ltd., New Delhi, 2009

3. Ramachandra, *Design of Steel Structures,* Vol- 1 & 2, Standard Book House, New Delhi, 2009.

4. Subramanian, N., *Design of Steel Structures*, Oxford University Press, New Delhi, 2008.

5. Kazimi and Jindal, *Design of Steel Structures*, 2ed., Prentice Hall of India, New Delhi, 2000.

References

1. Arya and Ajmani, *Design of Steel Structures*, Nem Chand Bros, Roorkee, 1977.

2. Negi, L.S., *Design of Steel Structures*, Tata McGraw Hi11 Publishers, 2004.

3. SP 6 (Part 1) Year: 1984 Handbook for structural engineers - Structural

steel sections

4. SP: 34 Year1987 Handbook on Concrete Reinforcement and Detailing
5. IS:800-2007 Code of Practice for general Construction in Steel.

Course Title: Finite Element Methods **Course Code: 15ECVE403**

L-T-P: 3-0-0 **Credits: 3** **Contact Hours: 3 Hrs/ week**

ISA Marks: 50 **ESA Marks: 50** **Total Marks: 100**

Teaching Hours: 40 **Examination Duration: 3 Hrs**

Unit I

1. Introduction to Finite Element method.

Introduction, Basic concepts on finite element analysis, Introduction to elasticity, Steps in Finite Element Analysis. **05 hrs**

2. Element Properties.

Natural Coordinates, Triangular Elements, Rectangular Elements , Lagrange and Serendipity Elements, Solid Elements, Isoparametric Formulation , Stiffness Matrix of Isoparametric Elements, Numerical Integration: One Dimensional, Numerical Integration: Two and Three Dimensional Worked out Examples **05 hrs**

3. Finite Element Formulation Technique. **05 hrs**

Virtual Work and Variational Principle, Galerkin Method, Rayleigh-Ritz Method.

Unit II

4. Analysis of Frame Structures

Stiffness of Truss Members , Analysis of Truss, Stiffness of Beam Members, Finite Element Analysis of Continuous Beams. **08 hrs**

5. FEM for Two and Three Dimensional Solids **10 hrs**

Constant Strain Triangle, Linear Strain Triangle, Rectangular Elements , Numerical Evaluation of Element Stiffness , Computation of Stresses, Geometric Nonlinearity and Static Condensation , Axisymmetric Element, Finite Element Formulation of Axisymmetric Element, Finite Element Formulation for 3 Dimensional Elements Worked out Examples

Unit III

6. FEM Program

Structure of FEM program for FEM Analysis, Description of different modules, Pre and post processing. **07 hrs**

Text Books

1. Reddy J.N., *An Introduction to Finite Element Method*, 3ed., McGraw- Hill Publishing Company Inc, New York, 2017.
2. Krishnamoorthy C. S., *Finite Element Analysis*, Tata McGraw-Hill Education Pvt. Ltd, New Delhi, 2004.

Reference Books:

1. Rajasekaran, S., *Finite Element Analysis in Engineering Design*, S. Chand Group, 2006.
2. Pandit G.S. and Gupta, S.P., *Structural Analysis, A Matrix Approach*, 2ed., Tata McGraw- Hill Education Pvt. Ltd, New Delhi, 2008.
3. Cook R.D., Malkus D.S., Plesha M.E. and Witt R.J. *Concepts And Applications Of Finite Element Analysis*, 4ed., John Wiley and Jous, Inc., 2013.
4. Bathe K.J., *Finite Element Procedures*, Klaus-Jürgen Bathe; 2ed., 2014.
5. Bhavikatti S.S., *Finite Element Analysis*, New Age International Publication Pvt. Ltd., New Delhi, 2010.
6. Daryl L. Logan., *A first course in the Finite Element Method*, 5ed, Cengage Learning, 2010.
7. Tirupathi R. Chandrupatla and Ashok D. Belegundu, *Introduction to Finite Elements in Engineering*, 4ed, Pearson, 2011

Course Title: Horizontal and Vertical Construction Methods **Course Code: 15ECVE405**

L-T-P: 3-0-0 **Credits: 3** **Contact Hours: 3 Hrs/ week**

ISA Marks: 50 **ESA Marks: 50** **Total Marks: 100**

Teaching Hours: 40 **Examination Duration: 3 Hrs**

Unit I

1. Planning for earthwork construction

Planning, Graphical presentation of Earthwork, Earthwork quantities, Mass diagram and its applications, Pricing of earthwork operations. **05 hrs**

