VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

(VJTI)

MATUNGA, MUMBAI 400 019

(Autonomous Institute affiliated to University of Mumbai)

Curriculum
(Scheme of Instruction & Evaluation and Course contents)

For
Second Year Syllabus
Bachelor of Technology (B.Tech.) Degree in Civil Engineering

Implemented from the batch admitted in Academic Year 2023-24

[NEP 2020 Based syllabus]

Program Educational Objective

PEO1	Develop a professional to pursue career as a Civil Engineer with adequate technical knowledge and skills while using modern tools for problem solving and exhibiting qualities of communication, team membership, and leadership
PEO2	Develop ability to practice ethically focusing on social relevance, environmental sustainability, optimal solutions and safety of stakeholders.
PEO3	Develop abilities of lifelong learning to continuously strive to enhance decision making abilities to investigate, design and develop complex facilities.

Program Specific Outcomes

PSO1	Able to analyze various Civil Engineering structures and systems by using basic and advanced technologies.
PSO2	Able to design civil engineering facilities and their elements and also use of modern software tools for the same.
PSO3	Able to plan, monitor and supervise construction activities to complete civil engineering facilities satisfactorily.
PSO4	Able to practice as a construction professional through ethical practice while focusing on sustainability and economy.

Program Outcomes

PO-1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering and technology to the solution of complex mechanical engineering problems.
PO-2	**Problem analysis**: Identify, formulate, review existing literature, and analyze complex engineering problems to reach substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO-3	**Design/Development of solutions**: Design solutions for mechanical engineering problems and design system components or processes that meet the specified needs with appropriate consideration for societal, economical and environmental considerations.
PO-4	**Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO-5	**Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex mechanical engineering activities with an understanding of the limitations.
PO-6	**The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
PO-7	**Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO-8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO-9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO-10	**Communication**: Communicate effectively with the engineering community and with society at large, including the ability to comprehend, create effective reports, make effective presentations, and give and receive clear instructions.
PO-11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO-12	**Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Credit Framework for UG Programme in Civil Engineering (Level 5.0- UG Diploma) -Semester - III

Sr.	Course Type	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %		
									TA	MST	ESE
1	PCC	R5MA2001T	Mathematics for Civil Engineers	2	1	0	3	3	20	30	50
2	PCC	R5SE2001T	Mechanics of Solids	3	0	0	3	3	20	30	50
3	PCC	R5CE2001T	Geomatics	2	0	0	2	2	20	30	50
4	PCC	R5CE2001L	Geomatics Laboratory	0	0	2	2	1	ISCE: 60		40
5	PCC	R5CE2002T	Fluid Mechanics	2	1	0	3	3	20	30	50
6	PCC	R5CE2002L	Fluid Mechanics Laboratory	0	0	2	2	1	ISCE: 60		40
7	PCC	R5CE2003T	Water and Wastewater Engineering	3	0	0	3	3	20	30	50
8	PCC	R5CE2003L	Water and Wastewater Engineering Laboratory	0	0	2	2	1	ISCE: 60		40
9	VEC	R5CE2004L	Development Engineering	1	0	2	3	2	ISCE: 60		40
10	MDM	R5CE2201T*	Multidisciplinary Minor – I	2	0	0	2	2	20	30	50
11	AEC	R5HS2501T#	Modern Indian Language (Sanskrit/ Marathi/ Hindi)	2	0	0	2	2	ISCE: 60		40
			Total	17	2	8	27	23			

Abbreviations: **T** Theory Course, **L** Laboratory Course, **I** Internship, **P** Project, **TA** Teacher Assessment / Term work Assessment, **MST** Mid Semester Test, **ESE** End Semester Written Examination, **ISCE** In-semester Continuous Evaluation, **PCC** Program Core, **MDM** Multi-Disciplinary Minor **VSEC** Vocational and Skill Enhancement Course, **OE** Open Elective, **VEC** Value Education Course

* Relevant Course Code for Multidisciplinary Minor (Sem III) to be used

\# Relevant Course Code for Modern Indian Language (Sem III) to be used

Dr. S. Y. Mhaske

Dr. S. S. Sutapreddi

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Dr. A. S. Wayal
(Head)

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Civil & Env. Engg. Dept.

Credit Framework for UG Programme in Civil Engineering (Level 5.0- UG Diploma) -Semester - IV

Sr.	Course Type	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %		
									TA	MST	ESE
1	PCC	R5CE2005T	Hydraulic Engineering	2	0	0	2	2	20	30	50
2	PCC	R5CE2005L	Applied Hydraulics Laboratory	0	0	2	2	1	ISCE: 60		40
3	PCC	R5SE2002T	Soil Mechanics	2	0	0	2	2	20	30	50
4	PCC	R5SE2002L	Soil Mechanics Laboratory	0	0	2	2	1	ISCE: 60		40
5	PCC	R5CE2006T	Building Drawing and Services	2	0	0	2	2	20	30	50
6	PCC	R5CE2006L	Building Drawing and Services Laboratory	0	0	2	2	1	ISCE: 60		40
7	PCC	R5SE2003T	Structural Analysis	3	0	0	3	3	20	30	50
8	VEC	R5HS2402O	Universal Human Values	2	0	0	2	2	ISCE: 60		40
9	MDM	R5CE2204T**	Multidisciplinary Minor – II	2	0	0	2	2	20	30	50
10	PCC	R5CE2007T	Hydrology and Water Resource Engineering	3	1	0	4	4	20	30	50
11	VSEC	R5CE2008L	Geospatial Technology Laboratory	0	0	2	2	1	ISCE: 60		40
12	CEP/FP	R5CE2601P	Community Engagement Project	0	0	4	4	2	ISCE: 60		40
			Total	16	1	12	29	23			

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** Relevant Course Code for Multidisciplinary Minor (Sem IV) to be used

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List of Exit Courses after completion of Semester III and IV

1. Exit option is available for students those who have earned the total 90 credits at the End of Fourth Semester.
2. Student who wants to avail the exit option after second year have to earn additional 6-8 credits from the list of courses shown below.
3. These courses student have to complete within summer vacation after 2nd Year.
4. After fulfilment as mentioned in 1 to 3 above, Students can earn U.G Diploma and same will be issued by the Institute.

List of Exit Courses after completion of Semester III and IV: Civil Engineering

Sr.	Course Type	Course Code	Course Name	L	T	P	Hr	Cr	Examination Weightage in %		
									TA	MST	ESE
1	EC	R5CE2901I	Internship (6-8 weeks)					6	ISCE: 60		40
2	EC	R5CE2902P	Project / Mini-Project	0	0	12	12	6	ISCE: 60		40
3	EC	R5CE2903T	Pavement materials and construction	2	0	0	2	2	20	30	50
4	EC	R5CE2903L	Pavement materials and construction Laboratory	0	0	2	2	1	ISCE: 60		40
5	EC	R5SE2901T	Geotechnical Field Exploration	2	0	0	2	2	20	30	50
6	EC	R5SE2901L	Geotechnical Field Exploration Laboratory	0	0	2	2	1	ISCE: 60		40
7	EC	R5CE2904T	Prefabricated structures	3	0	0	3	3	20	30	50
8	EC	R5CE2905T	Revit Modelling	2	0	0	2	2	20	30	50
9	EC	R5CE2905L	Revit Modelling Laboratory	0	0	4	4	2	ISCE: 60		40
10	EC	R5CE2906L	Digital Construction Laboratory	0	0	6	6	3	ISCE: 60		40
11	EC	R5CE2907T	Plumbing Engineering	3	0	0	3	3	20	30	50
12	EC	R5CE2907L	Plumbing Engineering Laboratory	0	0	2	2	1	ISCE: 60		40

Abbreviations: **T** Theory Course, **L** Laboratory Course, **I** Internship, **P** Project, **TA** Teacher Assessment / Term work Assessment, **MST** Mid Semester Test, **ESE** End Semester Written Examination, **ISCE** In-semester Continuous Evaluation, **PCC** Program Core, **MDM** Multi-Disciplinary Minor **VSEC** Vocational and Skill Enhancement Course, **OE** Open Elective, **VEC** Value Education Course

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Course Codes for Multi-Disciplinary Minors (MDM)

Sr. No.	Course Code	Name of the MDM Course in sem III	Name of the MDM
1	R5CE2201T	Understanding Incubation and Entrepreneurship	Innovation and Entrepreneurship
2	R5CE2202T	Legal Framework for Construction	Contract Law, Arbitration, and Valuation
3	R5CE2203T	Principles of Sustainability	Sustainable Environment
4	R5IT2201T	Introduction to Artificial Intelligence & Machine Learning	Artificial Intelligence & Machine Learning (AIML)
5	R5CO2201T	Introduction to Data Science.	Data Science
6	R5EL2201T	Foundations of Cyber security	Cyber Security
7	R5EL2202T	Introduction to IoT Systems	Internet Of Things (IOT)
8	R5EL2203T	Signals and Systems	Signal And Image Processing
9	R5EE2201T	Electro-mechanical Energy Conversion	Electrical Vehicles
10	R5ME2201T	Introduction to Robotics	Robotics
11	R5ME2202T	Warfare Platforms & Systems	Defence Technology
12	R5ME2203T	Introduction to Aerospace Engineering	Aerospace Technology
13	R5IL2201T	Orientation Programme in Entrepreneurship	Entrepreneurship and Start-up

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Course Codes for Languages

Sr. No.	Course Code	Name of the Language course sem III
1	R5HS2501O	Marathi
2	R5HS2502O	Hindi
3	R5HS2503O	Sanskrit
4	R5HS2504O	Kannada
5	R5HS2505O	Gujarati
6	R5HS2506O	Punjabi

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Semester III

Semester - III		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
1	R5MA2001T	Mathematics for Civil Engineers	2-1-0 = 3	3	20	30	50	3
	Course Outcome: 1. Demonstrate the ability to evaluate Laplace as well as Inverse Laplace Transform of functions to solve ordinary differential equations. 2. Apply the discrete and continuous probability distributions to find probabilities of various events and the expected value of a random variable. 3. Find the relation between two phenomena with the help of curve fitting and correlation-regression analysis. 4. Perform hypothesis testing on population means, variances and proportions and draw conclusions 5. Demonstrate knowledge of finite difference and finite element method.							

Module	**Course Contents**
1	**Laplace Transforms and Applications:** Introduction, Definition of the Laplace transform; Useful properties of Laplace transforms: Linearity, Frist shifting theorem, Multiplication and division by t, Transforms of derivatives and integrals, Heaviside unit step function, Dirac's delta function, Second shifting theorem, Laplace transform of Periodic function; Inverse Laplace transform using partial fraction and Convolution theorem; Application to solve initial and boundary value problems.
2	**Probability** Review of probability, Conditional probability, Bayes' theorem. Discrete and continuous random variables, Probability density function, Expectation, Variance, Moments, Binomial distribution, Poisson distribution, Normal distribution.
3	**Statistics** Introduction to bivariate data, Correlation analysis, Coefficient of correlation and Rank correlation, Regression analysis, curve fitting, method of least squares, Concepts of Statistical hypothesis, Null and Alternate hypothesis, Critical region, Two types of errors, Level of significance, Tests of significance based on Large sample theory, Student's t test, F test and Chi-square test.

4	**Finite difference and finite element method** Basics of Finite Difference Method (numerical solutions to partial differential equations) and Finite Element Method (limited to 1D elements).
5	**Optimization** Concept of Optimization, Linear Programming, standard form of problems, pivotal reduction of equations. Solutions of linear programming problems, Simplex method – single and two-phase methods. Civil Engineering Applications - Environmental Engineering, Water resources engineering, Structural engineering.
	Recommended Reading **1.** Erwin Kreyszig, Advanced Engineering Mathematics, 9th Edition, John Wiley & Sons, 2006. **2.** Ramana B. V., Higher Engineering Mathematics, Tata McGraw Hill New Delhi, 11th Reprint, 2010. **3.** Wiley C. R., "Advanced Engineering Mathematics", McGraw Hill Inc., New York Ed.1993. **4.** O'Neel Peter., "Advanced Engg. Mathematics", Thompson, Singapore, Ind. Ed. 2002. **5.** Greenbar Michael D., "Advanced Engg. Mathematics", Pearson, Singapore, Ind. Ed. a. 2007. **6.** Marsden J. E., Tromba A., Weinstein A., "Basic multivariable calculus", Springer, 1993. (ISBN 354097976X) **7.** A. R. Vasishtha, A. K. Vasishtha, "Matrices", Krishna Prakashan Media, 1991. (ISBN 8182837294) **8.** Froberg C.E., "Introduction to Numerical Analysis (2nd Edition), Addison Wesley, 1981. **9.** Johnson Richard A., Miller and Freund's, "Probability and Statistics (8th Edition)", PHI. (ISBN 0130417734) **10.** Gupta S.C. and Kapoor V. K., "Fundamentals of Mathematical Statistics (11^{th} Edition)", Sultan Chand & Sons. (ISBN 180545288) **11.** T. J. Akai, Applied Numerical Methods for Engineers, John Wiley & Sons, Singapore, 1994. (ISBN-0471575232/978-0471575238). **12.** Y. M. Desai, T. I. Eldho and A. H. Shah, Finite Element Method with Applications in Engineering, Dorling Kindersely Pvt. Ltd., Licensees of Pearson Education in South Asia. 2011. (ISBN-9788131724644/978-8131724644).

Semester - III		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
2	R5SE2001T	Mechanics of Solids	3-0-0 = 3	3	20	30	50	3
	Course Outcome: After completion of this course, students will be able to, 1. Evaluate stress-strain behaviour and other physical properties of materials. 2. Determine the internal forces in any type of structural elements and their graphical representation. 3. Analyse structural elements subjected to various forces using fundamental concepts of elastic stress-strain behaviour of materials. 4. Apply the concept of principal stresses and strains for analysis of structural elements.							

Module	Course Contents
1	**Simple stress and strain:** Definitions of stress, strain, modulus of elasticity, modulus of rigidity, bulk modulus, yield stress, ultimate stress, factor of safety, and shear stress. Poisson ratio, bars of varying sections, stresses due to self-weight. Composite sections, temperature stresses, strain energy, and resilience.
2	**Shear force and bending moment:** Axial force, shear force and bending moment diagram for statically determinate beams and frames.
3	**Theory of pure bending and shear stresses in beams**: Flexure formula for straight beams, moment of inertia, product of inertia, and polar moment of inertia of plane areas, principal axes of inertia, moments of inertia about principal axes, transfer theorem, and flitched beams. Distribution of shear stress across plane sections and shear connectors. Shear center of thin-walled sections such as angle, tee, channel, and I section.
4	**Simple theory of torsion** Torsion of circular solid and hollow shafts, stepped shaft, stresses in the shaft when transmitting power, close-coiled helical springs under axial load.
5	**Bending moment combined with axial loads** Application to members subjected to eccentric loads, the core of a section, problems on chimneys, retaining walls, etc., involving lateral loads.
6	**Thin cylinder and spherical shell** Stresses and strains in thin cylindrical and spherical shells under internal pressure.

