Curriculum for B. Tech.-M.Tech (Civil-Transportation Engineering) School of Infrastructure

Subject Name	Code	L-T-P	Credit	Contact Hour
SEMESTER - I				
Mathematics – I	**MA1L001**	3-1-0	4	4
Physics / Chemistry	**PH1L001 / CY1L001**	3-1-0	4	4
Mechanics / English for Communications or Learning English	**ME1L001 / HS1L001 or HS1L002**	3-1-0/3-0-2 or 3-1-0	4	4/5 or 4
Electrical Technology / Introduction to Programing and Data Structures	**EE1L001 / CS1L001**	3-1-0	4	4
Introduction to Manufacturing Processes / Engineering Drawing and Graphics	**ME1P001 / CE1P001**	0-0-3/1-0-3	2/3	3/4
Physics Laboratory / Chemistry Laboratory	**PH1P001 / CY1P001**	0-0-3	2	3
Electrical Technology Laboratory / Introduction to Programing and Data Structures Laboratory	**EE1P001 / CS1P001**	0-0-3	2	3
EAA – 1	**ID1T001**	0-0-3	1	3
		Total	**22/ 23 +1**	**25/ 27 or 26+3**
SEMESTER - II				
Mathematics – II	**MA1L002**	3-1-0	4	4
Chemistry / Physics	**CY1L001 / PH1L001**	3-1-0	4	4
English for Communication or Learning English / Mechanics	**HS1L001 or HS1L002 / ME1L001**	3-0-2 or 3-1-0/3-1-0	4	5 or 4/4
Introduction to Programing and Data Structures / Electrical Technology	**CS1L001 / EE1L001**	3-1-0	4	4
Chemistry Laboratory / Physics Laboratory	**CY1P001 / PH1P001**	0-0-3	2	3
Introduction to Programing and Data Structures Laboratory / Electrical Technology Laboratory	**CS1P001 / EE1P001**	0-0-3	2	3
Engineering Drawing and Graphics / Introduction to Manufacturing Processes	**CE1P001 / ME1P001**	1-0-3/0-0-3	3/2	4/3
EAA – 2	**ID1T002**	0-0-3	1	3
		Total	**23/22+1**	**27or 26/ 25 +3**
SEMESTER - III				
Introduction to Material Science and Engineering	**ID2L001**	2-0-0	2	2
Introduction to Bioscience and Technology	**ID2L002**	2-0-0	2	2
Basic Electronics		3-1-0	4	4
Mathematics – 3 (Probability, Statistics & Stochastic Processes)	**MA2L003**	3-1-0	4	4
Solid Mechanics	**CE2L001**	3-1-0	4	4
Surveying	**CE2L002**	3-0-0	3	3
Basic Electronics Laboratory		0-0-3	2	3
Surveying Practice	**CE2P002**	0-0-3	2	3
Project Seminar	**CE2S001**	0-0-0	2	0
		Total	**25**	**25**
SEMESTER – IV				
Lateral 1			3/4	3/4
Breadth-1			3/4	3/4
Environmental Science, Technology and Management	**ID3L003**	2-0-0	2	2
Introduction to Civil Engineering and Construction Materials	**CE2L003**	3-0-0	3	3
Structural Analysis	**CE2L004**	3-1-0	4	4
Hydraulics	**CE2L005**	3-1-0	4	4
Transportation Engineering	**CE2L006**	3-0-0	3	3
Transportation Engineering Laboratory	**CE2P001**	0-0-3	2	3
		Total	**24/26**	**25/27**

SEMESTER - V				
Lateral 2			3/4	3/4
Breadth-2			3	3
Design of Reinforced Concrete Structures	**CE3L001**	3-1-0	4	4
Soil Mechanics	**CE3L002**	3-1-0	4	4
Water Resources Engineering	**CE3L003**	3-0-0	3	3
Structural Engineering Laboratory	**CE3P001**	0-0-3	2	3
Soil Mechanics Laboratory	**CE3P002**	0-0-3	2	3
Water Resources Engineering Laboratory	**CE3P003**	0-0-3	2	3
		Total	**23/24**	**26/27**
SEMESTER - VI				
Lateral 3			3	3
Breadth - 3			3	3
Design of Steel Structures	**CE3L004**	3-0-0	3	3
Foundation Engineering	**CE3L005**	3-0-0	3	3
Water and Wastewater Engineering	**CE3L006**	3-1-0	4	4
Civil Engineering Drawing and Estimation	**CE3P004**	0-0-3	2	3
Structural Design and Detailing	**CE3P005**	0-0-6	4	6
Water and Wastewater Engineering Laboratory	**CE3P006**	0-0-3	2	3
		Total	**24**	**28**
INDUSTRIAL SUMMER TRAINING AFTER 6th SEMESTER				
SEMESTER - VII				
Breadth - 4			3/4	3/4
Urban Transportation Planning	**CE6L401**	3-1-0	4	4
Pavement Material Characterization	**CE6L403**	3-1-0	4	4
Elective-1	**CE4LXXX**	3-0-0	3	3
CAD Laboratory	**CE4P001**	0-0-3	2	3
Industrial Training Defence	**CE4T001**	0-0-0	2	0
Project – Part 1 (CE)	**CE4D001**	0-0-0	4	0
		Total	**22/23**	**17/18**
SEMESTER - VIII				
Fundamentals of Traffic Flow Theory	**CE6L402**	3-1-0	4	4
Elective - 2	**CE6LXXX**	3-1-0	4	4
Elective – 3	**CE6LXXX**	3-0-0	3	3
Elective – 4	**CE6LXXX/MA6LXXX**	3-1-0	4	4
Traffic Engineering Studies	**CE6P402**	0-0-3	2	2
Project – Part 2 (CE)	**CE4D002**	0-0-0	6	0
		Total	**23**	**17**
SEMESTER - IX				
Elective-5	**CE6LXXX**	3-1-0	4	4
Pavement Materials Laboratory	**CE6P401**	0-0-3	2	3
Thesis : Part-I (CE)	**CE6D001**	0-0-0	12	0
		Total	**18**	**7**
SEMESTER - X				
Seminar	**CE6S002**	0-0-0	2	0
Transportation Systems Planning Studio	**CE6P404**	0-0-3	2	3
Thesis : Part-I (CE)	**CE6D001**	0-0-0	12	0
		Total	**16**	**3**
	Grand Total	**Total**	**220/225**	

List of Electives (1):

#No	Code	Subject Name	L-T-P	Credit
1	**CE4L004**	Rock Mechanics and Tunnelling	3-0-0	3
2	**CE4L005**	Maintenance and Rehabilitation of Concrete Structures	3-0-0	3
3	**CE4L022**	Bridge Engineering	3-0-0	3
4	**CE4L023**	Pre-stressed Concrete	3-0-0	3
5	**CE4L044**	Soil Engineering	3-0-0	3
6	**CE4L045**	Earth Retaining Structures	3-0-0	3
7	**CE4L051**	Remote Sensing and GIS	3-0-0	3
NB: Any other subjects of same or higher level floated by any other specialisations of School of Infrastructure and/or any other Schools can also be taken as an elective, as suggested by faculty advisor/PG Coordinators				

List of Electives (2 to 5):

Sl. No	Subject Code	Subject Name	L-T-P	Credit
1	**MA6L002**	Advanced Techniques in Operation Research	3-1-0	4
2	**CE6L451**	Design of Transportation Facilities and Safety	3-1-0	4
3	**CE6L452**	Economic Evaluation of Transportation System	3-0-0	3
4	**CE6L453**	Analysis of Transportation Systems	3-0-0	3
5	**CE6L454**	Pavement Evaluation and Management	3-1-0	4
6	**CE6L404**	Analysis and Design of Pavements	3-1-0	4
7	**CE6L455**	Airport Planning and Design	3-0-0	3
8	**CE6L456**	Public Transportation System	3-0-0	3
9	**CE6L006**	Construction Project Management	3-0-0	3
10	**CE6L011**	Environmental Management & Impact Assessment	3-0-0	3
11	**CE6L022**	Ground Improvement	3-0-0	3
12	**CE6L023**	Computational Geomechanics	3-0-0	3
13	**CE6L025**	Geotechnical Risk and Reliability	3-0-0	3
14	**CE6L304**	Advanced Concrete Technology	3-0-0	3
NB: Any other subjects of same level floated by other specialisations of School of Infrastructure and/or by any other Schools can be taken as an elective after due consultation with the faculty advisor/PG Coordinator.				