2. Compaction and Stabilization Equipment

Compaction of soil and rock, Types of compaction equipment, roller production estimating, Dynamic compaction, Soil stabilization, stabilizing soils with lime, Cement-soil stabilization. **05 hrs**

3. Excavators and loaders **05 hrs**

Hydraulic Excavators, selection of front shovels, Calculating shovel production, height of cut effect on shovel production, angle of swing effect on shovel production, Loaders – introduction, Loader buckets/attachments, operating specifications, Loader production rates, Calculating wheel loader production, Calculating track loader production, Loader safety.

Unit II

4. Drilled Shaft Foundations

Introduction, Construction of drilled shafts – dry method of construction, casing method of construction, wet construction method, Installation of casings, Steel cages, Placement of concrete, Dewatering, open dewatering systems, deep well systems, well point systems – Types, techniques, Basement waterproofing systems. **05 hrs**

5. Formwork Systems **06 hrs**

Introduction, formwork materials, shores and scaffolding, Vertical formwork systems – Conventional wall/columns forming systems, Modular panel column form, adjustable wraparound column forms, circular steel forms for round columns, wall panel system, single sided wall formwork, formwork ties, Horizontal formwork systems – conventional wood form and metal systems, cup-lock type scaffolding system, slab flex system, tunnel form, flying formwork system, crane-jumped formwork, automatic climbing formwork, self-rising core system.

6. Concrete and Conveying Systems **05 hrs**

Introduction, Concrete – Mixers, Concrete plants, Pre-tensioning and Post tensioning, Transporting and handling – Concrete chute, concrete mixer with lift, concrete skip, truck mixer concrete pumps, concrete belt conveyors, concrete pump truck, trailer pump and pipeline with tower-mounted boom, trailer mounted pumps, pipeline system, mobile concrete placing booms, finishing.

Unit III

7. Cranes

Major cranes types, Mobile cranes, Crawler cranes, Telescoping-boom truck-mounted cranes, Lattice-boom truck-mounted cranes, Rough-terrain cranes, modified cranes for heavy lifting, crane booms, lifting capacities of cranes, Rated loads for lattice and telescopic boom cranes, Tower cranes – classifications, operation, Tower crane selection, Rated loads for tower cranes, rigging, slings, safety. **09 hrs**

Text Books

1. Peurifoy, *Construction Planning, Equipment & Method,* 7ed., Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2010.
2. Basem M*, Construction Technology for High-rise Buildings-Handbook*, 2014.

Reference Books:

1. Stephens W. Nunnally, *Managing Construction Equipment*, 2ed, Pearson Publications, USA, 2000.
2. Gupta B. L., Amit Gupta, *Construction Management and Machinary*, 5ed, Standard Publications, New Delhi, 2015.

Course Title: Construction Economics & Management		**Course Code: 15ECVE404**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Project Organization

Introduction, Forms of business organizations, Structure of construction organization, organizing for project management, management levels, traits of a project manager and project coordinator, Factors behind the success of a construction organization. **07 hrs**

2. Construction Economics

Introduction, economic decision making, Time Value of Money, Cash Flow Diagrams, Using Interest Tables, Evaluating Alternatives by Equivalence, Effect of Taxation on Comparison of Alternatives, Effect of Inflation on Cash Flow, Evaluation of Public Projects: Discussion on Benefit-cost Ratio **10 hrs**

Unit II

3. Construction Contract

Introduction, Contract Documents, Classification of Engineering Contracts, CPWD Contract Conditions, FIDIC Form of Contract Agreement, Subcontracting. **03 hrs**

4. Construction Material Management **07 hrs**

Introduction, Material procurement process in construction organization, material management functions, inventory management.

5. Construction Project Success: Factors **03 hrs**

Introduction, project performance measurement, criteria for project performance Evaluation, project performance attributes, effect of other elements on project Performance.