7	**Principal stresses and strains** General equations for the transformation of stress, principal planes, and principal stresses, maximum shear stress, determination using Mohr's circle, principal stresses in beams, and theories of failure.
8	**Trusses and compression member** Analysis of determinate trusses (method of joint and method of section) Struts subjected to axial loads, the concept of buckling. Euler's buckling theory of struts with different boundary conditions. Rankine's buckling theory for columns.
	Text Books: **1.** S.B. Junnarkar, Mechanics of Structures Vol I, Charotar Publication house, 32th Edition, 2016, (ISBN-9385039024/978-9385039027). **2.** E.P. Popov, Mechanics of Materials, Prentice Hall of India Pvt. Ltd.,2nd edition, 1976. (ISBN- 0135713560/978-0135713563). **3.** 3. F.L. Singer and Pytel, Strength of Materials, Harper Collins Publishers, 2002. **4.** S. Timoshenko, Strength of Materials: Part-I (Elementary Theory and Problems), CBS Publishers, New Delhi. **5.** S.S. Bhavikatti, Strength of Material, Vikas Publishing House Pvt. Ltd,3rd edition, 2013. (ISBN: 9789325971578/9325971577).
	Recommended Reading: 1. S. Timoshenko and Young, Engineering Mechanics, Tata McGraw Hill,2013. (ISBN: 9781259062667/125906266X). 2. W. A. Nash Strength of Material, Schaum's Outline Series, McGraw Hill, 4th edition, 1998. (ISBN- 9780071830805/978-0071830805). 3. S. Timoshenko and Gere, Mechanics of Materials, PWS Publication Co. Ltd.,3rd edition, 1997. (ISBN-0534921744/9780534921743). 4. J. M. Gere, Mechanics of Materials, Brooks/Cole. Publishing Co.,6th edition, 2008. (ISBN- 1111577730/9781111577735). 5. G.H. Ryder, Strength of Materials, Prentice Hall Publications, 3rd edition,2002. (ISBN:9780333935361/0333935365). 6. S.H. Crandall, N.C. Dahl and T.J.Lardner, An introduction to the Mechanics of Solids, Tata McGraw Hill, Third Edition, 2017

Semester - III		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
3	R5CE2001T	Geomatics	2-0-0 = 2	2	20	30	50	3
	Course Outcome: 1. Describe the principles of surveying and field procedures to conduct the Land survey. 2. Develop skills for collection of field data using traditional surveying equipments such as Levels, Compass, plane table and theodolite. 3. Prepare topographic map including contours of any site. 4. Record the field data and analyze the same. 5. Calculate the area of land parcel, volume of earthwork and to do the setting out works.							

Module	Course Contents
1	**Introduction:** Various types of surveying- based on methods and instruments, classifications, uses and necessity of geodetic surveying, photographic, astronomy and hydrographic surveying; Diagonal scale, various types of venires, micrometers on surveying instruments, principles of surveying; Chain surveying, instruments required for linear measurement, minor instruments for setting out right angle
2	**Leveling and contouring:** Definitions, technical terms, different types of levels such as dumpy, quickset, precise, auto level; Temporary and permanent adjustments of dumpy and auto level; Different methods of leveling, reduction of levels, problems; Difficulties in leveling work, corrections and precautions to be taken in leveling work; Contour – definitions, contour interval, equivalent, uses and characteristics of contour lines, direct and indirect methods of contouring Running a level line, L section, cross section, methods of interpolation; Grade contour- definition, use, setting out in field; Computation of volume by trapezoidal and prismoidal formula, volume from spot levels, volume from contour plan
3	**Plane Table Surveying:** Definitions, uses and advantages, temporary adjustments, Different methods of plane table surveying, Two-point problem Errors in plane table survey, use of telescopic alidade

4	**Traverse Surveying:** Compass: Bearings - different types, compass – prismatic, surveyor, whole circle, reduced bearings, Local Attraction; Theodolite:- Various parts and axis of transit, technical terms, temporary and permanent adjustments of a transit, horizontal and vertical angles, methods of repetition and reiteration; Different methods of running a theodolite traverse, Gales' traverse table, balancing of traverse by Bow-Ditch's transit and modified transit rules; Problems on one-plane and two-plane methods, omitted measurements, precautions in using theodolite, errors in theodolite survey, Use of theodolite for various works such as prolongation of a straight line, setting out an angle
5	**Setting out Works:** General horizontal and vertical control, setting out of foundation plan for load bearing and framed structure, batter board, slope and grade stakes, setting out with theodolite; Setting out of sewer line, culvert, use of laser for works; Setting out center line for tunnel, transfer of levels to underground work; Project / route survey for bridge, dam and canal; Checking verticality of high rise structures
6	**Areas:** Area of an irregular figure by Trapezoidal rule, average ordinate rule, Simpson's 1/3 rule, various coordinate methods; Planimeter: types of planimeter including digital planimeter, area of zero circle, use of planimeter
7	**Maps** Importance of maps to engineering projects, Types of maps, Scales and uses, Plotting accuracy, Map sheet numbering, Coordinate systems- Cartesian and geographical, map projections, map datum – MSL, Geoid, spheroid, **Aerial Photogrammetry** Types of photographs, Flying height and scale, Relief (height), displacement, Stereoscopy, 3-D Model, Height determination using Parallax Bar, Digital Elevation. Model (DEM), Slope.
	Text Books: **1.** N.N.Basak, Surveying and Leveling, Tata McGraw Hill Publications, 2nd Edition. (ISBN - 9789332901537) **2.** B C Punmiya, Surveying and Leveling, Vol I-16th edition & Vol II- 4th edition, Laxmi Publications. (ISBN - 9788170088530) **3.** R Agor, Surveying, Khanna Publishers- 11th edition. (ISBN - 8174092358) **Recommended Reading:** **1.** Kanetkar and Kulkarni, Surveying and Leveling, Vol I & II, Pune Vidyarthi Griha, Pune, 24th edition.(ISBN- 8185825114) **2.** R Agor, Surveying, Khanna Publishers- 11th edition. (ISBN - 8174092358)

Semester - III		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
4	R5CE2001L	Geomatics Laboratory	0-0-2 = 1	1	ISCE:60		40	3
	Course Outcome: 1. Demonstrate the use of minor and major surveying equipments. 2. Use equipments/instruments for conducting chain and compass traversing, levelling, theodolite traversing, Plane table survey and setting out curves and civil works. 3. Record observations in field book and prepare the various types of maps.							

	Course Contents
	Concepts: 1. Linear and angular measurements 2. Traditional surveying and mapping techniques 3. Contour maps, irregular area calculations and volumes of earthworks 4. Fieldwork record keeping and drawing sheet preparation 5. Land record documentation, height of buildings / Towers etc. **Practicals:** 1. Use of Amslar polar planimeter for finding the area of irregular figures and certifying it by using Digital Planimeter 2. Use of optical theodolite / Electronic theodolite for measurement of horizontal and vertical angles 3. Theodolite traverse, Gale's traverse table 4. A two day project on theodolite traversing and plane table detailing, 5. Use of optical theodolite / Electronic theodolite for one plane and two plane methods 6. Simple and compound leveling by using Dumpy / Auto Level, booking methods 7. Methods of plane tabling: - Radiation. Intersection and Traversing 8. Setting out a simple foundation plan in the field 9. Introduction to LiDAR/ LADAR

	Text Books: **1.** N. N. Basak, Surveying and Leveling, Tata McGraw Hill Publications, 2nd Edition. (ISBN - 9789332901537) **2.** B C Punmiya, Surveying and Leveling, Vol I-16th edition & Vol II- 4th edition, Laxmi Publications. (ISBN - 9788170088530) **3.** R Agor, Surveying, Khanna Publishers- 11th edition. (ISBN - 8174092358) **4.** P. Dong & Q. Chen, Lidar Remote Sensing and Applications, CRC press 2017, (ISBN - 9781138747241

Semester - III		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
5	R5CE2002T	Fluid Mechanics	2-1-0=3	3	20	30	50	3
	Course Outcome: 1. Use the various units of measure and basic fluid mechanics concepts to analyse incompressible fluids at rest or in motion. 2. Analyse and solve problems involving hydrostatic pressure and buoyancy forces. 3. Apply mass balance and momentum equations to analyze, model and solve problems involving water motion in open channels 4. Solve problems in fluid flow system.							

Module	**Course Contents**
1	**Properties of Fluid:** Properties of Fluid Mass density, specific weight, specific gravity, specific volume, vapour pressure, compressibility, elasticity, surface tension, capillarity; Newton's law of viscosity, classification of fluids, dynamic viscosity and kinematics viscosity, variation of viscosity with temperature; Basic concept applicable to fluid mechanics.
2	**Fluid Statics:** Measurement of Pressure. Pressure variation in a static fluid, Pascal's law, units and scales of pressure measurement – Atmospheric Pressure, Absolute Pressure, Gauge Pressure and Vacuum Pressure, Hydrostatic Paradox. Piezometer, U-Tube Manometer, Single Column Manometer, U-Tube Differential Manometer, Inverted U-Tube Differential Manometer, Micromanometers. Mechanical Pressure Gauges; Hydrostatic force on plane and curved surface:Total Pressure and Center of Pressure, Pressure Diagram, Total Pressure on Plane Surfaces and Depth of Center of Pressure, Total Pressure on Curved Surfaces, Practical applications of Total Pressure and Center of Pressure; Buoyancy and Flotation: Buoyant force, Buoyancy and Center of Buoyancy, Archimedes Principle, Principle of Floatation Metacentre and Metacentric Height, Equilibrium of Floating bodies and Submerged bodies Evaluation of Metacentric Height –Theoretical Method and Experimental Method Oscillation of Floating Body; Fluids in Relative Equilibrium: Static fluid subjected to uniform linear acceleration Liquid containers subjected to constant horizontal acceleration and constant vertical acceleration, Liquid containers subjected to constant rotation

3	**Fluid Kinematics:** Fluid flow Methods of analysis of fluid motion, Streamlines, Pathlines, Streaklines and Streamtubes. Types of fluid flow Steady and unsteady flow, Uniform and non-uniform flow, Laminar, Transitional and Turbulent flow Reynolds number, Reynolds Experiment, Rotational and Irrotational flow, Subcritical, Critical and Supercritical flow, Compressible and Incompressible Flow, One, Two and Three-dimensional Circulation and vorticity, Velocity potential and Stream function, Flow net
4	**Fluid Dynamics** Euler's equation, Bernoulli's equation, Energy correction factor
5	**Flow Measuring Devices:** Measurement of discharge: Venturi meter, Orifice meter, Nozzle meter, Bend meter, Rotameter. Measurement of velocity-Pitot tube. Orifice - Classification, Flow through a Reservoir Opening i.e. Orifice, Trajectory of free –jet, Hydraulic Coefficients, Experimental determination of hydraulic coefficient, small and large orifice, Time of emptying a tank with orifice Mouthpieces-Classification, External cylindrical mouthpiece, Convergent – divergent mouthpiece, Borda's mouthpiece. Notches and Weirs - Discharge over a rectangular notch and a triangular notch, Velocity of approach, End contractions, Cippoletti Notch, Discharge over a stepped notch, Time of emptying a tank with notch or weir, Ventilation of weir, Proportional Weir or Sutro Weir
6	**Flow Past immersed bodies:** Drag and lift, Types of drag, drag on a sphere, cylinder, flat plate and Airfoil, Karman Vortex Street, effect of free surface and compressibility on drag. Development of lift on immersed bodies, Lift, Magnus Effect and Circulation, lift characteristics of airfoils, polar diagram.
7	**Compressible flow and Ideal fluid flow:** Compressible flow, Mach number, Mach cone, Uniform flow, source and sink, doublet, free vortex.
	Text Books: **1.** K L Kumar, Engineering Fluid Mechanics S Chand &Company Ltd 8th Edition, (ISBN – 9788121901000) **Recommended Reading:** **1.** Dr. P M Modi and Dr S M Seth, Hydraulics and Fluid Mechanics, Standard Book House (ISBN-8189401262) **2.** K Subramanya, Theory and Applications of Fluid Mechanics, Tata McGraw Hill Publishing co. Ltd. (ISBN - 0074603698) **3.** A. K. Jain, Fluid Mechanics, 4th edition, Khanna Publishers (ISBN - 8174091947)

Semester - III		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
6	R5CE2002L	Fluid Mechanics Laboratory	0-0-2 = 1	1	ISCE:60		40	3
	Course Outcome: 1. Calculate the force exerted by fluid on object boundary. 2. Measure the rate of flow in open channel and pipe system. 3. Select proper discharge measurement techniques.							