Subject Code: CE1P001	Name: Engineering Drawing	L-T-P: 1-0-3	Credit: 3

Prerequisite: None

Introduction to IS code of drawing; Conics and Engineering Curves – ellipse, parabola, hyperbola, cycloid, trochoid, involute; Projection of lines – traces, true length; Projection of planes and solids; sold objects – cube, prism, pyramid, cylinder, cone and sphere; Projection on Auxiliary planes; Isometric projection, isometric scale; Section of solids – true shape of section; Introduction to CAD tools – basics; Introduction of Development and Intersection of surfaces.

Books:

- Bhatt, N.D., Elementary Engineering Drawing, Charotar Publishing House
- Gill, P.S., Engineering Drawing & Engg. Graphics, S. K. Kataria & Sons
- Lakshminarayan, L.V. & Vaish. R.S., Engineering Graphics, Jain Brothers

Subject Code: CE2L001	Name: Solid Mechanics	L-T-P: 3-1-0	Credit: 4

Prerequisite: None

Stress analysis: forces and moments, theory of stress, principal stresses and stress invariants, compatibility equations, equilibrium equations; Strain analysis: deformation and velocity gradients, Lagrangian and Eulerian description andfinite strain, small deformation theory, principal strains and strain invariants, compatibility conditions; Bending of Symmetric and non-symmetric sections; Thick cylinders and pressure vessels; Introduction of theory of elasticity Simple problems (semi-inverse method);Theories of failure; Stress concentration; Fatigue; Creep and relaxation.

Books:

- Kazioni, S.M.A., Solid Mechanics, Tata McGraw Hill,
- Popoo, E.P., Introduction to Mechanics of Solids, Prentice Hill of India
- Crandall, S.H., Dahl, N.C., Lardner, T.J. and Sivakumar, M.S., An Introduction to Mechanics of Solids, Tata McGraw Hill
- Jindal, U. C., Strength of Materials, Pearson
- Timoshenko, Strength of Materials, CBS

Subject Code: CE2L002	Name: Surveying	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Introduction: Elements of surveying and mapping, types of surveys, Measurement of Distance, Direction and Elevation. Chain Surveying, Compass Surveying, Plane Table Surveying, Levelling and Contouring, Theodolite Surveying, Layout of curves, Tacheometry, Triangulation, Computation of Area and Volume, Total Station, Global Positioning System, Introduction to Remote Sensing and Geographical Information System.

Books:

- Punmia, B.C., Surveying Vol. I, II and III, Laxmi Publication Pvt. Ltd.
- Arora, K. R., Surveying Vol. I, II and III, Standard Book House.
- Gopi, S., Sathikumar, R. and Madu, N., Advanced Surveying: Total Station, GISand Remote Sensing, Pearson Education India.

Subject Code: CE2P002	Name: Surveying Practice	L-T-P: 0-0-3	Credit: 2

Prerequisite: None

Introduction, Types of Surveys, Chaining, Taping, Corrections, Angle and Direction Measurements, Prismatic compass, Measurement of bearing, Computations of angles from bearings, Theodolite Surveying, Temporary Adjustments, Traversing, Principle of Levelling,

Simple and Differential Levelling, Adjustments, Plane table Surveying, Different Methods, Two and Three Point Problems, Minor Surveying Instruments, Setting out Simple Works. Practicals: Chaining, Offsets, Field book entry, Triangulation AND Traversing, Compass Surveying AND Traversing, Plane Table Surveying , Two Point and Three Point Problems, Levelling, Level book entry, Preparation of contour Map, Study of Theodolites and Angle Measurements, Theodolite Traversing, Techeometric Traversing, Use of Distomat / Theomat, Interpretation of Aerial Photographs AND Satellite Imagery. Surveying through Total Station equipment.

Subject Code: CE2L003	Name: Introduction to Civil Engineering and Construction Materials	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Introduction to Civil Engineering; Major Divisions; Civil Engineering Infrastructures; Ethics in Civil Engineering; Properties of construction material and their evaluation; test methods and specifications; Cement – chemical composition, properties such as setting, strength, fineness, hydration; Aggregates – sources, properties, chemical reactivity; Concrete - constituents, proportioning, properties in fresh and hardened state, characteristic strength, quality control, transportation and placing, testing, porosity; Admixtures – chemical, mineral; Steel – properties, types of steel, steel in civil engineering; Bricks – manufacture, properties and classification; masonry bonds; Wood - Structure, defects & preservation; Paints, New materials – Fibre reinforced plastics (FRPs), epoxy-coated bars, Geo-synthetics etc., Construction methodologies and equipment.

Books:

- Taylor, G.D., Materials of Construction, Prentice Hall
- Mehta P.K. and Montiero, P.M.J., Concrete – Material, Microstructure and Properties, Tata Mcgraw Hill
- Gambhir, M.L., Concrete Technology, Tata Mcgraw Hill
- Neville, A.M. and Brooks, J.J., Concrete Technology, ELBS/Longman
- Neville, A.M., Properties of Concrete, 4th Edition, ELBS/Longman
- Dayaratnam, P. Brick and Reinforced Brick Structures, Oxford and IBH
- Ghose, D.N., Construction Materials, Tata Mcgraw Hill
- Relevant IS codes for testing and specifications
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Subject Code: CE2L004	Name: Structural Analysis	L-T-P: 3-1-0	Credit: 4

Prerequisite: None

Stability and Determinacy of Structures; Analysis of Statically Determinate Structures; Review of shear force and bending moment diagrams in beams and frames; Plane trusses: Deflection of trusses; Deflection of beams and frames; Influence line diagrams and moving loads; Analysis of Statically Indeterminate Structures; Force and stiffness methods of analysis; Plane trusses by using method of consistent deformations, Beams and frames: Plane trusses by using direct stiffness method; Curved beams, arches and rings;

Books:

- Wang, C.K., Intermediate Structural Analysis, McGraw Hill
- Vazirani, V.N. and Ratwani, M.M., Analysis of Structures Vol-1, Vol-2, Khanna Publishers
- Ramamrutham, S. and Narayan, R., Theory of Structures, Dhanpat Rai

Subject Code: CE2L005	Name: Hydraulics	L-T-P: 3-1-0	Credit: 4

Prerequisite: None

Basic properties of water; Determination of hydrostatic forces; Kinematics of flow; Potential flow; Continuity, Energy and Momentum principles; Open channel flow; Uniform and gradually varied flows; Dimensional analysis; Hydraulic similitude and Modelling; Flow in pipes and Pipe networks; Hydraulics machines; Pumps and Turbines.

Books:

- Subramanya, K., Fluid Mechanics and Hydraulic Machines, Tata McGraw Hill
- Kundu, P.K., Cohen, I.M. and Dowling, D.R., Fluid Mechanics, Academic Press, Elsevier
- White, F.M., Fluid Mechanics, Tata McGraw Hill
- Streeter, V.L., Fluid Mechanics, Tata McGraw Hill

Subject Code: CE2L006	Name: Transportation Engineering	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Different Modes of Transportation; Highway Development in India; Highway Alignment, Survey and Detailed Project Report; Geometric Design of Highways: cross-sectional elements, horizontal and vertical alignments; Elements of Traffic Engineering; Pavement Materials: subgrade soil, aggregates, bituminous binders; Pavement Design: design of flexible and rigid pavements, Elements of Highway Construction: embankment, subgrade, subbase and base courses, bituminous surface courses, concrete pavements, soil stabilization; Drainage; Evaluation and Maintenance of highways.