Unit III

6. Construction Accounts Management

Introduction, Principles of Accounting, Accounting process, Construction Contract Revenue Recognition, Construction contract status report, Limitations of accounting, Balance Sheet, Profit and Loss Account, Working Capital, Ratio Analysis, Funds Flow Statement. **06 hrs**

7. Construction Equipment Management

Introduction, Plant and Equipment Acquisition, Depreciation, Methods of Calculating Depreciation, Example of Depreciation Calculations for Equipment on Site, The Effect of Depreciation and Tax on Selection of Alternatives, Evaluating Replacement Alternatives. **04 hrs**

Text Books

1. Kumar Neeraj Jha, *Construction Project Management – Theory and Practice*, 2ed., Pearson Publication, 2015.

Reference Books:

1. Shrivastava U. K., *Construction Planning and Management*, Galgotia Publication Pvt. Ltd., New Delhi-2007.
2. Verma Mahesh, *Construction planning and Management*, Metropolitan Book Co., Delhi,1982.
3. Seetharaman S., *Construction Engineering and Management*, Umesh Publications, New Delhi, 2006.

Course Title: Construction Quality Management		**Course Code: 15ECVE406**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit – I

1. Concept of Quality

Definition of Quality, Historical background of quality control, difference between Quality control and Quality Assurance (QA/QC). Total quality control (TQC) and Total Quality Management (TQM), Need for TQM in construction industry, TQM philosophy: Concept of Deming, Juran, Crosby, Imai, Ishikawa, Taguchi, Shingo philosophies. Models and frame works. **05 hrs**

2. Quality Control Tools

Cause and Effect diagrams, Check sheets, Control charts, Data collection, Flow charts, Histograms, Pareto analysis, Pie charts, Run chart, Scatter diagrams and Control charts (Concepts and examples in construction projects), Project Rework Reduction Tool (PRRT) software. **04 hrs**

3. Development of Human Resource and Quality Circles

Training and development, technical and managerial competencies necessary for achieving quality Cultural change, Innovation and learning, Leadership and commitment, Philosophy of quality circles, Organization of Quality Circles, Stages of Adoption, Areas of Interest to Quality circles, Essential Requirements for the success of circles, Gains from circles. Inspection reports, Monitoring and Control, 360 feedback for quality. **05 hrs**

Unit – II

4. Study of ISO 9001- Quality System Standards.

Purpose of ISO Standards. Difference between ISO 9001 and ISO 9004.Certification process for ISO 9001. Certification bodies involved. Eight Principles of ISO-Basic meaning, Quality management system requirements. **04 hrs**

5. Quality Management System Procedures

Introduction, procedure for management review, Format for writing procedures, Procedure for preparing Quality plans/ work Instructions, Contract review, Design control, Document and data control, Document numbering system, Change request, purchasing, control of customer supplied product, product identification and traceability, process control, inspection and testing, measuring and test equipments, the control of non- conforming product, corrective and preventive action, handling, storage, packaging and delivery, control of quality records. **09 hrs**

6. Work Instructions

Introduction -Document and Data Control, Material Procurement, Material Handling, Tendering and Estimating, Planning, Design, Training, Plant and Equipment, Bar Bending Schedule, Concrete Works, Earthworks and Compaction, Soil Investigation works, Survey works, Concrete Repair Works, Road Works, Painting Works, Water Proofing works, Drainage Works, Quality Assurance and Control, Patching and Transportation of Concrete. **03 hrs**

Unit – III

7. Method Statement

Introduction, Concrete Works, Earthworks and Compaction, General Soil Investigation works, Survey works, Concrete Repair Works, Concrete Demolition Works, Road Works, Fencing works etc. **04 hrs**

8. Job Description

Introduction, Job Description of: Managing Director, Project Manager, Site Manager, Site Engineer, QA/QC Engineer, Foreman, Typist/Clerk, Design Engineer, Planning Engineer. **03 hrs**

9. Introduction to Six Sigma

Introduction, Definition of Six Sigma, evolution – Historical aspects, Six Sigma methodology, Leadership principles, Six Sigma team, Six Sigma in construction projects **03 hrs**

Text Books

1. Bagchi, *ISO 9000 Concepts, Methods, Implementation,* Wheeler Publishing
2. Gary E. MacLean, *Documenting Quality for ISO 9000 and other Industry Standards,* Tata McGraw-Hill Publishing Company Limited, 1993.
3. Girdhar J. Gyani, *Training Manual on ISO 9000-2000 and* TQM, Raj Publishing House, 1994.
4. Mohamed Zairi, *Total Quality Management for Engineers,* Aditya Books Private Limited.
5. P.L.Jain, *Quality Control and Total Quality Management*, Tata Mcgraw Hill Publicaions
6. Rajendra Prasad, D.S., *Quality Management System in Civil Engineering ISO 9001-2000*, Sapna Book House, Bangalore, 2000.