	Course Contents
	List of Experiments: 1. Verification of Hydrostatics law 2. Study of Pressure Measuring Devices 3. Determination of metacentric height 4. Determination of hydrostatics Force on surface 5. Verification of Bernoulli's Theorem 6. Determination of coefficient of discharge of flow meter 7. Determination of hydraulic coefficient of orifice 8. Determination of coefficient of discharge of notch/weir 9. Flow Visualisation -Ideal Flow 10. Study of wind tunnel and determination of force acting on object
	Text Books: 1) K L Kumar, Engineering Fluid Mechanics S Chand & Company Ltd 8th Edition, (ISBN – 9788121901000) 2) Dr. P M Modi and Dr S M Seth, Hydraulics and Fluid Mechanics, Standard Book House (ISBN -8189401262) 3) K Subramanya, Theory and Applications of Fluid Mechanics, Tata McGraw Hill Publishing co. Ltd. (ISBN – 0074603698) 4) K Subramanya, Open channel Flow, Tata McGraw Hill Publishing Co. Ltd. (ISBN – 9789332901339

Semester - III		Program Core Course (PCC)					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
7	R5CE2003T	Water and Wastewater Engineering	3-0-0=3	3	20	30	50	3
	Course Outcome: 1. Determine sources and characteristics of water and wastewater. 2. Design treatment processes for potable water systems. 3. Design treatment processes for sewage collection and sewage treatment 4. Examine raw and treated water characteristics suitability for reuse							

Module	Course Contents
1	**Introduction:** Importance of environmental sanitation, Impact of human upon the environment, Impact of environment upon the human.
2	**Sources and characteristics of water and wastewater:** Physical, Chemical, Bacteriological properties, Quality of water and wastewater at source, Water quality standards for drinking and various applications, Aerobic and anaerobic decomposition of wastewater.
3	**Treatment of water:** Aeration, Sedimentation: factors affecting efficiency, design values of various parameters, tube settlers; Coagulation and flocculation: Mechanisms, common coagulants, rapid mixing and flocculating, devices, G and GT values, jar test, coagulant aids - polyelectrolyte etc. Filtration: classification, slow and rapid sand filters, dual media filters, sand, gravel and under drainage system, mode of action, cleaning, limitations, operational difficulties, performance, basic design consideration, pressure filters: construction and operation; Water softening: lime soda and base exchange methods, principle reactions, design considerations; Disinfection: chlorination, chemistry of chlorination, kinetics of disinfection, chlorine demand, free and combined chlorine, break point chlorination, superchlorination, dechlorination, chlorine residual

	use of iodine, ozone, ultraviolet rays, and chlorine dioxide as disinfectant, well water disinfection; Treatments for removal of dissolved solids: Reverse osmosis, Distillation, Electrodialysis.
4	**Miscellaneous treatment** Removal of iron and manganese, taste, odour and colour, Principles and methods of de-fluoridation and desalination.
5	**Wastewater treatment and disposal:** Wastewater treatment: Objectives, methods of sewage treatment and various flow sheets for preliminary, primary, and clarifiers, disposal of screenings and grits; Biological treatment methods: principles, activated sludge process, sludge volume index, operational problems in activated sludge process, trickling filter; Sludge digestion: principles of anaerobic digestion, quantity and characterization of sludge, design of sludge digestion tank, disposal of digested sludge, drying beds; Disposal of wastewater: Discharge of raw and treated sewage on land and in water, Standards of disposal of raw and treated sewage on land and in water, limits of dilution, Self-purification of streams and oxygen economy.
6	**Low cost sanitation:** Design considerations, suitability and principles of septic tanks, up flow anaerobic filter.
7	**Reuse and recycle of treated wastewater:** Disposal of treated effluent, gardening, sewage farming, W.C. Flushing, reuse in industry.

Text Books:

1. S. K. Garg, Sewage Disposal and Air Pollution Engineering, Khanna Publishers, Delhi, Thirty seventh edition, 2017. (ISBN: 9788174092304)
2. S. K. Garg, Water Supply Engineering, Khanna Publishers, Delhi, 28th edition, 2010. (ISBN: 9788174091208/8174091203)
3. Manual on Water Supply and Treatment, Ministry of Works & Housing, New Delhi, 1993.
4. Manual on Wastewater Treatment, Ministry of Works & Housing, New Delhi, 2013.

Reference Books:

1. T. J. McGhee, Water supply and sewerage, McGRAW Hill Inc., US, 6th editions, 1991 (ISBN: 0070609381/978-0070609389).
2. H. S. Peavy, D. R. Rowe and G. Tchobanoglous, Environmental engineering, McGRAW Hill Education, Indian edition, 1st edition 2013. (ISBN: 9351340260/978-9351340263)
3. Relevant Indian Standards Specifications.
4. CPHEEO manual on water supply and treatment, Ministry of urban development, May 1999.
5. CPHEEO manual on sewerage and sewage treatment systems, Ministry of urban development, Dec 2013.
6. Metcalf and Eddy, Wastewater Engineering Treatment and Reuse, Tata McGraw Hill Publications, 5th edition, 2017. (ISBN: 9780070495395, 0070495394)

Semester - III		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
8	R5CE2003L	Water and Wastewater Engineering Laboratory	0-0-2 = 1	1	ISCE:60		40	3
	Course Outcome: 1. Perform tests and analyze results of water and wastewater samples. 2. Assess the accuracy and precision of analytical results. 3. Use advanced water and wastewater characterization tools.							

	Course Contents
	List of Experiments:
	1. Determination of alkalinity of water sample. 2. Determination of hardness of water sample. 3. Determination of pH value of water and wastewater sample. 4. Determination of turbidity of water sample. 5. Determination of the optimum dose of coagulant by Jar test. 6. Determination of residual chlorine in water sample. 7. Determination of chlorides in water sample. 8. Determination of conductivity of the water sample. 9. Determination of total solids, suspended solids, dissolved solids and volatile solids in water and wastewater sample. 10. Determination of Dissolved Oxygen (D.O.) in water sample. 11. Determination of Chemical Oxygen Demand (COD) of sample of wastewater. 12. Determination of Bio-Chemical Oxygen demand of wastewater sample. 13. Determination of Sludge Volume Index (SVI) of the wastewater sample. 14. Determination of Coli-form Bacteria in water sample by Most Probable Number (M.P.N.) test. 15. Demonstration of procedure for oxidation and reduction potential.

	16. Demonstration of procedure for sampling.
	Text Books: 1. Standard Methods for the Examination of Water and Wastewater, jointly published by American Public Health Association (APHA), American Water Works Association (AWWA), Water Pollution Control Federation (WPCF), and Water Environment Federation (WEF), 23rd edition, 2017. (ISBN: 9781625762405/1625762402) **Reference Books:** 1. T. J. McGhee, Water supply and sewerage, McGraw Hill Inc., US, 6th editions, 1991. (ISBN: 0070609381/978-0070609389) 2. H. S. Peavy, D. R. Rowe and G. Tchobanoglous, Environmental engineering, McGRAW Hill Education, Indian edition, 1st edition 2013. (ISBN: 9351340260/978-9351340263) 3. Relevant Indian Standards Specifications 4. CPHEEO manual on water supply and treatment, Ministry of urban development, May 1999. 5. CPHEEO manual on sewerage and sewage treatment systems, Ministry of urban development, Dec 2013.

Semester - III		Value Education Course (VEC)					
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
9	R5CE2004L	Development Engineering	1-0-2=2	2	ISCE: 60		40	3
	Course Outcome: 1. Formulate and analyze problems in rural area. 2. Apply modern techniques for planning, development and report preparation. 3. Use the tools and processes required for feasibility analysis.							

Module	Course Contents
1	**Introduction to Development Engineering:** Introduction to development engineering; need of development engineering; core disciplines and concept; major issues in development; urban development; rural development; socioeconomic development; scientific social research, formulation of research problem, field work and data collection, report drafting.
2	**Design of Sustainable Communities:** Concept and development of sustainable communities; Sustainable design principles, building regulations, codes and standards, approval process; green buildings-green building techniques energy solutions, site solutions, exterior and interior solutions, Certification development Indices. Solar Energy: Recycling, Reuse, and applications of solar energy. Rooftop solar systems.
3	**Planning and Development of Rural Areas:** District administration, District Planning, introduction to various sectors of rural areas such as drinking water, waste water treatment, electricity, public transport, irrigation, sanitation and cooking energy; issues and challenges associated with these sectors; People's participation and role in development of rural areas; various schemes and policies floated by state and central government - phases in the schemes; life cycle costing of these schemes. Introduction to the village-level census data. Engineering content in various amenities indices. Comparison plots and correlation plots

4	**A Sectoral Engineering System** The geography of area and its irrigation systems. Listing stakeholders, i.e., villages-farmers, people with and without land, local industrial workers, agriculture-cash crops and traditional crops, irrigation department and the market. History of irrigation for the region. Protective vs. command irrigation and its consequences. Developing a methodology for assessment. An example of a design document Socio-Technical challenges-increasing irrigated area, drip irrigation and better farm practices. Groundwater regulation. Field Visit to an irrigation system. Meeting with an NGO, farmers, a state officer and an elected representative.
5	**Geoinfomatics:** Loading QGIS and a district data-set. Using a given data-set. Writingqueries and manipulating appearances, Types of objects and manipulating objects. Linking Census data to GIS. Basic analysis and representation Introduction to a case-study. Basics of spatial planning queries such as computing net supply and net demand.
6	**Tools and processes of feasibility analysis:** Demonstrate use of tools of market survey, demand forecasting, technology comparisons, environmental analysis, cash flow, risk analysis, return of investment.
	Reference Books: 1. Chand, M. and Puri, U.K., Regional Planning in India, Allied Publishers, New Delhi, 2011. (ISBN-9788170230588) 2. E. J. Kaiser, Urban Land Use Planning, Urbana, University of Illinois Press, 2006. (ISBN-9780252030796) 3. K. V. Sundaram, Geography & Planning, Concept Publishing Co., New Delhi, 1985. (ISBN-9788170220480) 4. C.P.V. Ayyar, Town Planning in Early South India, Mittal Publications, Delhi, 2015. (ISBN-9788183245913) 5. L. Reeder and N. J. Hoboken, Guide to Green Building Rating Systems, John Wiley & Sons, Inc., 2010. (ISBN:9780470401941/9781118259894) 6. Longley, P. A., Michael F. Goodchild, Maguire, D.J., Rhind, D. W. (2005), 'Geographic Information Systems and Science', Second Edition 2005: John Wiley & Sons, New York. (ISBN-9780471892755) 7. Desai, V. (2010), 'Rural Development of India', Himalaya publishing house, Mumbai. (ISBN-9788184884128) 8. Institute of Town Planners, India, Ministry of Urban Affairs & Employment, Government of India, New Delhi, UDPFI Guidelines , 2014. 9. Miles R. Simon, Metropolitan Problems, Methuen Publications, Canada, 2013. (ISBN:9780415860499) B.I.S., National Building Code of India, ISI, New Delhi, 2007.

Multidisciplinary Minor - Innovation and Entrepreneurship

Semester – III		Multidiscplinary Minor (Innovation and Entrepreneurship)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
1	R5CE2201T	Understanding Incubation and Entrepreneurship	2-0-0 = 2	2	20	30	50	3
	Course Outcome: **1.** Acquire knowledge of entrepreneurship, incubation and business principles. **2.** Understand Indian environment for entrepreneurship **3.** Explore entrepreneurship funding options and investments **4.** Understand the key concepts and theories of innovation **5.** Analyse legal and ethical implications of business decisions							

Module	Course Content:
1	**Introduction to Entrepreneurship** Definition and importance of entrepreneurship, characteristics of successful entrepreneurs, entrepreneurial mindset and motivation. identifying business opportunities, types of entrepreneurship, Lean Start-ups. Case studies and success stories of start-ups.
2	**Introduction to Business Incubation** Importance of incubation in the entrepreneurial ecosystem, Types of incubators: technology, social, corporate, etc. Organisational structure of Incubators, Management and Operations, Collaboration and partnership, Funding, Networking , Mentoring, Challenges, Measuring success and KPI's
3	**Innovation & Business development** Creativity and innovation in business ideas, principles and processes of innovation. analysing the current business scenario, application of design thinking in product design, role of technology and sustainability in product design, brainstorming, mind mapping, and other ideation methods, Challenges in Innovation, From Idea to Proof of Concept, Problem statement presentation
4	**Indian Environment for Entrepreneurship** Overview of entrepreneurship in India, historical perspectives and evolution of Indian start up ecosystem, Key sectors and industries driving entrepreneurship in India. Case studies of famous entrepreneurs and their impact, social norms and their impact on entrepreneurial activities.

5	**Exploring funding options** Overview of Entrepreneurial Investment, Types of Investors (Angels, VCs, etc.), Funding stages-seed funding, series A,B,C etc. debt vs equity financing , alternative funding sources (crowdfunding ,grants), Role of Angel Investors, Role of VC's, Role of financial institutions and banks in supporting start ups
6	**Government Policies and Support in India** Overview of government policies supporting entrepreneurship (Startup India, Make in India, Atmanirbhar Bharat), Regulatory environment and ease of doing business, Government grants, subsidies, and schemes for startups. Oligopolies and Public Policy
7	**Legal and Ethical Issues** Business law basics,, Ethical Issues in Business; Moral Responsibility and Blame; Utilitarianism: Weighing Social Costs and Benefits; Rights and Duties of Business. Perfect Competition; Monopoly Competition; Oligopolistic Competition; Oligopolies and Public Policy. Intellectual property protection , creation & types of IPR, Patents and Copyrights-Patents in India
	Recommended Reading: 1) Entrepreneurship by Robert D. Hisrich, Michael P. Peters, Dean A. Shepherd, Sabyasachi Sinha, latest edition, The McGraw Hill Company. 2) Dr T N Chhabra, Entrepreneurship Development, Sun India Publications, New Delhi. 3) Entrepreneurship- Principles and Practices by Donald Kurakto, Thomson Publication. 4) Disciplined Entrepreneurship: 24 Steps to a Successful Startup by Bill Aulet 5) India as Global Start-up Hub: Mission with Passion by C B Rao 6) Innovation and Entrepreneurship: Practice and Principles by Peter F Drucke

Multidisciplinary Minor - Contract Law, Arbitration, and Valuation

Semester – III		Multidisciplinary Minor (Contract Law, Arbitration, and Valuation)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
1.	R5CE2202T	Legal Framework for Construction	2-0-0 = 2	2	20	30	50	3
	Course Outcome: After completion of this course, students will be able to, **1.** Explain needs of various laws and legislation related to Construction Industry. **2.** Describe application of various Contracts and their form. **3.** Evaluate needs & Methods of arbitration and dispute resolution mechanism							

Module	Course Content:
1	**Introduction to Construction Law:** Overview of construction law and its importance, Key legal concepts and terminologies
2	**Legal Frameworks and Regulatory Environment:** Overview of relevant laws and regulations (e.g., Planning and Construction Law of 1965 in Israel), National and international standards and codes.
3	**Construction Contracts:** Types of construction contracts, Key clauses and contract negotiation, Contract management and administration
4	**Liability and Risk Management:** Legal responsibilities and liabilities in construction, Risk assessment and mitigation strategies, Insurance and bonding
5	**Construction Dispute Resolution:** Common disputes in construction projects, Mediation, arbitration, and litigation processes, Case studies on dispute resolution
6	**Regulatory Compliance and Ethics:** Compliance with environmental, safety, and building codes, compliance with labour laws, Ethical considerations in construction practice, Professional responsibility and conduct.
7	**Emerging Issues in Construction Law:** Impact of technology on construction law, Legal challenges in sustainable construction, Recent legal developments and case studies, Learning Outcomes

	Recommended Reading: 1) Jha K.N., Construction Project Management- Theory and practice, Pearson India Education Services Pvt. Ltd., 2nd Edition, 2015. (ISBN 9789332542013) 2) P C Markanda., Building and Engineering Contracts: Law and Practice, 6th Edition, 2023 (ISBN: 9788119403042) 3) G. T. Gajria and Kishore Gajria., Law Relating to Building and Engineering Contracts in India, Lexis Nexis, 4th Edition, 2000, (ISBN: 9788187162162) 4) Will Hughes, Ronan Champion and John Murdoch, Construction Contracts Law and management, Fifth Edition 2015, (ISBN 9780367240325)

Multidisciplinary Minor - Sustainable Environment

Semester – III		Multidiscplinary Minor (Sustainable Environment)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
1	R5CE2203T	Principles of Sustainability	2-0-0 = 2	2	20	30	50	3
	Course Outcome: **1.** Describe sustainable environment, sustainability processes and relate impact of various levels **2.** Formulate the methodology for assessment of sustainability of project using various indicators **3.** Apply environmental legislations to various development processes and projects.							