Books:

- Khanna, S. K. and Justo, C.E.G., Highway Engineering, Nem Chand & Bros
- Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna Publishers
- Chakraborthy, P. and Das, A., Principles of Transportation Engineering, Prentice Hall of India

Subject Code: CE2P001	Name: Transportation Engineering Laboratory	L-T-P: 0-0-3	Credit: 2

Prerequisite: None

Tests on Bitumen: Penetration Test, Viscosity Test, Ductility Test, Softening Point Test; Tests on Aggregates: Crushing test, Abrasion Test, Impact Test, Shape Test; CBR test on Soil, Dynamic Cone penetrometer Test, Roughness measurement of road surface, Traffic Studies: Classified Traffic Volume Count, Speed Studies etc.

Books:

- Khanna, S. K. and Justo, C.E.G., Highway Material Testing, Nem Chand & Bros.
- Khanna, S.K, Justo, A and Veeraragavan, A, Highway Materials and Pavement Testing, Nem Chand & Bros.
- Kadiyali, L. R., Traffic Engineering and Transportation Planning, Khanna Publishers

Subject Code: CE3L001	Name: Design of Reinforced Concrete Structures	L-T-P: 3-1-0	Credit: 4

Prerequisite: None

Introduction to the design of Concrete structures: Structural Systems, Materials, Loadings and Structural Analysis, Working Stress Design, Ultimate Load Design, Limit State Design; Working Stress Design: Beams for Bending Moment and Shear Force; Limit State Design: Beams for Bending Moment, Shear Force, Bond and Torsion. Axially and eccentrically loaded Columns. Beam-Columns for combined compression and flexure. One and two-way Slabs, Structural Components: Isolated and Combined Footings; Lintels, Stair Cases, Retaining Walls.

Books:

- Gambhir, M.L., Design of Reinforced Concrete Structures, PHI Learning
- Varghese, P.C., Limit State Design of Reinforced Concrete, PHI Learning
- Pillai, S.U. and Menon, D., Reinforced Concrete Design, Tata McGraw Hill
- Punmia, B.C., Jain A.K. and Jain A.K., Reinforced Concrete Structures Vol-I and II, Laxmi Publications
- Park, R. and Pauley, T., Reinforced Concrete Structures, Willey International

Subject Code: CE3L002	Name: Soil Mechanics	L-T-P: 3-1-0	Credit: 4

Prerequisite: None

Introduction, formation of soils, index properties and classification of soils, soil compaction, proctor and modified compaction, field control of compaction, effective stress, stress point and stress path, soil-water-system - surface tension and capillarity, Darcy's law, permeability of soils, methods of determining coefficient of permeability, seepage analysis, flow nets, piping, quick sand condition, compressibility and consolidation of soils, normally and over consolidated soil, time rate of consolidation, determination of coefficient of consolidation, shear strength of soils, direct shear and triaxial tests, Mohr-Coulomb strength criterion, CU, CD and UU tests, pore pressures, Skempton's pore pressure coefficients.

Books:

- Murthy, V.N.S., Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering by Marcel Dekkar, Inc., USA
- Das, B.M., Principles of Geotechnical Engineering, PWS Publishing Company, Boston, USA.
- Terzaghi, K., Ralph B.P. and Mesri, G., Soil Mechanics in Engineering Practice, John Wiely and Sons, Inc.
- Muniram, B., Soil Mechanics and Foundations, John Wiely and Sons, Inc.
- Lambe, T.W., Whitman, R.V., Soil Mechanics, John Wiely and Sons, Inc. Canada.
- Parry, R.H.G., Mohr Circles, Stress Paths and Geotechnics, E & FN SPON publishers.

Subject Code: CE3L003	Name: Water Resources Engineering	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Concepts of hydrologic cycle; Measurement and analysis of precipitation and runoff; Hydrograph analysis; Irrigation requirement of crops; Design of canals; Design and drawing of weirs and barrages; cross drainage works; Classification; analysis; design and drawing of Gravity and Earth dams; Design and drawing of spillways and energy dissipators.

Books:

- Subramanya, K., Engineering Hydrology, Tata McGraw-Hill
- Garg, S.K., Irrigation Engineering and Hydraulic Structures, Khanna Publishers
- Chow, V.T., Maidment, D.R. and Mays, L.W., Applied Hydrology, Tata McGraw-Hill

Subject Code: CE3P001	Name: Structural Engineering Laboratory	L-T-P: 0-0-3	Credit: 2

Prerequisite: None

Casting and load-deformation test of reinforced concrete and post tensioned beams; Cement test: Standard consistency, setting times, compressive strength, fineness and soundness; Aggregate Tests: Sieve analysis, Bulking of sand, Aggregate crushing value, Absorption, Unit weights; Tension test of MS, HYSD, HT bars: Yield/Proof stress, Ultimate Strength, Young's modulus, percentage elongation; Compressive strength of bricks and Pre-conditioning; Load deformation testing of steel beam; Concrete mix design and slump test; Demonstration of flow table, compacting factor and V.B. tests; Compressive strength of cubes by Non-Destructive Testing; Dynamics of SDOF, MDOF systems; Indirect tensile strength of cylinders.

Subject Code: CE3P002	Name: Soil Mechanics Laboratory	L-T-P: 0-0-3	Credit: 2

Prerequisite: None

Specific gravity test, sieve analysis, hydrometer analysis, Atterberg's limits tests, Proctor compaction test, relative density of sand, in-situ density test, permeability tests, direct shear test, unconfined compression test, vane shear test, triaxial tests, consolidation test.

Books:

- Lambe, T.W., Soil Testing for Engineers John Wiley & Sons Inc.
- Murthy, V.N.S., Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, Marcel Dekkar, Inc., USA.
- Robert W.D., Soil Testing Manual: Procedures, Classification Data, and Sampling Practices, McGraw-Hill Professional.

Subject Code: CE3P003	Name: Water Resources Engineering Laboratory	L-T-P: 0-0-3	Credit: 2

Prerequisite: CE2L005: Hydraulics

Experiments on flow measurements in open channels and pipes; verification of momentum and energy equations; hydraulic jump; measurement of hydrostatic and hydrodynamic forces; flow in open channels; specific energy

Subject Code: CE3L004	Name: Design of Steel Structures	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Introduction to Steel Structure Design: Structural Systems, Design Loads and Load Combinations, Rolled Sections and Built-up sections; Working Stress Design; Plastic Design; Limit State Design Methods; Design of structural fasteners: rivets, bolts and welds. Simple and Eccentric Connections; Design of tension members; Design of compression members; Design of Built-up column using lacing and battening; Design of flexure members; Design of Beam-Column; Design of Column Bases; Design of Plate Girder and Gantry Girder.

Books:

- Subramanian, N., Design of Steel Structures, Oxford University Press
- Duggal, S.K., Limit State Design of Steel Structures, McGraw Hill
- Ram, K S, Design of Steel Structures, Pearson Education

Subject Code: CE3L005	Name: Foundation Engineering	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Introduction, examples of foundation problems, site characterization, soil exploration, site investigation methods, in-situ tests, Bearing capacity: general, local and punching shear failure, effect of size, shape, depth and water table, Settlement of foundations: elastic, consolidation and total settlement, Types of foundation: shallow and deep foundations, isolated, combined, mat etc., contact pressure distribution, basics of design of shallow foundation, deep foundation type, load transfer mechanism in piles, pile capacity, laterally loaded pile, test pile and pile load test, efficiency of pile group, settlement of pile, earth pressure theories: Rankine's theory, Coulomb's theory, Stability analysis of earth retaining structures - gravity, cantilever, counterfort, Slope stability: finite slopes and infinite slopes, Bishop's simplified method, method of slices.