References

1. Elwyn E. Seelye, *Data Book for Civil Engineers Field Practice,* John Wiley & Sons, inc., 1957.
2. Feigenbaum Armand V., "*Total Quality Control*", McGraw Hill Inter- national Edition,1991
3. John L. Hardesky, *Productivity and Quality Improvement,* McGraw Hill Book Company
4. Neville, A.M., *Properties of Concrete,* ELBS Publications.

IS Codes

1. IS: 456-2000, *Indian Standard Specifications for Plain and Reinforced Concrete Code of Practice,* 4th Revision, Bureau of Indian Standards.
2. IS: 383-1990, *Indian Standard Specifications for Coarse and Fine Aggregates from Natural sources for Concrete,* Bureau of Indian Standards.
3. ISO 9001-2015*, Quality Management System in Civil Engineering*
4. ISO 9004:2018, *Quality management — Quality of an organization — Guidance to achieve sustained success*

Course Title: Solid Waste Management **Course Code: 15ECVE407**

L-T-P: 3-0-0 **Credits: 3** **Contact Hours: 3 Hrs/ week**

ISA Marks: 50 **ESA Marks: 50** **Total Marks: 100**

Teaching Hours: 40 **Examination Duration: 3 Hrs**

Unit I

1. Introduction

Solid waste -Definition, Land Pollution -scope and importance of solid waste management, functional elements of solid waste management. SOURCES: Classification and characteristics- municipal, hospital / biomedical waste, Quantity -Generation rate, methods. **05 hrs**

2. Collection and Transportation

Systems of collection, collection equipment, garbage chutes, transfer stations - bailing and compacting, route optimization **05 hrs**

3. Processing Techniques **05 hrs**

Components separation, volume reduction, size reduction, chemical reduction and biological processing

Unit II

4. Disposal Methods

Open dumping -selection of site, ocean disposal, feeding to hogs, composting, sanitary land. filling, merits and demerits. Construction/Demolition waste. **04 hrs**

5. Incineration **04 hrs**

Processes -3 T 's, factors affecting incineration process, incinerators -types, prevention of air pollution, pyrolysis.

6. Composting **05 hrs**

Aerobic and anaerobic composting, factors affecting, composting, Indoor and Bangalore processes, mechanical and semi-mechanical composting processes. Vermi composting

Unit III

7. Sanitary Land Filling

Definition, methods, trench area, Ramp and pit method, site selection, basic steps involved, cell design, prevention of site pollution, leachate collection and control methods, gas collection systems. **07 hrs**

8. Recycle and Reuse

Material and Energy Recovery Operations, Reuse In Other Industries, Plastic Wastes, Environmental Significance and Reuse **05 hrs**

Text Books

1. George Tchobanoglous, Hilary Theisen and Vigil S. A., *Integrated solid waste management: engineering principles and management issues*, McGraw-Hill Inc,US, 1993.
2. Bhide A. D. and , Sundaresan B. B., *Solid Waste Management in Developing Countries,* Indian National Scientific Documentation Centre, 2010.
3. Ministry of Environment and Forests, Govt. of India, The Municipal Solid Wastes (Management and Handling) Rules, 2000.

Reference Books:

1. Joseph L. Pavoni, John E. Heer, D. Joseph Hagerty, *Solid Waste Management, Van Nostrand Reinhold Co.,* 1973.
2. Howard S. Peavy, Donald R. Rowe, George Tchobanoglous, *Environmental Engineering,* McGraw-Hill Publishing Company Inc., New York, 2017.
3. Ramesha Chandrappa, Jeff Brown, *Solid Waste Management – Principles and Practice,* Springer Science & Business Media, 2012.