Module	Course Content:
1	**Concept of sustainability:** Definition of sustainability, three pillars of sustainable development, environmental, social, and economic aspects of development, interconnectivity of people, planet, and prosperity aspects.
2	**Sustainable Development Goals:** Millenium development goals, formulation of sustainable development goals, indicators for various sustainability goals, sustainability index and associated targets.
3	**Ecosystem services:** Understanding various ecosystem services, effect of industrialization on ecosystem services, impact of climate change.
4	**Sustainability in supply chain:** Understanding sustainable supply chain management, sustainability reporting and associated standards, national and global legislations associated to sustainable reporting.
5	**Principles of green chemistry:** Definition of green chemistry, 12 principles of green chemistry, resource recovery, environmentally sound reject management practices.
6	**Engineering applications of sustainability principles:** Applications of sustainability principles to engineering projects, sustainable product design, innovative thinking and optimum resource management.

	Recommended Reading: 1) P Tatyana, P. Soubbotina, Beyond Economic Growth: An Introduction to Sustainable Development, World Bank Institute Learning Resources Series, 2nd edition, 2004. (ISBN: 0-8213-5933-99) 2) P. P. Roger, F. J. Jalal and J. A. Boyd, An Introduction to Sustainable Development, Earthscan Publications, 2nd edition, 2008. (ISBN: 9781844075201/1844075206) 3) T. Strange and A. Bayley, Sustainable Development: Linking Economy, Society, Environment, 2008. (ISBN: 9789264047785) 4) H. G. Brauch, Sustainable Development and Sustainability Transition Studies, Series: Springer Briefs in Environment, Security, Development and Peace, Series Ed.

Semester IV

Semester - IV		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
1	R5CE2005T	Hydraulic Engineering	2-0-0=2	2	20	30	50	3
	Course Outcome: **1.** Apply knowledge of integrated mass continuity and energy/ momentum balance equations to pressurized pipe and open channel system. **2.** Design and develop the Civil Engineering system (pipe and open channel flow **3.** Use basic concepts of Hydraulics to analyse flow in open channel and pipes.							

Module	**Course Content:**
1	**Laminar Flow:** Laminar flow through: circular pipes, annulus and parallel plates. Stokes law, Measurement of viscosity.
2	**Turbulent Flow:** Reynolds experiment, Transition from laminar to turbulent flow. Definition of turbulence, scale and intensity, Causes of turbulence, instability, mechanism of turbulence and effect of turbulent flow in pipes. Reynolds stresses, semi-empirical theories of turbulence, Prandtl's mixing length theory, universal velocity distribution equation. Resistance to flow of fluid in smooth and rough pipes, Moody's diagram.
3	**Boundary Layer Analysis:** Assumption and concept of boundary layer theory. Boundary-layer thickness, displacement, momentum & energy thickness, laminar and Turbulent boundary layers on a flat plate; Laminar sub-layer, smooth and rough boundaries. Local and average friction coefficients. Separation and Control.
4	**Dimensional Analysis and Hydraulic Similitude:** Dimensional homogeneity, Rayleigh method, Buckingham's Pi method and other methods. Dimensionless groups. Similitude, Model studies, Types of models. Application of dimensional analysis and model studies to fluid flow problem.
5	**Introduction to Open Channel Flow:** Comparison between open channel flow and pipe flow, geometrical parameters of a channel, classification of open channels, classification of open channel flow, Velocity Distribution of channel section.

6	**Uniform Flow:** Continuity Equation, Energy Equation and Momentum Equation, Characteristics of uniform flow Chezy's formula, Manning's formula Factors affecting Manning's Roughness Coefficient 'n'. Hydraulic Channel Design, Most economical section of channel. Computation of Uniform flow Normal depth.
7	**Non-Uniform Flow** Specific energy, Specific energy curve, critical flow, discharge curve Specific Force Specific depth, and Critical depth. Channel Transitions. Measurement of Discharge and Velocity – Venturi Flume, Standing Wave Flume, Parshall Flume, Broad Crested Weir. Measurement of Velocity- Current meter, Floats, Hot-wire anemometer.
8	**Gradually Varied Flow** Dynamic Equation of Gradually Varied Flow, Classification of channel bottom slopes, Classification of surface profile, Characteristics of surface profile. Computation of water surface profile by graphical, numerical and analytical approaches. Direct Step method, Graphical Integration method and Direct integration method.
9	**Hydraulic Jump** Theory of hydraulic jump, Elements and characteristics of hydraulic jump in a rectangular Channel, length and height of jump, location of jump, Types, applications and location of hydraulic jump. Energy dissipation and other uses, surge as a moving hydraulic jump. Positive and negative surges.
10	**Dynamics of Fluid Flow:** Momentum principle, applications: Force on plates, pipe bends, moments of momentum equation
11	**Flow through Pipes:** Loss of head through pipes, Darcy-Wiesbatch equation, minor losses, total energy equation, hydraulic gradient line, Pipes in series, equivalent pipes, pipes in parallel, flow through laterals, flows in dead end pipes, siphon, power transmission through pipes, nozzles.
12	**Analysis of pipe networks:** Hardy Cross method, water hammer in pipes and control measures, branching of pipes , three reservoir problem
13	**Hydraulic Machinery:** Pumps, Turbines basics and classification, design and capacity of pumps, submersible pumps
14	**Hydraulic Design:** Pipe flow and channel flow.
	Text Books: 1 Dr. P.M. Modi and Dr. S.M. Seth, Hydraulics and Fluid Mechanics, Standard Book House. Edition: 20th, Year-2015 ISBN - 8189401262

	Recommended Reading: 1) Dr. P M Modi and Dr S M Seth, Hydraulics and Fluid Mechanics, Standard Book House (ISBN -8189401262) 2) K Subramanya, Theory and Applications of Fluid Mechanics, Tata McGraw Hill Publishing co. Ltd. (ISBN - 0074603698) 3) Dr A K Jain, Fluid Mechanics, 4th edition, Khanna Publishers (ISBN - 8174091947) 4) Ven Te Chow, Open channel Hydraulics, Tata McGraw Hill Publications. 30057th edition (1 January 2009) (ISBN -1932846182)

Semester - IV		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
2	R5CE2005L	Applied Hydraulics Laboratory	0-0-2=2	1	ISCE: 60		40	3
	Course Outcome: **1.** Calculate the force exerted by air on object boundary. **2.** Design an open channel. **3.** Design a pipe system.							

SN	Course Content: (List of Experiments)
1	Study of different type flow using Reynolds apparatus
2	Study of open channel and control structure
3	Determination of Chezy's constant and Manning's constant
4	Gradually Varied Flow
5	Determination of characteristics of hydraulic jump
6	Determination of coefficient of discharge of control structure
7	Determination of friction factor
8	Determination minor losses in pipeline
9	Hydraulic design of small pipeline system
10	Hydraulic design of small channel
	Text Books: 1 Dr. P.M. Modi and Dr. S.M. Seth, Hydraulics and Fluid Mechanics, Standard Book House. Edition: 20th, Year-2015 ISBN - 8189401262 **Recommended Reading:** 1) Dr. P M Modi and Dr S M Seth, Hydraulics and Fluid Mechanics, Standard Book House (ISBN -8189401262) 2) K Subramanya, Theory and Applications of Fluid Mechanics, Tata McGraw Hill Publishing co. Ltd. (ISBN - 0074603698) 3) Dr A K Jain, Fluid Mechanics, 4th edition, Khanna Publishers (ISBN - 8174091947) 4) Ven Te Chow, Open channel Hydraulics, Tata McGraw Hill Publications. 30057th edition (1 January 2009) (ISBN -1932846182)

Semester - IV		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
3	R5SE2002T	Soil Mechanics	2-0-0=2	2	20	30	50	3
	Course Outcome: **1.** Determine basic properties and index properties of soil using knowledge of engineering mechanics and hydraulics. **2.** Evaluate hydraulic properties and compaction of soil, identify the soil classification, **3.** Estimate the compressibility potential and analyze shear strength parameters. **4.** Apply shear strength parameters for stability of slopes and soil exploration.							

Module	**Course Content:**
1	**Introduction:** Definitions: soils, soil mechanics, soil engineering, rock mechanics, geotechnical engineering. Scope of soil engineering.
2	**Phase relationship and basic soil properties:** Soil as three-phase system in terms of weight, volume, voids ratio, and porosity Definitions: moisture content, unit weights, degree of saturation, void ratio, porosity, specific gravity, mass specific gravity etc. Relationships between volume- volume, weight-volume and weight-weight. Discussion on Grain size Analysis, Specific Gravity and Relative Density.
3	**Plasticity characteristics of soil:** Introduction to definitions of: plasticity of soil, consistency limits-liquid limit, plastic limit, shrinkage limit, consistency indices, Determination of: liquid limit, plastic limit and shrinkage limit.
4	**Classification of soils:** Introduction of soil classification: particle size classification, Indian standard soil classification system.
5	**Permeability of soil:** Introduction to hydraulic head, Darcy's law, validity of Darcy's law. Determination of coefficient of permeability by Laboratory. Permeability aspects: permeability of stratified

	soils, Graded filters.
6	**Seepage analysis:** Introduction, stream and potential functions, characteristics of flow nets.
7	**Effective stress principle:** Introduction, effective stress principle, nature of effective stress, effect of water table. Fluctuations of effective stress, quick sand condition.
8	**Compaction of soil:** Introduction, theory of compaction, laboratory determination of optimum moisture content and maximum dry density.
9	**Consolidation of soil:** Introduction, types of clay deposits, initial, primary & secondary consolidation, spring analogy for primary consolidation, one dimensional consolidation test results, Terzaghi's theory of consolidation.
10	**Shear strength:** Principle planes, Mohr's circle, Mohr-Coloumb theory, Drainage conditions, types of shear test: direct shear test, triaxial compression tests, test, relation between major and minor principal stresses, unconfined compression test, Shear strength of sand and clay,
11	**Stability of slopes:** Introduction, different factors of safety, types of slope failures, analysis of finite and infinite slopes, wedge failure Swedish circle method.
12	**Soil exploration** Boring of holes, Drilling and sampling in soil and rock.
	Text Books: 1) G. Ranjan and A.S.R. Rao, Basic and Applied Soil Mechanics, New Age International Pvt. Ltd., 2005 (ISBN: 9788122440393/8122440398). 2) V.N.S. Murthy, Advanced Foundation Engineering, CBS Publishers and Distributors, New Delhi, 2016. (ISBN- 978-8123915067). 3) B. M. Das, Principles of Foundation Engineering, PWS Publishing Company, 2012. (ISBN- 978-8131518786). **Recommended Reading:** 1) R F Craig, Soil Mechanics, Chapman & Hall. 2004. (ISBN- 9780415327039 / 0415327032). 2) C. Venktatramaiah, Geotechnical Engineering, New Age International.2009. (ISBN-9386649705/978-9386649706). 3) Robert D. Holtz, William D. Kovacs, Thomas C. Sheahan, (2010) "An Introduction to Geotechnical Engineering" Pearson Pub. 4) Terzaghi Karl, Peck Ralph and Mesri Gholamreza, 1996. Soil Mechanics in Engineering Practice. John Wiley & Sons Inc; 3rd edition (11 March 1996).

Semester - IV		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
4	R5SE2002L	Soil Mechanics Laboratory	0-0-2=2	1	ISCE: 60		40	3
	Course Outcome: **1.** Determine the basic and index physical properties of soil/rock. **2.** Evaluate consistency of soil for its classification. **3.** Determine the hydraulic behavior of soil, mechanical properties **4.** Measure shear strength behavior of soil.							

SN	Course Content: (List of Experiments- Minimum 14)
1	Natural moisture content using Oven Drying method.
2	Specific gravity of Soil grains
3	Field Density using Core Cutter method
4	Field Density using Sand replacement method
5	Grain size distribution by Sieve Analysis
6	Field identification of Fine-Grained soils.
7	Consistency limits by Atterberg Limit
8	Permeability test using Constant Head test method.
9	Permeability test using Falling Head method
10	Compaction test: Standard Proctor test or Modified Proctor test.
11	Direct Shear Test
12	Unconfined Compression Test
13	Triaxial Compression Test
14	Consolidation Test
15	Grain size distribution by Hydrometer Analysis (optional)

16	Lab. CBR method (optional)
	Text Books: 1) Prof. Krishna Reddy, "Engineering Properties of Soils Based on Laboratory Testing." Department of Civil and Materials Engineering, University of Illinois at Chicago. **Recommended Reading:** 1) R F Craig, Soil Mechanics, Chapman & Hall. 2004. (ISBN-9780415327039/0415327032). 2) C. Venktatramaiah, Geotechnical Engineering, New Age International.2009. (ISBN- 9386649705/978-9386649706). 3) A. Singh, Soil Engineering in Theory and Practice, Standard Publishers and Distributors, New Delhi. 2009. (ISBN-8123900392/978-8123900391). 4) D.W. Taylor, Fundamentals of Soil Mechanics, Asia publications Bombay, 1967. (ASIN: 5) B002XBX0HY). 6) T.W. Lambe and R.V. Whitman (1979). 'Soil Mechanics', John Wiley and Sons, New York, USA (ISBN: 978-0-471-51192-2).

Semester - IV		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
5	R5CE2006T	Building Drawing and Services	2-0-0=2	2	20	30	50	3
	Course Outcome: **1.** Implement principles of planning of buildings **2.** Design and draw various constructional drawing of the buildings. **3.** Plan various building services.							