Books:

- Bowles, E., Foundation Analysis and Design by Joseph, McGraw Hill Higher, USA.
- Das, B. M., Principles of Foundation Engineering, Cengage Learning.
- Das, B. M., Principles of Geotechnical Engineering, Cengage Learning.
- Budhu, M., Soil mechanics and foundations, Wiley Publishers, New Delhi.
- Murthy, V. N. S., Principles of Soil Mechanics and Foundation Engg, UBSPD.
- Khan, I.H., A text book of Geotechnical Engg, Prentice Hall India.
- Gopal Ranjan & Rao, A. S. R. Basic and Applied Soil Mechanics, Wiley Eastern Ltd.

Bowles, Joseph E. Foundation analysis and design, McGraw-Hill Publishers

Subject Code: CE3L006	Name: Water and Wastewater Engineering	L-T-P: 3-1-0	Credit: 4

Prerequisite: None

General requirement for water supply, population forecasting and water demand, sources, intake, pumping and transportation of water; Physical, chemical and biological characteristics of water and their significance, Water quality criteria, Water borne diseases, Natural purification of water sources. Engineered systems for water treatment: aeration, sedimentation, softening, coagulation, filtration, adsorption, ion exchange, and disinfection. Generation and collection of wastewater, quantities of sanitary wastes and storm water. Design of sewerage system Primary, secondary and tertiary treatment of wastewater; Wastewater disposal standards. Basics of microbiology. Biological wastewater treatment systems: Aerobic processes - activated sludge process and its modifications, trickling filter, RBC, Anaerobic Processes- conventional anaerobic digester, High rate and hybrid anaerobic reactors. Sludge digestion and handling. Disposal of effluent and sludge Design problems on water and wastewater treatment units and sludge digestion.

Books:

- Peavy, H. S., Rowe, D. R. and Tchobanoglous, G., Environmental Engineering, McGraw-Hill International Ed.
- McGhee, T. J, Water Supply and Sewerage, McGraw-Hill Inc.
- Davis, M. L and Cornwell, D. A, Introduction to Environmental Engineering, McGraw-Hill, Inc.
- Metcalf & Eddy, Wastewater Engineering- Treatment and Reuse (Revised by G. Tchobanoglous, F. L. Burton and H. D. Stensel), Tata McGraw Hill.
- Sawyer, C. N, McCarty, P. L and Parkin, G. F., Chemistry for Environmental Engineers, McGraw- Hill.
- APHA, Standard Methods Examination of Water and Wastewater, American Public Health Association, Washington DC.
- Manual for Sewer and Sewerage, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India.

- Manual for water supply and treatment, Central Public Health & Environmental Engineering Organisation, Ministry of Housing and Urban Development, Govt. of India.

Subject Code: CE3P004	Name: Civil Engineering Drawing and Estimation	L-T-P: 0-0-3	Credit: 2

Prerequisite: None

Building drawing: Components of buildings - Plan, elevation and section of buildings; Hands on Practice using AutoCAD or Solid Works, Estimation: Central line method, short wall - long wall method, units of measurement, Rate analysis, Cost estimation for buildings and other structures.

Books:

- Malik, R.S. and Meo, G.S. Civil Engineering Drawing, Computech Publications Limited
- Dutta, B.N., Estimating and Costing in Civil Engineering: Theory and Practice including Specification and Valuation, Sangam Books
- Chakraborti, M., Estimating, Costing, Specification, Valuation in Civil Engineering, Chakraborti

Subject Code: CE3P005	Name: Structural Design and Detailing	L-T-P: 0-0-6	Credit: 4

Prerequisite: CE3L001: Design of Reinforced Concrete Structures

Detailed Design of Multistoried RC Building and Detailing of RC Slabs, Beams, columns and footings; Design of Industrial Steel Building with Truss Roof and Detailing of Trusses, Gusseted Joints, Eccentric Connections Riveted/Welded, Beam End Connections, Built-up Column; Design and detailing of Special Structures: Pile foundation, Water tank and Retaining wall.

Subject Code: CE3P006	Name: Water and Wastewater Engineering Laboratory	L-T-P: 0-0-3	Credit: 2

Prerequisite: None

Physical characteristics of water - Turbidity, Taste, Odor, Colour, Electrical conductivity; Analysis of solids content of water - Dissolved, settleable, suspended, total, volatile, inorganic;; Alkalinity and acidity; Hardness - Total, calcium and magnesium; Analysis of ions - Fluoride, copper, arsenic; Optimum coagulant dose; Break point chlorination; Settling column analysis for sedimentation tank design; BOD and BOD rate constant determination; COD; DO and re-aeration constant determination; Bacteriological quality measurement: MPN, plate count

COMPULSORY SUBJECTS			
Subject Code: CE 6L403	Subject Name: Pavement Material Characterization	L-T-P: 3-1-0	Credit: 04
Pre-requisite(s): None			

Subgrade Soil: Classification, desirable properties, determination of soil strength characteristics, resilient modulus, Road aggregates: classification, properties of aggregates, design of aggregate gradation, Bituminous road binders: bitumen, emulsions, cut backs and modified binders, Rheology of bituminous binders, modified binders, Hot mix, Warm mix and Cold mix Bituminous constructions, Mix design: Marshall method and Superpave procedure, Visco-elastic and fatigue properties of bituminous mixtures, Requirements of paving concrete, design of mixes for recycling of bituminous and concrete pavement surfaces.

Books:
- A. T. Papagiannakis and E. A. Masad, Pavement Design and Materials, Wiley Publications
- J. Read and D. Whiteoak, The Shell Bitumen Handbook, 5th edition, Thomas Telford Ltd
- Asphalt Institute, Asphalt Binder Handbook, Manual Series No. 2 (MS-26). Asphalt Institute. Lexington, KY
- Asphalt Institute. Mix Design Methods for Asphalt, Manual Series No. 2 (MS-02). Asphalt Institute. Lexington, KY
- Rajib B. Mallick, Tahar El-Korchi Pavement Engineering: Principles and Practice, Second Edition, CRC Press
- Roberts, F.L.; Kandhal, P.S.; Brown, E.R.; Lee, D.Y. and Kennedy, T.W. Hot Mix Asphalt Materials, Mixture Design, and Construction. National Asphalt Pavement Association Education Foundation. Lanham, MD

Subject Code: CE 6L401	Subject Name: Urban Transportation Planning	L-T-P: 3-1-0	Credit: 04
Pre-requisite(s): None			

Fundamentals of transportation system planning, transportation system planning process, Characteristics of Travel and urban transportation system, Demand theory and supply theory of transportation system, Steps of urban travel demand forecasting- trip generation, trip distribution, modal split and trip assignment, basics of urban transportation network, basics of tour-based or activity-based travel demand model, land use transport model, urban mass transportation, urban goods movement, Basics of activity-based model

Books:
- L.R. Kadiyali, Traffic Engineering and Transport Planning
- Williumsen and Ortuzar, Modelling Transport
- Kanafani, Transp. Demand Analysis.
- B.G. Hutchinson, Principles of Urban Transport System Planning
- Marvin L. Manheim, Fundamentals Of Transportation Systems Analysis, Volume 1
- Travel Demand Software for example TRANSCA, CUBE

Subject Code: CE6L402	Subject Name: Fundamentals of Traffic Flow Theory	L-T-P: 3-1-0	Credit: 04
Pre-requisite(s): None			

Driver behaviour, traffic information and control systems, traffic studies- volume, speed and delay studies, elements of traffic flow theory, PCU concept, characteristics of uninterrupted traffic, mathematical theories of traffic flow (Poisson arrivals, binomial and negative binomial distributions), headway distributions, gap acceptance, critical gap estimation, queuing theory, shock wave, capacity and LOS of Uninterrupted facilities, characteristics of interrupted traffic, traffic characteristics at unsignalised intersections, queue discharge characteristics at signalised intersections, dilemma zone.