Course Title: Advanced Waste Water Treatment **Course Code: 15ECVE408**

L-T-P: 3-0-0 **Credits: 3** **Contact Hours: 3 Hrs/ week**

ISA Marks: 50 **ESA Marks: 50** **Total Marks: 100**

Teaching Hours: 40 **Examination Duration: 3 Hrs**

Unit I

1.Introduction

Wastewater Characteristics, Effluent Quality Standards, Receiving Stream Quality **03 hrs**

2. Primary Treatment- Screening, Grit removal, Neutralization, equalization, Sedimentation, Flotation (oil & grease removal), **06hrs**

3. Secondary Treatment- Fundamental concept of reactors: Mass balance relationships, analysis and descriptions of reactors- batch, completely mixed flow and plug flow oxygen requirement in aerobic process. **06hrs**

Unit II

4. Biological Treatment : Activated Sludge Process: Substrate Utilization and Biomass Growth, Kinetic Parameters, Process Description and its Modification, Process Design , Biofilm Process: Trickling Filter, Rotational Biological Contactor **10 hrs**

Aerated lagoons, oxidation pond-operation and maintenance

5.Advanced Treatment Processes- Chemical Coagulation, Carbon Adsorption, Phosphorus Removal, Nitrogen Removal (Nitrification/Denitrification), Media Filtration, UV Disinfection **06 hrs**

Unit III

6. Solids Handling Processes- Gravity Thickening, Flotation Thickening, Dewatering, Pressure Filtration, Stabilization, Aerobic and Anaerobic Digestion, Composting, Drying, Incineration, Landfilling, Land Application **09 hrs**

Text Books

1. Eddy and Metcalf ,*Wastewater Engineering – Treatment and Reuse* ,Tata McGraw Hill Education Pvt Ltd., New Delhi, 2003.
2. Modi, P.N., *Sewage Treatment and Disposal Engg.*, Standard Book House, New Delhi, 2000.
3. Howard S. Peavy, Donald R. Rowe, George Techno Bano Glous, *Environmental Engineering*, McGraw Hill International, 2010.

Reference Books:

1. Qasim S.R., Motley E. M., *Wastewater Treatment Plants – Planning, Design and Operation*, Prentice Hall, New Delhi. 2002.
2. Davis, M.L. and Cornwell, D.A., *Introduction to Environmental Engineering*, Tata McGraw Hill Education Pvt. Ltd., New Delhi,. 2010
3. Hammer M.J., *Water and Waste Water Technology*, John Wiley and Sons, New York , 2000.

Course Title: Air Pollution		**Course Code: 15ECVE409**
L-T-P: 3-0-0	**Credits: 3**	**Contact Hours: 3 Hrs/ week**
ISA Marks: 50	**ESA Marks: 50**	**Total Marks: 100**
Teaching Hours: 40	**Examination Duration: 3 Hrs**	

Unit I

1. Introduction

Definition -Classification and properties of Air pollutants, Primary and secondary Air pollutants, Concentrations of Air pollutants and sources. Behavior and Fate of Air Pollution: Chemical reaction in the Atmosphere, photochemical Smog. **05 hrs**

2. Effects of Air Pollution **05 hrs**

On human health, Animals, Plant and properties, Major Episodes.

3. Meteorology

Introduction -Meteorological Variables, Lapse Rate – Adiabatic - Dispersion, inversion, stability conditions, wind rose, general characteristics of stack plumes **05 hrs**

Unit II

4. Sampling and Analysis of Air Pollutants

Sampling and measurement of Gaseous and particulate pollutants, stack sampling, smoke and its measurements. **05 hrs**

5. Control of Air Pollutants **10 hrs**

Control methods -Particulate emission control, gravitational settling chambers, cyclone separators, fabric filters, Electrostatic precipitators, wet scrubbers, control of gaseous emissions (Design not requires)

Unit III

6. Air Pollution Due to Automobiles

Air pollution due to gasoline driven and Diesel driven engines, effects, control - direct and indirect methods. **02 hrs**

7. Global Environmental Issues **04 hrs**

Acid rain, Green House effect, Global warming, Ozone layer Depletion.

8. Environmental Impact Assessment

Environmental Impact Assessment in industrial plant locations and planning. Standards and legislation -Air quality and emission standards - legislation and regulation, Air pollution index **04 hrs**

Text Books

1. Rao, H.V.N., and Rao, M.N., *Air Pollution*, Tata McGraw Hill Education Pvt. Ltd., New Delhi, 2007.

2. Rao, C.S., *Environmental Pollution Control*, New Age International Pvt. Ltd, New Delhi, 2006.

Reference Books:

1. A.O.C., Stem, *Air Pollution -Vol I -IV*, Academic Press., 2010.
2. Henry C Perkins, *Air pollution*, Tata McGraw Hill Education Pvt Ltd., New Delhi, 1974.