Module	Course Content:
1	**Planning Principles and Laws for Buildings:** Concept of built environment and its application in planning. Recommendation of National building code, Building Bye-laws, RERA.
2	**Planning and Drawing of Building: -** Preparation of constructional details and drawings - Plan (Single line and Double line plan), Elevation, Section, Site plan, Foundation plan, Terrace plan, Layout Plan Planning of Load bearing and RCC structures such as • Residential building • Building for Education – School, College, Library • Building for health – Dispensary, Hospital Industrial Structure • Building for Entertainment -Theatre, club house, sports club. • Other structure - Office, Hostel, Guest house.
3	**Building's Water Supply and Drainage System: -** Design of water supply, waste water and storm water collection system for various types of buildings. Pumps and Pump House.
4	**Electrical Services: -** Domestic Supply, Distribution Circuits, basic wiring systems. Design and planning: - Lighting of staircase, corridors. Automatic Water Level controller, Closed Circuit Security Monitors with Intercom/ EPBX facility, Common Dish TV antenna, Use of Solar Panels as source of power, Lightening Conductor for High-rise Buildings.
5	**Fire Protection System: -** Introduction, Fire protection, requirement of water quantity estimation. Systems of firefighting external and internal. Wet and dry risers, smoke alarm, Sprinkler system.

	Safety corridors in High-rise structures. Fire retarding coating.
6	**Elevators and Escalators: -** Introduction, Types of elevators and escalator. Essential features its size and requirement of minimum numbers, Safety norms. Control systems, electrical requirement, and generator back-up.
7	**Heating, Ventilation and Air Conditioning:** Ventilation, functional requirement, Heat balance system of ventilation, General rules and regulations in artificial ventilation system, Central air conditioning: - ducting and glass claddings. Wind Rose Diagram.
8	**Green building:** Introduction, Benefits, National priorities, rating system, check list, Site selection and planning, Water efficiency, Energy efficiency, Materials, Indoor environmental quality, Innovation and design process. Introduction to concepts of LEED and GRIHA.
	Text Books: 1. M.G.Shah, Kale, Patki, Building Drawing with an Integrated Approach to Built Environment, Tata McGraw-Hill Education India, 5th edition, 2011, (ISBN: 9780071077873, 0071077871). 2. Building Services Environmental And Electro Mechanical Services, Second Revised, 2014, (ISBN: 9788175259805) **Recommended Reading:** 1) Bureau of Indian Standards, " HAND BOOK OF FUNCTIONAL REQUIREMENTS OF BUILDINGS, (SP-41 & SP- 32)", BIS 1987 and 1989, (SP-41: ISBN: 8170610117) 2) Croome, J. D. & Roberts, B. M., "AIR-CONDITIONING AND VENTILATION OF BUILDINGS VOL-1". Pergamon Press, (ISBN: 0080247792) 3) SP-35 (1987): Handbook of Water supply & drainage-BIS, (SP- 35: ISBN: 8170610095) 4) N.B.C.-2016, Volume 1 & 2, BIS, (ISBN: 8170610990)

Semester - IV		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
6	R5CE2006L	Building Drawing and Services Laboratory	0-0-2=1	1	ISCE: 60		40	3
	Course Outcome: **1.** Draw various constructional drawings of buildings. **2.** Use of ICT tools for preparing construction drawings. **3.** Prepare Line plan for various public buildings **4.** Prepare layout of various building services.							

Sl. No.	**Course Content:**
1	Preparation of detailed constructional plan of a residential building.
2	Preparation of Front Elevation, Detailed Sectional View, Site Plan, Foundation Plan, Terrace Plan, Layout Plan.
3	Concept of perspective drawing- one point, two-point, three point and uses.
4	Preparation of line plans of various public buildings like: • Building for Education – School, College. Library • Building for health –Dispensary, Hospital Industrial Structure • Building for Entertainment-Theatre, Club House, Sports Club. • Other Structure- Office, Hostel, Guest house.
5	Prepare layout plan and sectional view for water supply and drainage for a building.
6	Prepare electrical connections plan.
7	Fire Protection System: Design of emergency exits and emergency vehicle routes with fire protection symbols
	Text Books: 1. Scott Onstott, AutoCAD 2018 and AutoCAD LT 2018 Essentials, Wiley (2017), (ISBN: 9788126569298)

	2. M. G. Shah, Kale, Patki, Building Drawing with an Integrated Approach to Built Environment, Tata McGraw-Hill Education India, 5th edition, 2011, (ISBN: 9780071077873, 0071077871). 3. Building Services Environmental and Electro Mechanical Services, Second Revised, 2014, (ISBN: 9788175259805) **Recommended Reading:** 1) Bureau of Indian Standards, "H A N D BOOK OF FUNCTIONAL REQUIREMENTS OF BUILDINGS, (SP-41 & SP- 32)", BIS 1987 and 1989, (SP-41: ISBN: 8170610117) 2) Croome, J. D. & R o b e r t s , B . M., "AIR-CONDITIONING AND VENTILATION OF BUILDINGS VOL-1". Pergamon Press, (ISBN: 0080247792) 3) SP-35 (1987): Handbook of Water supply & drainage-BIS, (SP- 35: ISBN: 8170610095) 4) N.B.C.-2016, Volume 1 & 2, BIS, (ISBN: 8170610990)

Semester - IV		Program Core Course						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
7	R5SE2003T	Structural Analysis	3-0-0=3	3	20	30	50	3
	Course Outcome: After completion of this course, students will be able to, 1. Determine deflection of statically determinate structures under various loading and support conditions. 2. Apply basic concepts of structural mechanics for the analysis of statically determinate structures. 3. Apply concepts of structural mechanics for the analysis of statically determinate arches and stiffened suspension bridges. 4. Apply concept of Influence Line Diagram to statically determinate structures.							

Module	**Course Content:**
1	**General theorems** Theorems relating to elastic structures, principle of virtual work, strain energy in elastic structures, complementary energy, Castigliano's theorems, Maxwell-Betti's reciprocal theorem. Classification of structural forms such as plane frame, space frames, plane and space trusses, arches, cables and surface structures, stability of structures, static and kinematic indeterminacy of structures, behavior of symmetric structures subjected to symmetric and anti-symmetric loads, the distinction between linear and nonlinear material, and geometric behavior of structures.
2	**Elastic arches** Normal thrust, shear force and bending moment for parabolic and segmental three hinged arches. Influence lines for normal thrust, shear force and bending moment for three hinged parabolic arch.
3	**Influence lines for statically determinate structures** Influence lines for cantilever beam, simply supported beam, overhanging beam. Criteria for maximum shear force, bending moment and absolute maximum bending moment under moving loads for simply supported beams.
4	**Deflection of statically determinate structures** Deflection of determinate beams by double integration (Macaulay's) method, moment area and conjugate beam methods, principle of virtual work (unit load method) and Castigliano

	theorems, Deflection of determinate pin jointed trusses and rigid jointed frames by principle of virtual work (unit load method), Strain Energy and Castigliano's theorems.
5	**Analysis of indeterminate structures by flexibility method** Flexibility coefficients and their use in the formulation of compatibility equations. Application of Castigliano's theorem of least work to propped cantilevers, fixed beams, continuous beams, and rigid jointed frames (without sway), two hinged arch.
6	**Analysis of indeterminate structures by stiffness method** Stiffness coefficients and their use for formulation of equilibrium equation, direct stiffness method, slope deflection method, moment distribution method, applications of these methods to indeterminate beams and rigid jointed frames (without sway).
	Text Books 1. S.B Junnarkar, Structural Mechanics Vol.I, Charotar Publishers, 2016. (ISBN:978-9385039270). 2. D. Menon, Structural Analysis Volume – I, Narosa Publication, 2010. (ISBN- 978-1842653371/1842653377). 3. C.S. Reddy, Basic Structural Analysis, Publisher: Tata McGraw Hill, 2010. (ISBN-1283187140/978-1283187145). **Recommended Reading** 1. C.K. Wang, Intermediate Structural Analysis, McGraw Hill, 1984. (ISBN-10:0070666237/978-0070666238). 2. B.G. Neal, Structural theorems and their application, Pergaman Press, 1972. (ISBN:978-1483139029). 3. S.S. Bhavikatti, Structural Analysis Volume – I, Vikas Publishers, 3rd edition, 2011. (ISBN: 9788125942696/8125942696). 4. S. Timoshenko and Young, Theory of Structures, Publisher: Tata McGraw Hill, 1965.(ISBN- 9780070648685/978-0070648685). 5. Norries and Wilbur, Elementary Structural Analysis, Publisher: McGraw Hill, 1990. (ISBN- 0071008365/978-0071008365). 6. H I Laursen, Structural Analysis, Publisher: McGraw Hill, 1988. (ISBN-0070366454/978-0070366459).

Semester - IV		Value Education Course (VEC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
8	R5HS2402T	Universal Human Values	2-0-0=2	2	ISCE: 60		40	3
	Course Outcome: **1.** Understand value education. **2.** Understand harmony in nature. **3.** Design sustainable solutions to the problems in society and nature							

Module	Course Content:
1	**Introduction to Value Education** Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education), Understanding Value Education, Sharing about Oneself, Self-exploration as the Process for Value Education, Continuous Happiness and Prosperity – the Basic Human Aspirations, Happiness and Prosperity – Current Scenario, Method to Fulfill the Basic Human Aspirations
2	**Harmony in the Human Being** Understanding Human being as the Co-existence of the Self and the Body, Distinguishing between the Needs of the Self and the Body, The Body as an Instrument of the Self, Understanding Harmony in the Self, Harmony of the Self with the Body, Programme to ensure self-regulation and Health
3	**Harmony in the Family and Society** Harmony in the Family – the Basic Unit of Human Interaction, 'Trust' – the Foundational Value in Relationship, Exploring the Feeling of Trust, Other Feelings, Justice in Human-to-Human Relationship, Understanding Harmony in the Society, Vision for the Universal Human Order
4	**Harmony in the Nature/Existence** Understanding Harmony in the Nature, Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature, Realizing Existence as Co-existence at All

	Levels, The Holistic Perception of Harmony in Existence
5	**Implications of the Holistic Understanding – a Look at Professional Ethics** Natural Acceptance of Human Values, Definitiveness of (Ethical) Human Conduct, A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order, Competence in Professional Ethics, Strategies for Transition towards Value-based Life and Profession
	Text Book 1. The Textbook - A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1. 2. The Teacher's Manual- Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, RR Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53 3. Professional Ethics and Human Values, Premvir Kapoor, ISBN: 978-93-86173-652, Khanna Book Publishing Company, New Delhi, 2022. **Recommended Reading** 1. Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999. 2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004. 3. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi 4. Vivekananda - Romain Rolland 5. Gandhi - Romain Rolland

Semester - IV		Program Core Course (PCC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
9	R5CE2007T	Hydrology and Water Resource Engineering	3-1-0=4	4	20	30	50	3
	Course Outcome: **1.** Measure and analyze rainfall, runoff and water losses **2.** Construct and analyze different hydrographs **3.** Use stream gauging techniques and determine ground water flow **4.** Compute the water requirement of crops. **5.** Carry out reservoir planning, describe hydraulic structures and design distribution systems							

Module	Course Content:
	HYDROLOGY:
1	**Introduction** Hydraulic Cycle, Water Budget Equation, World Water Balance, History of hydrology, Applications in Engineering and Sources of Data.
2	**Precipitation:** Introduction, Forms of Precipitation, Weather systems of Precipitation , Characteristics of Precipitation in India, Measurement of precipitation , Rain Gauge Network, Preparation of Data, Presentation of rainfall Data, Mean precipitation over an area , Depth Area Duration Relationship, Frequency of Point rainfall, Maximum Intensity- duration-frequency relationship, PMP, Rainfall data in India, Evapo-transpiration, Transpiration, Measurement of EV.
3	**Water losses** Evapo-transpiration, Transpiration, Measurement of Evapotranspiration, Evapo-transpiration equations, AET, PET, Infiltration, Infiltration Capacity, Measurement of Infiltration capacity, Modeling of infiltration capacity, classification of infiltration capacity, Infiltration Indices.
4	**Rainfall – runoff process** Introduction, Hydrograph, Runoff Characteristics of Streams, Runoff Volumes, Flow

	duration Curve, Flow Mass Curve, Drought, surface water resources in India.
5	**Hydrograph analysis** Introduction, Factors affecting Flood Hydrograph, Components of Hydrograph, Base Flow separation, Effective Rainfall, Unit Hydrograph, Derivation of Unit Hydrograph, Unit hydrograph of different duration, Use and limitation of Unit Hydrograph, Duration of Unit Hydrograph, Distribution graph, Synthetic unit hydrograph, IUH.
6	**Stream gauging:** Introduction, Measurement of stage, measurement of velocity, Area velocity Method, Dilution Techniques, Electromagnetic Method, Ultrasonic Method, Indirect method.
7	**Flood and Flood Routing** Introduction, Rational method, Empirical Formulae, unit Hydrograph Method, Flood Frequency Studies, Gumbell Method, Design Flood, Design Storm, Risk Reliability and safety Factor Introduction of flood routing , Basic equation, storage routing, reservoir routing, attenuation, hydrogic channel routing, hydraulic method of flood routing, Flood control, Flood control in India.
	WATER RESOURCE ENGINEERING:
1	**Water requirement of crops:** Irrigation systems: Need, minor and major, command area development, Crops and crop seasons in India, cropping pattern, duty and delta, Quality of irrigation water, Soil-water relationships: soil characteristics significant from irrigation considerations, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation, Methods of applying water to the fields: surface, sub-surface, sprinkler and trickle / drip irrigation
2	**Reservoirs:** Types, capacity of reservoir, fixing of control levels, yield of reservoir, reservoir regulation, erosion and sedimentation, economic height of dam, selection of suitable site, Reservoir Planning, Reservoir sizing, Sequent Peak Algorithm, Mass Flow Curve.
3	**Dams and spillways:** Embankment dams: Classification, selection of site for dam, design considerations, estimation and control of seepage, slope protection, failure of earthen dams Gravity dams: forces on gravity dams, causes of failure, elementary and practical profile, structural joints, keys and water seals, galleries, outlets, Arch and buttress dams: types of Spillways: components of spillways, types, terminal structures, types of gates for spillway crests, Weir and barrage- types of weirs, Theories of seepage for design of weirs, failure of gravity dams
4	**Distribution system:**