Books:

- Fred. L. Mannering, Walter P. Kilareski and Scott S. Washburn, Principles of Highway Engineering and Traffic Analysis, John Wiley & Sons.
- D. R. Drew, Traffic Flow Theory and Control, MaGraw-Hill Book Company.
- A. D. May, Traffic Flow Fundamentals, Prentice Hall.
- Mike Slinn, Peter Guest and Paul Mathews, (2012). Traffic Engineering design, Taylor & Francis.
- Roess and McShane, Roger P. Roess, Elena S. Prassas, William R. McShane, Traffic Engineering, Pearson.
- L. R. Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers.
- Louis J. Pignatro, Traffic Engineering-Theory and Practice, Prentice-Hall, Englewood Cliffs, New Jersey.
- Khisty & Lal, Transportation Engineering, Prentice Hall India.
- C. S. Papacostas and P. D. Prevedouros, Transportation Engineering & Planning.

LABORATORY SUBJECTS			

Subject Code: CE4P001	**Name: CAD Laboratory**	**L-T-P: 0-0-3**	**Credit: 2**
Prerequisite: None			
Exposure to commercial software tools for analysis, design and research in civil engineering.			

Subject Code: CE6P401	**Subject Name: Pavement Materials Laboratory**	**L-T-P: 0-0-3**	**Credit: 02**
Pre-requisite(s): None			
Tests on Soils: Density of soil, CBR, Determination of Field CBR using Dynamic Cone Penetrometer Tests on Aggregate: gradation, shape tests, specific gravity, water absorption, aggregate crushing value, Los Angeles abrasion value, aggregate impact value. Tests on Bitumen: penetration, viscosity, flash and fire point, ductility and elastic recovery, softening point, specific gravity, Ageing of Bitumen, Rheology of Bitumen using Dynamic Shear Rheometer Tests on Bituminous Mixes: Marshall mix design, Bitumen content determination using centrifuge extractor.			
Books: • Highway Material Testing Laboratory Manual by Khanna S. K., Justo, C.E.G and Veeraraghavan, A., Nem Chand & Bros. • Various Relevant IRC, ASTM and AASTHO Codes			

Subject Code: CE6P402	**Subject Name: Traffic Engineering Studies**	**L-T-P: 0-0-3**	**Credit: 02**
Pre-requisite(s): None			
Volume studies: Direction, Duration and Classification of Traffic Volume at Mid-Block Section and Intersections, Headway Distributions Speed studies: Spot Speed Studies Journey time and delay studies: Travel Time and Delay Studies by Floating Car Method Arrival pattern studies of vehicles, Queue discharge characteristics Gap acceptance studies: Study of Gaps, Lags, Critical Gaps Intersection delay studies: Delay Measurement at Intersections Highway Capacity Estimation: Videographic method, Dynamic PCU			
Books: • Currin, T. R. (2013). Traffic Engineering-A Manual for Data Collection and Analysis, 2nd Edition, Cenage Learning. • Slinn, M. Guest, P., Mattehews, P. (2006). raffic Engineering Design-Principles and Practice, 2nd Edition Elseiver. • Highway Capacity Manual, 2010 • Relevant Indian Roads Congress (IRC) Codes			

Subject Code: CE6P404	**Subject Name: Transportation Systems Planning Studio**	**L-T-P: 0-0-3**	**Credit: 02**
Pre-requisite(s): None			
Parking study, OD study, travel demand survey, questionnaire development of mode choice, trip generation, trip distribution, mode choice model parametric and non-parametric modelling, dealing with different transportation planning packages and traffic engineering packages, economic analysis and accident analysis			
Books: • Simon P. Washington, Matthew G. Karlaftis, Fred L. Mannering, Statistical and Econometric Methods for Transportation Data Analysis, CRC Press • User Manuals of various packages • Relevant Indian Roads Congress (IRC) Codes • Williumsen and Ortuzar, Modelling Transport			

Subject Code: CE4L004	Name: Rock Mechanics and Tunnelling	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Introduction - objective, scope and problems of Rock Mechanics. Classification by origin, Lithological, Engineering. Rock exploration - rock coring, geophysical methods. Laboratory testing of rocks - all types of compressive strength, tensile strength and flexural strength tests. Strength and failure of rocks, Griffith's theory, Coulombs theory, rheological methods. In-situ tests on rock mass. Deformation characteristics of rocks, instrumentation and measurement of deformation of rocks. Permeability characteristics - interstitial water on rocks, unsteady flow of water through jointed rock mass. Mechanical, thermal and electrical properties of rock mass. Correlation between laboratory and field properties. Analysis of stresses. Thick wall cylinder, formulae, Kreish equation, Green span method. Openings in rock mass and stresses around openings. Pressure tunnels, development of plastic zone. Rock support needed to avoid plastic deformation. Lined and unlined tunnels. Underground excavation and subsidence. Rock mechanics applications. Bearing capacity of homogeneous as well as discontinuous rocks. Support pressure and slip of the joint. Delineation of types of rock failure. Unsupported span of underground openings, pillars. Rock slopes. Rock bolting. Plastic mechanics. Tunnels, shapes, usages, Methods of Construction, Problems associated with tunnels, tunnelling in various subsoil conditions and rocks.

Books:

- Goodman, R. E., Introduction to Rock Mechanics, John Wiley and Sons.
- Hudson, J.A. and Harrison, J.P. Engineering rock Mechanics: an introduction to the principles, Pergamon publishers.
- Chapman, David, Metje, Nicole and Stärk, Alfred, Introduction to Tunnel Construction. Spon Publishers, Taylor and Francis Group.
- Brady, B. H. G. and Brown, E. T. Rock Mechanics: for underground mining, Kluwer Academic Publishers.

Subject Code: CE4L005	Name: Maintenance and Rehabilitation of Concrete Structures	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Maintenance and Repair strategies - Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration; Serviceability and Durability of Concrete - Quality assurance for concrete construction concrete properties- strength, permeability, thermal properties and cracking. - Effects due to climate, temperature, chemicals, corrosion - design and construction errors - Effects of cover thickness and cracking; Materials and Techniques for Repair - Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, Ferrocement and polymers coating for rebars loadings from concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels and cathodic protection.; Repairs to Structures - Repair of structures distressed due to earthquake – Strengthening using FRP Strengthening and stabilization techniques for repair.

Books:

- Denison Campbell, Allen and Harold Roper, Concrete Structures, Materials, Maintenance and Repair, Longman Scientific and Technical UK.
- Allen R.T and Edwards S.C, Repair of Concrete Structures, Blakie and Sons, UK.
- Raikar, R.N., Learning from failures - Deficiencies in Design, Construction and Service - R&D Centre (SDCPL), Raikar Bhavan, Bombay.
- Santhakumar A.R., Concrete Technology, Oxford University Press, Printed in India by Radha Press, New Delhi.
- Emmons, Peter H., Concrete Repair and Maintenance Illustrated Galgotia Publications pvt. Ltd.

Subject Code: CE4L022	Name: Bridge Engineering	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Types of Bridges and loading standards. Hydraulic Design of Bridges, Foundation for piers and abutments, Open Foundation, Pile Foundation, Well Foundation, Bridge Substructure: Piers and Abutments. Bridge Superstructure: Design aspects, RC slab deck, Tee Beam and Slab deck. Composite Bridges. Pre-stressed concrete bridges, Steel trussed bridges; Bridge Construction, Inspection and Maintenance.

Books:

- Ponnuswamy, S, Bridge Engineering, McGraw Hill
- Jagadeesh and Jayaram, Design of Bridge Structure, PHI Learning

- Victor, D. J., Essentials of Bridge Engineering, Oxford and IBH Publishing

Subject Code: CE4L023	Name: Pre-stressed Concrete	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Concept on Mechanics; Materials; Properties of sections; Stress analysis - three methods; Prestressing and Post stressing; Beam design - no tension and ultimate; Poles and slab panels; Loss assessment; Composite beams; Design for shear. Large span structures; Structural forms and design principles; Special materials, open web and built-up structures.