	Canal systems, alignment of canals, canal losses, estimation of design discharge Design of channels: Kennedy's and Lacey's theory of regime channels Canal Outlets: non-modular, semi-modular and modular outlets Water logging: causes, effects and remedial measures, Lining of canals: economics of lining, types of lining, Drainage of irrigated lands: necessity, methods
5	**Hydraulic structures:** Surface and sub-surface flow considerations for design of canal structures: hydraulic jump, seepage forces, uplift forces Canal falls, cross regulator, distributary head regulator, canal escapes: types, components and design considerations, Cross drainage works: need, types, design considerations, different units of headworks, sediment control in canals, river training for canal headworks,
	Text Books: 1) G L Asawa, Irrigation Engineering, Wiley eastern, New Age International Publisher (1999) (ISBN: 8122412025) 2) K. Subramanya "Engineering Hydrology", McGraw Hill Education; Fourth edition (1 July 2017), (ISBN: 1259029972) 3) S K Garg, Water Resources Engineering Vol. II Irrigation Engineering & Hydraulic Structures, Khanna Publishers (2017), (ISBN: 8174090479) 4) P N Modi, Irrigation Engineering & Hydraulic Structures, Standard Book House; Edition: 9th, Year-2014 edition (2014), (ISBN: 8189401297) 5) V.P. Singh, Elementary Hydrology, Prentice-Hall; Facsimile edition (13 December 1991), (ISBN: 0132493845) **Recommended Reading:** 1) R. S. Varshney, S. C. Gupta, R. L. Gupta, Theory and Design of Irrigation Structures, Nem Chand & Bros, (ISBN 13: 9788185240473) 2) Punmia B. C., Ashok Kumar Jain & Pande B. B. Lal, Irrigation Engineering and Water Power Engineering, Laxmi Publications; Revised edition (2016), (ISBN: 9788131807637) 3) J D Zimmerman, Irrigation, John Wiley & Sons; 99th edition (1 September 1966), (ISBN: 0471983799) 4) IS:1192-1981 Velocity area methods for measurement of flow of water in open channels (First Revision). 5) IS:2800 Code of Practice for Tube Well. 6) IS:3910-1992 Requirements for Water Flow Measurement in Open Channels- Rotating elements current meters (first revision). 7) IS:3918-1966 Code of Practice for use of Current Meter (cup type) for Water Flow Measurement. 8) IS:6936-1992 Methods for Determination of Evaporation from Reservoirs (first revision). 9) IS:3860-1966 precast cement concrete slabs for canal lining.(superseded by IS:10646). 10) IS:3872-1966 code of practice for lining of canals with burnt clay tiles. 11) IS:4410 glossary of terms relating to the river valley projects. 12) IS:4877-1968 canals structures, drains outlets jungle clearance, plantation and regulations (second revision) 13) IS: 5477 methods for fixing the capacities of reservoirs.

Semester - IV		Vocational Skill Enhancement Course (VSEC)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
10	R5CE2008L	Geospatial Technology Laboratory	0-0-2=2	1	ISCE: 60		40	3
	Course Outcome: **1.** Design and set out horizontal and vertical curve. **2.** Use of various electronic instruments such as Digital Planimeter, Electronic Theodolite, Total station, Auto and Digital Levels and GPS receiver. **3.** Apply geospatial techniques such as Geographical Information System (GIS), Global Positioning System (GPS) and Remote Sensing in the field of Surveying and Mapping.							

Module	Course Content:
1	**Tachometric surveying:** Principles and uses, advantages, stadia formula, different methods of tachometer, subtense bar method, location details by tachometer, stadia diagram and tables, error and accuracy in tachometry survey work
2	**Curves:** Definitions of different terms, necessity of curves and types of curves. Simple circular curves and compound curves, office and field work, linear methods of setting out of curves Angular methods for setting out of curves, two theodolite and Rankine deflection angle methods Reverse and transition curves, their properties and their advantages, design of transition curves, shift, spiral angle Composite curves – office and field work, setting out of curve by angular method, composite curve problems Vertical curves – definitions, geometry and types, tangent correction and chord gradient methods, sight distance on a vertical curve, difficulties in setting out curves and solutions for the same

3	**Global Positioning System (G.P.S):** G.P.S. Segments: Spaces Segment, Control Segment, User Segment, Features of G.P.S. Satellites, Principle of Operation, Surveying with G.P.S.: Methods of observations, Absolute Positioning, Relative Positioning, differential G.P.S., Kinematics of G.P.S., G.P.S. Receivers: Navigational Receivers, Surveying Receivers, Geodetic Receivers, Computation of Co- ordinates:- Transformation from Global to Local Datum , Geodetic Coordinates to map co- ordinates , G.P.S. Heights and mean sea level Heights, Applications of G.P.S
4	**Remote Sensing:** Electromagnetic remote sensing process, Physics of radiant energy: Nature of Electromagnetic radiation, Electromagnetic spectrum, Energy Source and its Characteristics, Atmospheric influences: Absorption, Scattering Energy interaction with Earth Surfaces: Spectral reflectance Curve, Image Acquisition: Photographic sensors, Digital Data, Earth Resource satellites, Image resolution, Image Interpretation, Application of Remote Sensing
5	**Geographical Information System (GIS):** Information systems, spatial and non- spatial information, geographical concept and terminology, advantages of GIS, Basic component of GIS, Commercially available GIS hardware and Software, Field data, statistical data, maps, aerial Photographs, satellite data, points, lines, and areas features, vector and raster data, data entry through keyboard, digitizer and scanners, pre-processing of data rectification and registration, interpolation technique
6	**Introduction to surveying with Drones:** Introduction to Drones, History of Drone/UAS/UAVs, payload, battery life, Specs for good results, Regulations of DGCA and Drone license, Pre and Post Flight planning- Flight execution and photography, data collection- Image Format, GSD, Scale and Resolution. Consideration for hardware selections, comparison on surveying drone and its accuracy, Techniques of controlling errors, Consideration of GCP in vertical and horizontal accuracies, Planning and estimation of drone surveying jobs, Autonomous flight vs. manual and hybrid flight profiles.
7	**Practical's:** 1. To find the constants of a tacheometer and to verify field distances 2. Height and distance problems in tacheometric surveying 3. Setting out the circular curve by Rankine's method of deflection of angles 4. A two-day project on L section and cross section, block contouring and tachometric survey (Mandatory) 5. Study of satellite images and its interpretation, false color combination etc. 6. Determination of horizontal, sloping and vertical distance between any two points by using Total Station 7. Preparation of contour map by using road suitable software such as Surfer or Road Master Q-GIS, Arc-GIS

	8. Geo-registration Geo-Referncing of map and its digitization by using suitable GIS software. 9. Map editing, vector and raster analysis of digitized map by using suitable GIS software 10. Preparation of Contour map by using Triangulated Irregular Network (TIN) or contour extraction tools in GIS software 11. Generation of 2D and 3D digital elevation model (DEM) from contour map using GIS software 12. Collection of field data like point data, line data and area data by using surveying and mapping GPS receiver 13. Post-processing the GPS data by using post processing software such as Pathfinder Software Q-GIS, Arc-GIS. 14. Generation of Databases and relation database management system (RDBMS) using MS ACCESS. 15. Application of drone for Surveying & Mapping- Construction project, Irrigation plot.
	Text Books: 1) Satheesh Gopi, R. Sathikumar, N. Madhu, Advanced Surveying - Total station, GIS and Remote sensing, First edition Pearson education (ISBN No 9788131700679) 2) Lo C P, Yeung A K W, Concepts and Techniques of Geographic Information Systems, 2nd edition, Prentice Hall India. **Recommended Reading:** 1) N. N. Basak, Surveying and Leveling, Tata McGraw Hill Publications, 2nd Edition. (ISBN - 9789332901537) 2) B C Punmiya, Surveying and Leveling, Vol I-16Th edition & Vol II- 4th edition, Laxmi Publications. (ISBN - 9788170088530) 3) R Agor, Surveying, Khanna Publishers- 11th edition. (ISBN - 8174092358) 4) Concepts and Techniques of Geographical Information System, Lo C. P. Yeung A K W, Prentice Hall India 5) Kang-tsung Chang, Introduction to Geographical Information System Tata McGraw Hill, 8 edition (16 February 2015) (ISBN - 0078095131) 6) K. Anji Rao, Remote sensing and Geographical information system, BS Publications (ISBN - 9381075972)

Semester - IV		Community Engagement Project (CEP)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
11	R5CE2601P	Community Engagement Project	0-0-4=4	2	ISCE: 60		40	3
	Course Outcome: 1. Gain an understanding of rural life, Indian culture & ethos and social realities 2. Develop a sense of empathy and bonds of mutuality with local community. 3. Appreciate significant contributions of local communities to Indian society and economy. 4. Identify opportunities for contributing to community's socio-economic improvements							

Module	Course Content:
1	**Appreciation of Rural Society:** Rural lifestyle, rural society, caste and gender relations, rural values with respect to community, nature, and resources, elaboration of "soul of India lies in villages" (Gandhi), rural infrastructure
2	**Understanding rural and local economy & livelihood:** Agriculture, farming, landownership, water management, animal husbandry, non-farm livelihoods and artisans, rural entrepreneurs, rural markets, migrant labour
3	**Rural and local Institutions** Traditional rural & community organisations, Self-help Groups, Panchayati raj institutions (Gram Sabha, Gram Panchayat, Standing Committees), Nagarpalikas & municipalities, local civil society, local administration
4	**Rural and National Development Programmes:** History of various development in India, current national programmes: Sarva Shiksha Abhiyan, Beti Bachao, Beti Padhao, Ayushman Bharat, Swachh Bharat, PM Awaas Yojana, Skill India, Gram Panchayat Decentralised Planning, NRLM, MNREGA, SHRAM, Jal Jeevan Mission, SFURTI, Atma Nirbhar Bharat, etc.
5	**Assignment and recommended field based practical activities:** 1. Prepare a map (physical, visual, or digital) of the village you visited and write an essay about it.

	2. Describe your analysis of rural household economy, its challenges, and possible pathways to address them. Circular economy and migration patterns focus. 3. How effectively are Panchayati Raj & Urban Local Bodies (ULBs) institutions functioning in the village? What would you suggest to improve their effectiveness? Present a case study (written or audio-visual). 4. Describe the benefits received and challenges faced in the delivery of one of these programmes in the local community; give suggestions about improving implementation of the programme for the poor. Special focus to urban informal sector and migrant households. 5. Visit MGNREGS project sites, interact with beneficiaries, and interview functionaries at the work site. 6. Visit local NGOs, civil society organisations, and interact with their staff and beneficiaries. 7. Field visit to Swachh Bharat project sites, conduct analysis, and initiate problem-solving measures. 8. Conduct Mission Antyodaya surveys to support under Gram Panchayat Development Plan (GPDP). 9. Conduct soil health tests, drinking water analysis, mapping of different and surveys. 10. Raise understanding of people's impacts of climate change, building up community's disaster preparedness.
	Recommended Reading 1. Singh, Katar, Rural Development: Principles, Policies and Management, Sage Publications, New Delhi, 2015. 2. A Hand book on Village Panchayat Administration, Rajiv Gandhi Chair for Panchayati Raj Studies, 2002. 3. United Nations, Sustainable Development Goals, 2015 un.org/sdgs/ 4. M. P. Boraian, Best Practices in Rural Development, Shanlax Publishers, 2016

EXIT COURSES

Semester - IV		Program Exit Course						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
1	R5CE2901I	Internship		6	ISCE: 60		40	3
	Course Outcome: 1. Relate engineering knowledge and civil engineering works 2. Use Standard practices in civil engineering projects 3. Write technical report 4. Work as an individual and team							

Module	Course Content:
1	Student will undergo internship for summer vacation for minimum of 40 days in any of the Civil engineering firms to have an exposure to practical aspects of structural engineering, geotechnical engineering, environmental engineering, transportation engineering, water resources engineering, construction engineering and management etc. Student will submit a report and give presentation based on internship. The internship report shall cover the following: Introduction, Brief History of the Organization, Summary of the Project Assignment, Technical and practical information gained during the summer training period, Planning, Designing, check lists, Quality practices, safety measures, record keeping etc. (This must constitute the major part of the report), Conclusion and Recommendations, Photo gallery, References, Appendices.

Semester - IV		Program Exit Course						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
2	R5CE2902P	Project	0-0-12 = 12	6	ISCE: 60		40	3
	Course Outcome: 1. Review available knowledge with reference to specific problem 2. Formulate the problem and collect relevant data. 3. Define systematic approach to arrive at solution							

Module	**Course Content:**
1	Every student has to work on a one year project in the last year under the guidance of a Guide allotted by the department. In case of a group project, role of every individual should be clearly defined. The project may be related to theoretical analysis, fabrication of a model and experimental work, etc. Through the project, students have to exhibit both the analytical and practical skills. The evaluation shall be done at the end of the project period. Students are expected to define the problem and its scope, complete literature survey and finalize methodology for data collection. They are also expected to give critical comments, necessity of work, scheme of experiments etc.

Semester - IV		Program Exit Course						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
3	R5SE2901T	Geotechnical Field Exploration	2-0-0=2	2	20	30	50	3
	Course Outcome: 1. Evaluate earth pressures and apply to check external stability of retaining structures. 2. Analyze and design shallow foundations by shear and settlement criteria under different. 3. Evaluate the load carrying capacity and settlement of deep foundation by shear and settlement criteria for different soil conditions under axial load. 4. Apply principles of Three-Dimensional Consolidation and soil reinforcement for soft soil improvement.							

Module	Course Content:
1	**Lateral earth pressures theories** Earth pressure theories, earth pressure at rest. Rankine's Earth Pressure: active and passive earth pressure for horizontal and inclined backfill including non-homogenous deposit, Coloumb's Wedge Theory: mathematical approach, condition for failure plane, graphical methods. passive pressure by friction circle method.
2	**Earth retaining structures** Stability analysis of cantilever retaining wall or sheet piles in sand and clay.
3	**Bearing capacity of shallow foundation** Definitions of ultimate bearing capacity, gross, net and safe pressures, allowable bearing pressure, types of shallow foundations, modes of failures. Bearing capacity theories: Terzaghi's approach, Vesic's approach and IS 6403 (1981) method. Bearing capacity based on Standard Penetration Test. Settlement estimation, plate load test (IS 1888) and SPT for estimation of settlements. Bearing capacity of foundation on compact and weathered rock.
4	**Axially loaded pile foundations** Introduction, necessity, and classification of pile foundation, classification of piles. Pile capacity and settlement based on static analysis, single and group piles in sand and clay, critical depth method, dynamic methods and their limitations, in-situ penetration tests and pile load test as per IS 2911 specifications, negative skin friction.
5	**Ground improvement techniques** Ground improvement techniques: Stone columns and sand/band drains. Basic principle of Geogrid design for Reinforced Earth wall. Shallow Stabilization with additives: Lime,

	flyash, cement and other chemicals and bitumen, in-situ soil mixing; Grouting: permeation, compaction, and jet;
6	**Planning of subsurface investigation** Planning of investigation programmes, Geophysical methods. Methods of site investigations: Direct methods, semi-direct methods and indirect methods, Drilling methods. Boring in soils and rocks.
	Text Books: **1.** G. Ranjan and A.S.R. Rao, Basic and Applied Soil Mechanics, New Age International Pvt. Ltd., 2022. (ISBN: 978-9393159373/9393159378). **2.** V.N.S. Murthy, Advanced Foundation Engineering, CBS Publishers and Distributors, New Delhi, 2016. (ISBN- 9788123915067). **3.** B. M. Das, Principles of Foundation Engineering, Cengage India Private Limited, 2017. (ISBN- 978-9386650955). **Recommended Reading:** 1. K. Terzaghi and R. B. Peck, Gholamreza Mesri, Soil Mechanics in Engineering Practice, Wiley and Sons, 1996. (ISBN-8126523816/978-8126523818). 2. A. Singh, Soil Mechanics and Foundation Engineering, Vol I & Vol II, Standard book House, 2013. (ISBN- 812390276X/978-8123902760). 3. H. Winterkorn and F.Y. Fang, Foundation Engineering Handbook, CBS Publishers & Distributors, New Delhi, 2013. (ISBN 9788123905457). 4. J. E. Bowles, Foundation Analysis and Design, McGraw-Hill Book Co, 2001. (ISBN-0071188444/ 978-0071188449). 5. P. Shamsher and H. Sharma, Pile Foundations in Engineering Practice, Wiley and Sons, 2012. (ISBN- 9788126539932). 6. J. K. Mitchell and K. Soga, Fundamentals of Soil Behavior, 3rd edition, John Wiley & Sons, New York, 2005. (ISBN-9780471463023/978-0471463023). 7. R.D. Holtz and W.D. Kovacs, An introduction to geotechnical engineering, Prentice Hall,2013. (ISBN- 9332507619). 8. IS1892 (1979), Subsurface Investigation for Foundation. 9. IS6403 (1981), Determination of Bearing Capacity of Shallow Foundation.\ 10. IS 8009 Part I (1978), Calculation of Settlement of Foundation and Shallow foundation Subjected to Symmetrical Static Vertical Loads. 11. IS2911 Part I (2010), Design and Construction of Pile Foundations, Part I Concrete Piles. 12. IS1888 (1982), Method of Load Test on Soil. 13. IS1904 (1986), Design and Construction of Foundation in Soil – General Requirements.

Semester - IV		Program Exit Course						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
4	R5SE2901L	Geotechnical Field Exploration Laboratory	0-0-2=2	1	ISCE: 60		40	3
	Course Outcome: **1.** Determine shear strength parameters of soil **2.** Evaluate bearing capacity of foundations **3.** Determine settlement, time of consolidation of different clay deposits. **4.** Knowledge of preparation of geotechnical report							

Sl. No.	**Course Content: (List of Experiments)**
1	Determine shear strength parameters using Box shear test
2	Evaluate compression parameters by performing consolidation test
3	Compare the consolidation characteristics of different clay deposits
4	Evaluate pore pressure and volume change using compression test setup
5	Perform DCPT test as per ASTM
6	Evaluate the shear strength parameters using unconfined compression tests
7	Prepare geotextile report.
	Text Books: 1 R.D. Holtz and W.D. Kovacs, An introduction to geotechnical engineering, Prentice Hall,2013. (ISBN-9332507619). **Recommended Reading:** 1. A. Singh, Soil Mechanics and Foundation Engineering, Vol I & Vol II, Standard book House, 2013. (ISBN- 812390276X/978-8123902760) 2. J. E. Bowles, Foundation Analysis and Design, McGraw-Hill Book Co, 2001. (ISBN- 0071188444/ 978-0071188449). 3. P. Shamsher and H. Sharma, Pile Foundations in Engineering Practice, Wiley and Sons, 2012. (ISBN-9788126539932). 4. P. Purushothama Raj, Ground Improvement Techniques (HB), Laxmi Publication Pvt Ltd., New Delhi, 2015. (ISBN-9788170080985/978-8170080985).

Semester - IV		Program Exit Course						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
5	R5CE2903T	Pavement materials and construction	2-0-0=2	2	20	30	50	3
	Course Outcome: **1.** Acquire the basic knowledge of Construction techniques of Flexible and Concrete pavements. **2.** Plan various highway cross sectional element. **3.** Carry out structural design flexible and rigid pavements. **4.** Design pavement material mix for flexible and rigid pavements							

Module	Course Content:
1	**Highway Planning** Classification of roads, a brief history of road development in India, present status of roads in India, road patterns, saturation systems, highway alignment: basic requirements for an ideal alignment.
2	**Geometric Design of Highways** Terrain classification, design speed, highway cross-section elements Sight distance: introduction to sight distance, reaction time, analysis of safe sight distance, analysis of overtaking sight distance, Intermediate sight distance Design of horizontal alignment: horizontal curves, design of super elevation and its provision, radius at horizontal curves, widening of pavements at horizontal curves, analysis of transition curves Design of vertical alignment: different types of gradients, grade compensation on curves, analysis of vertical curves, summit curves, valley curves
3	**Pavement Materials** Stone aggregates: nature and desirable properties, tests, and requirements of aggregates for different types of pavements Bituminous materials: types, tests on bitumen, desirable physical and chemical properties, and uses, selection of the grade of bitumen., Bituminous mix design by Marshall Stability principle, methods, modified binder Concrete, Light weight aggregate, Tests on aggregate, Specification. Bituminous Materials: Conventional and modified binders production, Types and grade. Geosynthetics: Types and functions, properties of geo-synthetics, materials and manufacturing

	processes, testing and evaluation, application of geotextiles and geogrids in pavements Reclaimed/Recycled Waste Products: Reclaimed Materials, Waste products in civil engineering applications, Effect of waste products on materials, Structure and properties, self-healing, and smart materials.
4	**Design of Pavements** Types of pavements, comparison of different types of pavements, functions of pavement components, pavement design factors, design wheel load, equivalent single wheel load, repetition of loads, equivalent wheel load factors, strength characteristics of pavement materials, climatic variation; design of flexible highway pavement as per IRC approach, Stresses in rigid highway pavements, critical load positions, stresses due to loads, stresses due to temperature change, combined loading and temperature stresses, Joints in rigid pavements: transverse joints, longitudinal joints, fillers and sealers
5	**Highway Construction** Equipment used for construction, embankment design and construction, construction of different Types of roads: water bound macadam, different types of bituminous pavements, cement concrete pavements, Modern Techniques for construction of Roads (Bituminous and concrete roads)
	Text Books: 1. L. R. Kadiyali, N. B. Lal, Principles and Practice of Highway Engineering, Khanna Publications, 2005 (ISBN- 9788174091659). 2. Partha Chakroborty and Animesh Das, Principles of Transportation Engineering, PHI Learning, 1st edition 2011, (ISBN- 9788120353459) 3. Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski, John Wiley, Principles of Highway Engineering and Traffic Analysis, 4th Edition, 2011, (ISBN-9781118120149) **Recommended Reading** 1. Morlok, E. R., An Introduction to Transportation Engineering and Planning, McGraw Hill Kagakusha International Student Edition, 1978, (ISBN: 0070431329) 2 Hay, W. W., Introduction to Transportation Engineering. John Wiley and Sons,New York, (1988), 2nd edition, (ISBN: 0471364339) 3 Papacostas, C. S., Fundamentals of Transportation Engineering, Prentice Hall of India, New Delhi, (1987), (ISBN: 0133448703) 4. IRC 37 –Design of Flexible Pavement 2012, 5. IRC-58- Design of Rigid Pavement 2002 6. IRC-SP62 Design of Low volume roads-2014

Semester - IV		Program Exit Course						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
6	R5CE2903L	Pavement materials and construction laboratory	0-0-2=2	1	ISCE: 60		40	3
	Course Outcome: **1.** Perform quality control Tests needed for pavement construction and maintenance. **2.** Prepare mix design for pavements. **3.** Plan and conduct traffic studies for estimating traffic flow characteristics. **4.** Conduct physical evaluation of pavements using modern tools and equipment.							

Sl. No.	**Course Content: (List of Experiments)**
1	**Bituminous / Asphalt Pavement Design:** Mix design for pavements: Water Bound Macadam, Bituminous Macadam, and Asphalt concrete.
2	**Traffic Studies:** Spot Speed Study
3	**Physical Evaluation of Pavements:** Roughness Index Measurement: Benkelman Beam Test, Bump Integrator Test. Skid Resistance Test, Ground Penetration Radar: Underground utility mapping test.
4	**Evaluation of soil subgrade for flexible pavements** C.B.R test (soaked and unsoaked Lab, Field), Tests on Soils: Density of soil, moisture content.
	Text Books 1. Khanna S.K, Justo C.E.G. and Veeraraghavan A, Highway Engineering, New Chand Publications, New Delhi, 10th edition 2018, (ISBN: 978-8185240930) 2. Rao D.V. B, Rao G. V, and Pahari, K. Highway Material Testing and Quality Control, Dreamtech Press, 2019 (ISBN: 9389447321) 3. Ministry of Road Transport and Highways, by Indian Road Congress, 5th Revision 2013, reprint July 2016, (ISBN: 9788193293201). 4. Asphalt Institute Manual Series No.2 (MS-2) Mix design methods for Asphalt concrete and other hot mix types Lexington Ky, 7th edition. **Recommended Reading:** 1. Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski, John Wiley, Principles of Highway Engineering and Traffic Analysis, 4th Edition, 2011, (ISBN-9781118120149)

Semester - IV		Program Exit Course						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
7	R5CE2904T	Prefabricated structures	3-0-0=3	3	20	30	50	3
	Course Outcome: 1. Apply the basics of prefabrication in construction 2. Select appropriate materials for prefabricated units 3. Identify the methods for structural analysis of prefabricated members 4. Analyze the challenges and future trends in prefabricated structures							

Module	**Course Content:**
1	**Introduction to Prefabricated structures** Need for prefabrication, Definition and history of prefabrication, Principles of prefabrication, Advantages and disadvantages of prefabricated construction, Comparison with conventional construction methods.
2	**Prefabricated Construction Materials** Introduction to Prefabricated concrete construction materials -concrete masonry unit (CMU), aerated autoclave concrete block (AAC) and pavement blocks. Composition and advantages of CMU, AAC and pavement blocks over conventional building blocks. Installation of paver blocks.
3	**Prefabricated Components** **Precast Wall panels -**The characteristics and ingredients of precast wall panels. Fixing details of precast wall panels.Types of precast wall panels -expanded polystyrene panels (EPS), wafflecrete, puff panels, precast large construction panel (PLCP). **Precast floor Panels-** Floor panel system for short span and long span. Waffle panel system for a long span. The assembly system- Precast beams and precast girders.Beam column slab connection. **Precast concrete foundation and precast concrete column-**Precast concrete footing-steel column fixing, column to column connection, beam column connection.

4	**Design Considerations and asthetics** Introduction to methods of analysis of prefabricated elements, Design considerations for stability and load-bearing capacity, Design considerations for architectural flexibility and customization, Aesthetic possibilities.
5	**Challenges Faced in Prefabricated Construction** Challenges faced during Manufacturing, Handling and Transportation and Assembly. Analysis of various challenges faced during construction of prefabricated structures based on case studies.
6	**Future Trends and Emerging Technologies** Exploration of advanced prefabrication techniques (3D printing, robotics, etc.), Predictions for the future of prefabricated construction, Ethical and social implications of widespread prefabrication adoption
	Text Books: 1. Bruggeling A.S. G and Huyghe G.F. “Prefabrication with Concrete”, A.A. Balkema Publishers, USA,1991. 2. Lewitt,M. ” Precast Concrete- Materials, Manufacture, Properties And Usage ,CRC Press, 2019. 3. Alfred Steinle, Hubert Bachmann, Mathias Tillmann, Philip Thrift . “Precast Concrete Structures”, Ernst & Sohn, Berlin, 2019. **Recommended Reading:** 1. Koncz T., “Manual of precast concrete construction”, Vol. I, II and III, Bauverlag, GMBH, 1976. 2. “Handbook on Precast Concrete Buildings”, Indian Concrete Institute, 2016. 3. “Precast concrete connection details”, Structural Design manual, Society for the studies in the use of precast concrete, Netherland Betor Verlag, 2009. 4. https://archive.nptel.ac.in/courses/124/105/124105013/

Semester - IV		Program Exit Course						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
8	R5CE2905T	Revit Modelling	2-0-0 = 2	2	20	30	50	3 hours
	Course Outcome: **1.** Able to understand planning designing, modelling concept of a building using Revit tools **2.** Able to create model document using Revit software.							

Module	Course Content: (List of Experiments)
1	**Introduction:** Introduction to Revit, it's key features, Navigating views: floor plans, elevations, sections, and 3D views, introduction to the Revit Project Browser and Properties palette and it's use in industry.
2	**Basic Elements and Modelling Tools:** Architectural components: Creating and modifying walls, doors and windows, Working with floors, ceilings and roofs, Introduction to families.
3	**Views and Presentation:** Creating and managing different view types (plan, section, elevation, 3D), Annotation tools (Adding dimensions, text notes, and tags), Schedules of opening preparation.
4	**Staircase, Rams and Railings:** Designing and editing stairs and ramps, Creating custom railings.
5	**Linking, Importing Files and Creating Construction Documents** Importing and managing CAD files and other external reference, Setting up sheets and title blocks, placing views on sheets and managing sheet set.
6	**Rendering**
	Text Books: 1) Autodesk Revit user's guide

Semester - IV		Program Exit Course						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
9	R5CE2905L	Revit Modelling Laboratory	0-0-4 = 4	2	ISCE:60		40	3 hours
	Course Outcome: **1.** Able to understand planning designing, modelling concept of a building using Revit tools **2.** Able to create model document using Revit software.							