Books:

- Lin and Burns, Design Of Prestressed Concrete Structures, Wiley India
- Dayaratnam, P Prestressed Concrete Structures, Oxford and IBH
- Raju, K., Prestressed Concrete Bridges, CBS

Subject Code: CE4L044	Name: Soil Engineering	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Shear strength of cohesionless and cohesive soils, physico-chemical aspects, experimental determination of shear strength, failure theories, Yield criteria, influence on failure conditions of inter-mediate principal stress, history, drainage, rate of stress applications etc.; Plastic equilibrium in soils, Mohr diagram, active and passive states, theories of earth pressure on retaining walls, effect of wall friction on the shape of sliding surface, theories of arching, bearing capacity, concepts of general and local shear failure, critical height of vertical banks, various methods of computation of slope stability, earth pressure on timbering of cuts and on free and anchored bulkheads.

Books:

- Lambe, T. W. and Whitman, R. V., Soil Mechanics in SI Version, Wiley, New Delhi.
- Scott, R. F., Principles of Soil Mechanics, Addison Wesley, World Student Edition.
- Leonards, G. A., Foundation Engineering, McGraw-Hill.
- Bowles, J. E., Foundations Analysis and Design, McGraw-Hill.
- Peck, R. B., Hanson, W. E., and Thornburn, T. H., Foundation Engineering, John Wiley and Sons.

Subject Code: CE4L045	Name: Earth Retaining Structures	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Earth Pressure: Fundamental relationships between the lateral pressures and the strain with a back fill. Rankine's and Coulomb's theories, Active, passive and earth pressure at-rest; Backfill with broken surface, wall with broken back, concentrated surcharge above the back fill, earth pressure due to uniform surcharge, earth pressure of stratified backfills, saturated and partially saturated backfill. Passive earth pressure in engineering practice. Assumption and conditions, point of application of passive earth pressures; Bulkheads: Definition and assumptions, conditions of end supports and distribution of active earth pressure and bulkheads, bulkheads with free and fixed earth supports, equivalent beam method, Improvements suggested by Rowe, Tschebotarioff's method, Anchorage of bulkheads and resistance of anchor walls, spacing between bulkheads and anchor walls, resistance of anchor plates, Consideration of effects of ground water, seepage, surcharge loading together with possibility of shallow and deep sliding failures on retaining structure; Sheet Pile wall: Free earth system, fixed earth system, Dead man; Tunnel and Conduit: Stress distribution around tunnels, Types of conduits, Load on projecting conduits; Arching and Open Cuts: Arching in soils, Braced excavations, Earth pressure against bracings in cuts, Heave of the bottom of cut in soft clays; Reinforced earth retaining structures-Design of earth embankments and slopes; Recent advances in Earth retaining structures.

Books:

- Das, B. M., Principles of Foundation Engineering, Thomson, Indian Edition.
- Clayton, C. R. I., Milititsky, J. and Woods, R. I., Earth Pressure and Earth-retaining Structures, Chapman and Hall Publishers.
- Bowel, J., Foundation Engineering, Analysis and Design, McGraw Hill.
- Raj, P., Geotechnical Engineering, Tata McGraw Hill.
- Craig, R. F., Soil Mechanics, Chapman and Hall (ELBS).

Subject Code: CE4L051	Name: Remote Sensing and GIS	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Physics of remote sensing: Electromagnetic spectrum, atmospheric effects, energy interaction with earth surface features. Platforms and remote sensing sensors: Photographic camera, scanners, earth resources satellites, active and passive microwave sensors. Digital image processing: Image rectification, image enhancement, image classification and accuracy. Image interpretation. Geographical Information System (GIS): Map data representation, geographic database concepts and analysis. Application of remote sensing

and GIS in land and water resources system and evaluation.

Books:

- Bhatta, B., Remote Sensing and GIS, Oxford University Press.
- Mesev, V., Integration of GIS and Remote Sensing, John Wiley & Sons Ltd.
- Nayak, S., and Zlatanova, S., Remote Sensing and GIS Technologies for Monitoring and Prediction of Disasters, Springer.

Subject Code: MA6L002	Name: Advanced Techniques in Operation Research	L-T-P: 3-1-0	Credit: 4

One variable unconstrained optimization, multivariable unconstrained optimisation, Karush-Kuhn-Tucker (KKT) conditions for constrained optimization, quadratic programming, separable programming, convex and non convex programming, steepest and Quasi-Newton method.

Dynamic Programming: Characteristics of dynamic problems, deterministic dynamic programming and probabilitistic dynamic programming, Network analysis, Shortest path
problems, minimum spanning tree problem, maximum flow problem, minimum cost flow problem, network simplex, interior point methods, stochastic programming, Nonlinear goal
programming applications, Geometric Programming.

Multi-objective Optimization Problems: Linear and non linear programming problems, Weighting and Epsilon method, P-norm methods, Gradient Projection Method, STEM
method, Convex Optimization.

Text Book:
- S.S. Rao, Engineering Optimization Theory and Practices, John Wiley and Sons, 2009

Books:
- M. Ehrgott, Multi-criteria Optimization, Springer 2006
- K.M, Miettien, Non-linear multi-objective optimization, Kluwers International Series, 2004
- K. Deb, Multi-Objective Optimization using Evolutionary Algorithms, John Wiley & Sons, 2001.

Subject Code: CE6L451	Subject Name: Design of Transportation Facilities and Safety	L-T-P: 3-1-0	Credit:04

Pre-requisite(s): None

Geometric design provisions for various transportation facilities, Discussion of controls governing geometric design, Route layout and selection, Elements of design - sight distances, horizontal alignment, transition curves, super elevation and side friction. Vertical alignment: - grades, crest and sag curves. Highway cross-sectional elements and their design for rural highways, urban streets and hill roads. At-grade Inter-sections - sight distance consideration and principles of design, channelisation, mini round-abouts, layout and design of round-abouts, Design of signalised intersections, capacity and LOS for signalised intersections, signal design, signal coordination, interchange design templates, entrance and exit ramps, acceleration and deceleration lanes, Bicycle and Pedestrian Facility Design; Parking Layout and Design; Terminal Layout and Design. Accident prevention through better planning, Designing for safety, Highway operation and accident counter measures, Road safety checklists, accident data analysis and its prediction models.

Books:
- A policy on geometric design of highways and streets, American Association of State Highway Officials.
- Geometric design standards for urban roads in plains (IRC:86-1983), The Indian Roads Congress.
- Geometric design standards for rural (non-urban) highways (IRC:73-1980), The Indian Roads Congress, 1980.
- Manual of specifications & standards for six laning of highway through public private partnership (IRC: SP: 87-2010), The Indian Roads Congress.
- Manual of specifications & standards for four laning of highway through public private partnership (IRC:SP:84-2009), The Indian Roads Congress.
- Hill road manual (IRC:SP:48-1998), The Indian Roads Congress.
- Guidelines for expressways – Part I, Ministry of Road Transport & Highways.
- Guidelines for the design of interchanges in urban areas (IRC:92-1985), The Indian Roads Congress.
- Roadside design guide, American Association of State Highway Officials.
- Manual of geometric design standards for Canadian roads, Transportation Associations of Canada.
- Pline, J.L., Traffic Engineering Handbook, Institute of Transportation Engineers.
- Manual on Uniform Traffic Control Devices, Federal Highway Administration.
- Highway Capacity Manual 2010, Transportation Research Board.
- S.K. Khanna and C.E.G. Justo, Highway Engineering, Khanna Publishers, Roorkee, MXRoad Suite and manual for geometric design

Subject Code: CE6L452	Subject Name: Economic Evaluation of Transportation System	L-T-P: 3-0-0	Credit:03

Pre-requisite(s): None

Concept of demand, Elasticity of demand, Supply of transport, demand-supply interaction, Public Policy, Travel demand and value of time, Willingness-to-pay, valuation of user's benefit and optimal transport pricing policy, Appraisal and Economic Evaluation of Transportation Projects, Case Studies, Economic evaluation of highway projects in India, Road-users' cost study in India-Objectives and Methodology, Application of HDM Software, Behavioural aspect of transportation planning: Basics of travel behaviour analysis, stated and revealed preference data, experimental design, travel behaviour survey, binary, multinomial, nested logit model, maximum likelihood, case studies on choice modelling and estimation of value of travel attribute