Sl. No.	**Course Content: (List of Experiments)**
1	Familiarize with the Revit interface, tools, and commands.
2	Design a simple floor plan using walls, doors, and windows.
3	Create a basic structural model including columns, beams, and foundations.
4	Design a multi-story building, including floors, stairs, and elevators.
5	Create a 3D model of a building from a 2D floor plan
6	Design different types of roofs and ceilings.
7	Create and edit custom Revit families (e.g., furniture, fixtures).
8	Design basic MEP systems within a building model.
9	Experiment with Revit's worksharing features for collaborative project development.
10	Create realistic renderings of a building model.
	Text Books: Autodesk Revit user’s guide

Semester - IV		Program Exit Course						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
10	R5CE2906L	Digital Construction Lab	0-0-6=6	3	ISCE: 60		40	3
	Course Outcome: **1.** Develop plan and schedule for construction of civil engineering facility **2.** Use project management software for generation of plans, schedules and reports..							

Sl. No.	**Course Content:** **(List of Experiments)**
1	Preparation of a project plan for one of the following projects using working drawings - • Residential bungalow • Single storied building for commercial purpose • Single span bridge • Other Special Structure
2	Use of project management software, capability, input requirements, possible outputs. Preparation of project Reports. Use of software like MS Project and Primavera, Project Libre for real time applications.
	Text Books: 1. K. K. Chitkara, Construction Project Management- Planning, Scheduling and Controlling, Tata McGraw Hill Education, 2nd edition, 2010. (ISBN: 9780070680753/ 0070680752) 2. K. N. Jha, Construction Project Management- Theory and Practice, Pearson Education India, 2nd edition, 2015. (ISBN: 978-9332542013/9332542015) **Reference Books:** 1. J. M. Antill and R. W. Woodhead, Critical Path Methods in Construction Practice, Wiley Interscience, 4th edition, 1990. (ISBN:9780471620570/0471620572) 2. P. K. Joy, Handbook of Construction Management, Macmillan Publishers India, 2nd edition, 2000. (ISBN:9780333926932/0333926935) 3. M. L. Sidney, Project Management in Construction, McGraw-Hill Education, 7th edition, 2017. (ISBN: 9781259859700/1259859703)

Semester - IV		Program Exit Course						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
11	R5CE2907T	Plumbing Engineering	3-0-0=3	3	20	30	50	3
	Course Outcome: **1.** Understand plumbing terminology, hydraulics, and associated standard codes. **2.** Demonstrate various traps and sanitary fittings. **3.** Design and develop domestic water supply and drainage systems.							

Module	Course Content:
1	**Plumbing Terminology and Formulas:** Technical terminology widely used for plumbing engineering, Hydraulic radius, Friction head loss, Manning Formula, Pipeline sizing, Economic velocity. Introduction to plumbing and manhole materials.
2	**National and International Plumbing Standards:** History and development of plumbing standards, Uniform Illustrated Plumbing Code India (2022), ASPE plumbing engineering design standards.
3	**Fundamentals of Plumbing Systems:** Typical piping systems layout considerations for following various systems. Distillation systems and heat exchanger systems. Cooling water, process water, chilled water/ brine systems. Pumps, air compressor suction / discharge piping. Condensate cycle, steam distribution. Gas / steam turbines, vacuum system and flare lines. Selection and design considerations for hoses, strainers, sight glasses, TSVs, rubber and metallic expansion bellows. Information to and from piping departments with other engineering departments in reference to layouts preparation. Do's and Don'ts for routing of pipelines in consideration with operating feasibility.
4	**Plumbing System Equipment:** Connections from municipal main, water meters, valves, bends, fixtures, and pumps. Pipe network design and layout. Techniques to address leakage.
5	**Plumbing Cost Estimation:** Direct and indirect costs associated with plumbing, estimating requirement of consumables

	and man hours, relative economics of various materials of construction, relative economics for different systems, concept of economic plumbing Diameter. Case study in optimizing pipe size and estimating cost of piping for yard piping and ISBL piping. Direct and indirect costs associated with piping fabrication and installation and testing inch-dia, inch- m concepts.
6	**Storm Drainage and Water Supply:** Storm Drains required, prohibited connection, subdrains, sizing of gutters/channels/ scuppers, window are away drains, roof drains, strainers, leaders, conductors and connections, siphonic drains, under-ground drains, materials, traps required, prohibited installations, sizing, testing, introduction to rain water harvesting. Source of water, potable and non-potable and non-portable water, reclaimed water, water storage, treatment, hot and cold water distribution system, back flow prevention, air gap, cross connection control, pipe materials and jointing methods, pressure control, pipe materials and jointing method, pressure controls unions, thermal expansion, type of valves ,installation and testing disinfection, water supply fixture Units (WSFU), sizing, protection of underground pipes ,color codes and arrow making.
7	**Sanitary Services:** Classification of fixtures, Bathroom accessories and fittings. Recycling and reuse of grey water.
8	**Acoustics in Plumbing:** Factors contributing to plumbing acoustics. Causes, effects, and prevention of air lock. Effect of corrosion. Addressing corrosion issues in plumbing networks.
9	**Plumbing of High Rise Buildings and Hilly Areas:** Types of various water supply systems (down take pressure reducer valve system, multiple storage system, break pressure tanks, hydro pneumatic systems). Pumping system. Roofing materials. Use of low density polyethylene pipes in hilly areas.
	Recommended Reading: 1) Building and Plumbing handbook – A guide for working with Water Corporation 2) National Building Code 3) Associated publications from Indian Plumbing Association 4) Standard Plumbing Engineering Design by Louis S. Nielsen 5) Plumbing Engineering Design Handbook published by ASPE

Semester - IV		Program Exit Course						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
12	R5CE2907L	Plumbing Engineering Laboratory	0-0-2=2	1	ISCE: 60		40	3
	Course Outcome: **1.** Study of plumbing components along with their locations and functions. **2.** Preparation of plumbing line sketches for water supply and sanitary works. **3.** Complete understanding of plumbing requirements of high rise buildings.							

Sl. No.	**Course Content:** **(List of Experiments)**
1	Study of existing water supply scheme to VJTI campus.
2	Study of various plumbing tools, valves, joints, and bends.
3	Study of types of pipes used for plumbing and sanitary services
4	Study of various trapes used for plumbing and sanitary fixtures.
5	Preparation of plumbing line sketches for a selected hostel building on VJTI campus.
6	Site visit to a high rise building and understanding on-site plumbing requirements.
	Recommended Reading: 1) Building and Plumbing handbook – A guide for working with Water Corporation 2) National Building Code 3) Associated publications from Indian Plumbing Association 4) Standard Plumbing Engineering Design by Louis S. Nielsen 5) Plumbing Engineering Design Handbook published by ASPE

Multidisciplinary Minor - Innovation and Entrepreneurship

Semester – IV		Multidiscplinary Minor (Innovation and Entrepreneurship)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
1	R5CE2204T	Entrepreneurship Essentials	2-0-0 = 2	2	20	30	50	3
	Course Outcome: **1.** Develop skills to generate and evaluate innovative ideas and address business challenges **2.** Identify role of team, technology and sustainability in businesses **3.** Explore strategies for successfully launching and marketing new products. **4.** Analyse financial health, risk management and contingency planning in businesses **5.** Develop skills to build and maintain support networks and mentorship relationships							

Module	Course Content:
1	**Business Model Development** Identifying business opportunities, Creating a Business Model Canvas, Building proof of concept-developing a business model, Components of a business plan, Setting business goals and milestones, Drafting a business plan outline, Value Proposition Design, strategic planning, Intellectual Property, Business Registration and Licensing
2	**Building & Managing a Team** Understanding Employment Law, Team dynamics- assistance with administrative tasks such as accounting, legal issues, and HR., Leadership styles, Recruitment and hiring, benefits of diversity and inclusion, setting and achieving team goals, defining and developing company culture. Tools and technologies for virtual collaboration. Discussions on best practices. Team building activities and exercises
3	**Market Research and Analysis** Market research methods, Identifying Target Markets, Competitor Analysis- Perfect Competition; Monopoly Competition; Oligopolistic Competition. Customer Discovery, customer acquisition and retention, Marketing strategies, Branding and Positioning, Digital Marketing and social media, customer acquisition, budgeting and forecasting, analysis and performance measurement. Case studies on Developing a marketing plan.
4	**Financial Planning and Management**

	Funding and investment strategies. Creating a business budget, Understanding balance sheets, income statements, and cash flow statements, budgeting and forecasting, Choosing the right funding mix, cost -benefit analysis, break-even analysis, identifying financial risks, strategies for risk mitigation, contingency planning
5	**Resources and Support** Importance of networking in entrepreneurship, Finding and working with mentors and advisors, Investor Relations, Access to co-working spaces, Tools and technologies needed for product development, such as software licenses or lab equipment. Strategies for building professional networks, Building advisory boards
6	**Failures, Resilience and Recovery** Importance of studying failed start-ups , overview of common reasons for failures, Case studies: of Start-ups that failed : -due to poor market fit, due to flawed business models, due to financial mismanagement, due to team issues, due to operational issues, due to customer-related issues, due to competition etc, Building resilience in the face of failure, Overcoming business challenges in entrepreneurship, Case studies: Entrepreneurs who bounced back after failure
	Recommended Reading: 1) "Financial Intelligence for Entrepreneurs" by Karen Berman and Joe Knight 2) "Startup Failures: 10 Reasons Why Startups Fail" by B.J. Allen 3) Design Thinking: Integrating Innovation, Customer Experience, and Brand Value" by Thomas Lockwood 4) Stay Hungry Stay Foolish by Rashmi Bansal 5) The Entrepreneur's Guide to Financial Statements" by David Worrell 6) "The Lean Startup" by Eric Ries

Multidisciplinary Minor - Contract Law, Arbitration, and Valuation

Semester – IV		Multidisciplinary Minor (Contract Law, Arbitration, and Valuation)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
1.	R5CE2205T	Contracts, Claims, and Dispute Management	2-0-0 = 2	2	20	30	50	3
	Course Outcome: After completion of this course, students will be able to, **1.** Demonstrate the ability to manage contract lifecycles, from initiation to closure, by effectively drafting, negotiating, and administering various contract types. **2.** Develop the skills to identify, document, and analyze different types of claims and insurance issues, using critical thinking to prepare effective claim resolutions. **3.** Apply various dispute avoidance and resolution techniques, including alternative dispute resolution methods and litigation strategies, to manage conflicts effectively. **4.** Assess the legal frameworks, regulations, and ethical considerations that impact contract and claims management.							

Module	Course Content:
1	**Introduction to Contract Management** Definition and importance of contract management, Types of contracts and key elements, Contract lifecycle: initiation, execution, and closure
2	**Contract Formation and Negotiation** Key principles of contract law, Drafting and reviewing contracts, Negotiation techniques and strategies
3	**Contract Administration** Effective contract management practices, Roles and responsibilities in contract administration, Monitoring performance and compliance
4	**Claims and Insurance Management** Types of claims and insurances (e.g., delay, disruption, acceleration), Identifying and documenting claims, Claim analysis and preparation
5	**Construction Dispute Resolution:** Common disputes in construction projects, Mediation, arbitration, and litigation processes, Case studies on dispute resolution

6	**Dispute Avoidance and Resolution** Techniques for preventing disputes, Alternative Dispute Resolution (ADR) methods: mediation, arbitration, Litigation process and strategies
7	**FIDIC Contracts and Claims** Overview of FIDIC contract types, FIDIC claims procedures and management, Case studies on FIDIC disputes
8	**Legal and Ethical Considerations** Legal frameworks and regulations impacting contracts and claims, Ethical issues in contract and dispute management, Professional responsibility and conduct
9	**Case Studies and Practical Applications** Real-world case studies and examples, Practical exercises and role-plays, Group discussions and presentations
	Recommended Reading: 1. Jha K.N., Construction Project Management- Theory and practice, Pearson India Education Services Pvt. Ltd., 2nd Edition, 2015. (ISBN 9789332542013) 2. P C Markanda., Building and Engineering Contracts: Law and Practice, 6th Edition, 2023 (ISBN: 9788119403042) 3. Pauline Collins, Dalma Demeter, Susan Douglas, Dispute Management, Cambridge University Press, 2021, (ISBN: 1108881793)

Multidisciplinary Minor - Sustainable Environment

Semester – IV		Multidiscplinary Minor (Sustainable Environment)						
SN	**Course Code**	**Course Title**	**L-T-P (Hours/Week)**	**Credit**	**TA**	**MST**	**ESE**	**ESE hours**
1	R5CE2206T	Water and Wastewater Management	2-0-0 = 2	2	20	30	50	3
	Course Outcome: **1.** Understand the physical, chemical, and biological characteristics of water and wastewater **2.** Design treatment schemes for various drinking water and wastewater sources **3.** Study industrial effluent treatment and residual management systems							

Module	Course Content:
1	**Characteristics of water and wastewater:** Physical, chemical, and biological characteristics of water and wastewater, drinking water standards in India (IS10500-2012), treated wastewater discharge standards, water quality index.
2	**Water treatment processes:** Design of unit processes used for water treatment such as aeration, sedimentation, filtration, and chlorination, developing water treatment scheme for ground water and surface water.
3	**Wastewater treatment processes:** Design of unit processes used for wastewater treatment such as screening, coagulation and flocculation, biological treatment, filtration, and adsorption, developing wastewater treatment scheme for domestic wastewater.
4	**Resource recovery:** Understanding efficient water and wastewater management, resource recovery from waste streams, concepts of reuse and recycle.
5	**Industrial effluent treatment:** Effluent characteristics for ‘red category’ industries, treatment units used for industrial effluent treatment, effluent management for major polluting industries.
6	**Zero Liquid Discharge:** Definition of Zero Liquid Discharge (ZLD) systems, tertiary treatment units and reject management

	systems, advantages and disadvantages of ZLDs, case studies on sectors implementing ZLD regulations.
	Recommended Reading: 1) Metcalf, Leonard, Harrison P. Eddy, and Georg Tchobanoglous. *Wastewater engineering: treatment, disposal, and reuse*. Vol. 4. New York: McGraw-Hill, 1991. 2) Peavy, Howard S., D. R. Rowe, and G. Tchobanoglous. "Wastewater treatment and disposal." *Environmental Engineering. McGraw Hill Education Pvt. Ltd* (1985). 3) Bui, Xuan-Thanh, Chart Chiemchaisri, Takahiro Fujioka, and Sunita Varjani, eds. *Water and wastewater treatment technologies*. Singapore: Springer, 2019.