Books:
- McCarthy, P. Transportation Economics, Blackwell Publishers
- Transportation Decision Making: Principles of Project Evaluation and Programming, Wiley, by Kumares C. Sinha, Samuel Labi,
- C. Jotin Khisty, B. Kent Lall, Transportation Engineering: An Introduction, Prentice Hall.
- Indian Roads Congress, "Manual for Road Investment Decision Model", Special Publication 38, New Delhi.
- Indian Roads Congress, "Manual on Economic Analysis of Highway Projects", Special Publication 30, New Delhi. Revised version.
- John Hibbs, Transport Economics & Policy: A Practical Analysis of Performance, Efficiency and Marketing Objectives Kogan
- Economics of Urban Transport by Kenneth A Small and Erik T Verhoef
- Principles of Traffic and Highway Engineering by Garber and Hoel
- Economic Evaluation of highway projects in India-IRC
- Road Users cost study in India - IRC
- Swait, Louviere and Hensher, Stated Preference Methods
- Moshe Ben Akiva, Discrete Choice Analysis: Theory and Analysis to Travel Demand
- Applied choice analysis: A Primer by David Hensher and Willium Greeene
- Discrete choice methods with simulation- by Kenneth Train
- HDM Software and manuals
- LIMDEP with NLOGIT Software and manual
- ALOGIT Software and manual
- NGENE Software Manual

Subject Code: CE6L453	Subject Name Analysis of Transportation Systems	L-T-P: 3-0-0	Credit:03

Pre-requisite(s): None

Transportation demand theory, supply theory and their interaction, transportation network and its analysis, shortest-path algorithm, concept in minimization problems and convex optimization, mathematical formulation of user equilibrium (UE) and System optimal (SO) traffic assignment methods, Uniqueness of UE and SO traffic assignment, solution of UE and SO traffic assignment, traffic assignment with variable demand and link-interaction, combined distribution-assignment models, Supernetworks, Stochastic network loading and stochastic user-equilibrium, multi-class assignment, basics of optimal network geometry and non-convex functions, concept of dynamic traffic assignment, brief introduction of probabilistic modelling, Queuing theory and its applications, spatially distributed queues, application of network models, Simulation in the urban context.

Books:
- Yosef Sheffi, Urban Transportation Networks
- Transportation Systems Engineering: Theory and Methods by Ennio Cascetta
- Marvin L. Manheim, Fundamentals Of Transportation Systems Analysis, Volume 1
- Urban travel demand modelling by Norbert Oppenheim
- Urban Operations Research by Larson and Odoni
- Ran, B., and Boyce, D. E., Modeling Dynamic Transportation Network - An Intelligent Transportation System Oriented Approach, Springer-Verlag, Heidelberg

Subject Code: CE6L454	Subject Name Pavement Evaluation and Management	L-T-P: 3-1-0	Credit:04

Pre-requisite(s): None

Types of pavements, Distresses in flexible and rigid pavements , Techniques for functional and structural evaluation of pavements, pavement rehabilitation techniques, overlay design procedures, recycling of flexible and rigid pavements, Maintenance of paved and unpaved roads, Pavement management systems, Introduction to HDM-4

Books:
- Y. H. Huang, Pavement Analysis and Design, Pearson Education
- Rajib B. Mallick, Tahar El-Korchi, Pavement Engineering: Principles and Practice, Second Edition, CRC Press
- Derek Pearson, Deterioration and Maintenance of Pavements, ICE Publishing
- Ralph Haas, W. Ronald Hudson, John P. Zaniewski, Modern pavement management Modern Pavement Management, Krieger Pub Co
- Croney, D. and P. Croney, The design and performance of road pavements, McGraw-Hill Book Company, London, UK.

Subject Code: CE6L404	Subject Name: Analysis and Design of Pavements	L-T-P: 3-1-0	Credit: 04

Pre-requisite(s): None

Types of Pavements, Pavement Composition, Philosophy of design of flexible, composite and rigid pavements, analysis of pavements using different analytical methods, selection of pavement design input parameters, traffic loading and volume, material characterization, drainage, failure criteria, reliability, design of flexible, composite and rigid pavements using different methods (IRC, AASHTO, Austroads etc), comparison of different pavement design approaches, design of overlays.

Books:
- Y. H. Huang, Pavement Analysis and Design, Pearson Education.
- E.J. Yoder and M. W. Witczak, Principles of Pavement Design, McGrawPub.
- Rajib B. Mallick, Tahar El-Korchi, Pavement Engineering: Principles and Practice, Second Edition, CRC Press
- Animesh Das, Analysis of Pavement Structures, CRC Press
- Nick Thom, Principles of Pavement Engineering, ICE Publishing

*The examination for this course may be considered for open book examination system.

Subject Code: CE6L456	Subject Name Public Transportation Systems	L-T-P: 3-0-0	Credit:03

Pre-requisite(s): None

Urban Passenger Transport Modes Classifications, Role of Mass Transportation System, Transit Modes and Characteristics, System Performance, Capacity, Quality of Service, efficiency and utilization, trip makers' perception analysis to various travel attributes, Willingness-to-pay estimation, demand analysis and user's benefit policy issue with reference to public transportation service improvement, optimal transport pricing policy, planning Issues, Route Determination, Network Design, Service Policy and Schedule development, Life Cycle cost in public transportation, Scheduling, Priority Measures and their Implementations, Issues and Challenges related to development of Mass Transportation System, Para-transits

Books:
- Public Transit Planning and Operation: Theory, Modelling and Practice by Avishai Ceder
- Urban Transit Systems and Technology by Vukan R. Vuchik.
- Urban Transit: Operations, Planning and Economics by Vukan R. Vuchik
- Studies in the economics of transportation by Beckmann et al.
- Applied choice analysis: A Primer by David Hensher and Willium Greeene
- Transportation Decision Making: Principles of Project Evaluation and Programming, Wiley,2007 by Kumares C. Sinha, Samuel Labi
- Fundamentals of Transportation Engineering by Fricker and Whitford
- Public Transportation related analysis using software like TRANSCAD, CUBE Software

Subject Code: CE6L006	Subject Name: Construction Project Management	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Principles of Project Management, Project Planning, Introduction to scheduling -work/project break down structures, Bar-charts; Principles of application of CPM and PERT; Precedence Method; Updating; Time -cost tradeoffs, Resource constrained scheduling;Resource leveling Project control; Performance Measurement, Earned value; Multiple Construction Projects; Other network techniques; Project Management Software Packages.

Books:

- Construction Project Management by Neeraj Kumar Jha , (Pearson Education India)
- Construction Management by Trefor Williams (Pearson Education India)
- Construction project managemnet techniques and practice by Krishnan Chitkara (Tata Mcgraw Hill)
- Purifoy, "Construction Planning, equipments and Methods", Mc Graw Hill, Tokyo, Japan.

Subject Code: CE6L008	Subject Name: Hydraulics of Sediment Transport	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Sediment properties; Initiation of motion; Bed Load; Bed Forms; Effective bed roughness; Armouring; Suspended Load; Total Load; Transport of Sediment due to unsteady flow; Meandering of rivers; Braided river; Local scour at different structures; Sediment sampling; Mathematical models of sediment transport.

Books:

- Yang, Sediment Transport: Theory and Practice
- Graf, Hydraulics of Sediment Transport
- Fredsoe and Diegaard, Mechanics of Coastal Sediment Transport
- Garde, History of Fluvial Hydraulics

Subject Code: CE6L011	Subject Name: Environmental Management & Impact Assessment	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Environmental management, problems and strategies; Review of political, ecological and remedial actions; Future strategies; multidisciplinary environmental strategies, the human, planning, descision-making and management dimensions. Environment Risk assessment, Pollution prevention and Waste minimization; sustainable development (SD), Life cycle assessment. Environmental impact assessment (EIA), definitions and concepts, Screening and scoping criteria; Rapid and comprehensive EIA, Legislative and environmental clearance procedures in India and other countries, Siting criteria; CRZ; Public participation; Resettlement and rehabilitation. Practical applications of EIA; EIA methodologies; Baseline data collection; Prediction and assessment of impacts on physical, biological and socio-economic environment; Environmental management plan; Post project monitoring, initial environmental examination (IEE), environmental impact statement (EIS), environmental appraisal, environmental audit (EA); Environmental impact factors and areas of consideration, measurement of environmental impact, organisation, scope and methodologies of EIA, case studies stressing physical aspects of environment. Evolution of EIA; EIA at project; Regional and policy levels; Strategic EIA; EIA process;

Books:

- Canter, L., Environmental Impact Assessment, McGraw Hill, 1996.
- Kiely, G., Environmental Engineering, Tata McGraw Hill, 2007
- Rau, G.J. and Wooten, C.D., Environmental Impact Analysis Handbook, McGraw Hill, 1980.
- Dhameja, Suresh K., Environmental Engineering and Management, S. K. Kataria & Sons
- World Bank, 'Environmental Assessment Source Book', Environment Dept., Washington D.C., 1991
- Welford, R., Corporate Environmental Management, Earthscan Publications Limited, London, 1996.
- Sayre, D., Inside ISO 14000 : Competitive Advantage of Environmental Management, St. Louis Press, Florida, 1996.
- Rosencranz, A., Divan, S. and Noble, M.L., Environmental Law and Policy in India : Cases, Materials and Statutes, Tripathi Pvt. Ltd, Bombay, 1992.
  Asolekar, S. R. and Gopichandran, R. Preventive Environmental Management - An Indian Perspective Foundation Books Pvt. Ltd., New Delhi (the Indian association of Cambridge University Press, UK), 2005.

Subject Code: CE6L022	Subject Name: Ground Improvement	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Introduction, ground improvements schemes for cohesive soil sites (preloading, staged construction, accelerated consolidation with prefabricated drains, granular columns, lime columns, electro-osmosis, compaction piles, deep mixing, and vibro-replacement), ground improvement schemes for cohesionless soil sites (deep dynamic compaction, vibro-compaction, blast densification, grouting, and jet grouting), mechanically stabilized earthwork, soil nailing, ground anchors, light weight fill, and monitoring and quality control in ground improvement projects.

Books:
- P. Puroshothama Raju, Ground Improvement Techniques, Laxmi Publications, New Delhi.
- M.P. Moseley and K. Kirsch, Ground Improvement, Spon Press, Taylor and Francis Group.
- B. M. Das, Principles of Foundation Engineering, Cengage Learning.
- Buddhima Indraratna and Jian J Chu, Ground Improvement: Case Histories, Elsevier.
- Chris A. Raison, Ground and Soil Improvement, Thomas telford, UK.
- Robert M. Koerner., Designing with Geosynthetics, Pearson Prentice Hall.

Subject Code: CE6L023	Subject Name: Computational Geomechanics	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Numerical modeling, constitutive modeling of soils and rock, continuum and discrete element modeling. Concept of stress and strain, principle stresses and strains. Octahedral stresses and strains, finite element discretization of a continuum, geomechanics problems of plane strain and axisymmetric problem. Failure criteria for soils, associated and non-associated flow rule. Finite elements for non-linear material problems in soil mechanics computational procedures. Finite difference approach. Simulation of soil-structure interaction problems, application in consolidation, bearing capacity and slope stability problems using numerical approaches.

Books:
- Chandrakant S. Desai and J.T. Christian Numerical Methods in Geotechnical Engineering, McGraw-Hill Publishers.
- Plasticity and Geomechanics by R. O. Davis, A. P. S. Selvadurai, Cambridge University Press
- Finite Element Analysis in Geotechnical Engineering: Theory and Application Author: David M. Potts and Lidija Zdravkovic (January 1, 2001)
- John T. Christian, Numerical Methods in Geotechnical Engineering, McGraw-Hill Publishers
- Computational Geomechanics with Special Reference to Earthquake Engineering by O. C. Zienkiewicz, A. H. C. Chan, M. Pastor, and B. A. Schrefler (Hardcover - May 11, 1999), Publisher: Wiley

Subject Code: CE6L025	Subject Name: Geotechnical Risk and Reliability	L-T-P: 3-0-0	Credit: 3

Prerequisite: None

Introduction to probabilistic geotechnical engineering, variability measures, random variables, probability mass and density functions, moments of distribution, modelling of uncertainty, engineering judgment, spatial variability of soil, autocovariance functions, functions of random fields, levels of reliability, loads and resistances, reliability methods, first order second moment (FOSM) method, Hasofer-Lind approach, Response Surface Method, Monte Carlo simulations.

Books:
- Achintya Haldar and Sankaran Mahadevan, Probability, Reliability, and Statistical Methods in Engineering Design, John Wiley and Sons
- Gregory Baecher and John Christian, Reliability and Statistics in Geotechnical Engineering, John Wiely and Sons, Inc.
- Alfredo Hua-Sing Ang and Wilson H. Tang, Probability Concepts in Engineering Planning and Design: Basic Principles (Vol. I), John Wiely and Sons, Inc.
- Alfredo Hua-Sing Ang and Wilson H. Tang, Probability Concepts in Engineering Planning and Design: Decision, Risk, and Reliability (Vol. II), John Wiely and Sons, Inc.
- Alfredo Hua-sing Ang, Wilson H. Tang, Probability Concepts In Engineering: Emphasis On Applications In Civil & Environmental Engineering, Publisher: Wiley
- Robert E. Melchers, Structural Reliability Analysis and Prediction, John Wiley and Sons.
- Andrzej S Nowak and Kevin R. Collins, Reliability of Structures
- Erik Vanmarcke, Random Fields: Analysis and Synthesis, The MIT Press, Cambridge, Massachusetts.

Subject Code: CE6L304	Subject Name: Advanced Concrete Technology	L-T-P: 3-0-0	Credit:3

Prerequisite: None

Fundamental of concrete - constituents, proportioning, mixing, transportation, placing and curing., Properties of fresh and hardened concrete., Quality control in concrete construction, Concrete mix design, Durability of concrete - alkali aggregate reaction, reinforcement corrosion, freezing and thawing, etc., Special concretes - high strength, low heat of hydration, high early strength, self-compacting, etc., Construction methods – shot-crete, roller compacted concrete, etc., Reinforcing materials - epoxy coated bars, fibre-reinforced plastics, Introduction to 'maintenance' of concrete structures - use of non-destructive testing, evaluation criteria.

Books:
- Gambhir, M,L., Concrete Technology, Tata Mcgraw Hill
- Neville, A.M. and Brooks, J.J., Concrete Technology, Neville, ELBS/Longman
- Neville, A.M., Properties of Concrete, ELBS/Longman
- Ghose, D.N., Construction Materials, Tata Mcgraw Hill
- Mehta, P.K. and Montiero, P.M.J., Concrete Material, Microstructure and Properties, Tata Mcgraw Hill

Subject Code: CE6L455	Subject Name Airport Planning and Design	L-T-P: 3-0-0	Credit:03

Pre-requisite(s): None

Air transport and its characteristics, Capacity and configuration, Runway and Taxi way design, Design, maintenance and rehabilitation of airfield pavements, terminal area lay-out, air traffic control, Grading and drainage, Environmental guidelines for airport projects, air-traffic demand estimation.

Books:

- Khanna,S. K., Arora A. K. and Jain S. S., Airport Planning and Design, Nem Chand & Bros.
- Ashford, N. and Wright, P.H., Airport Engineering, Third ed, John Wiley & Sons
- Robert Horonjeff, Francis X. McKelvey, William J. Sproule and Seth B. Young, Planning and Design of Airports, Fifth Ed., McGraw Hill Pub.