Semester IV						
Sr. No	**Course Code**	**Course Name**	**L**	**T**	**P**	**C**
1	CE 204	Hydraulic Engineering	2	1	0	6
2	CE 205	Structural Analysis	2	1	0	6
3	ME 312	Solid Mechanics Lab	0	0	3	3
4	ME 224	Fluid Mechanics and Hydraulics Laboratory	0	0	3	3
5	CE 212	Surveying and Geomatics Laboratory	0	0	3	3
6	CE 301	Environmental studies	3	0	0	6
7	CE 206	Water Resources Engineering	2	1	0	6
8	CE	Institute Elective-I	2	1	0	6
		Total Credits				**39**

1	**Title of the course** (L-T-P-C)	**Hydraulic Engineering** **2-1-0-6**
2	**Pre-requisite courses(s)**	
3	**Course content**	**Module 1:** Laminar Flow- Laminar flow through: circular pipes, annulus and parallel plates. Stoke's law, Measurement of viscosity. **Module 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. **Module 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. **Module 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. **Module 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. **Module 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". Most economical section of channel. Computation of Uniform flow, Normal depth. **Module 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. 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. **Module 8:** 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. Dynamics of Fluid Flow-Momentum principle, applications: Force on plates, pipe bends, moments of momentum equation,

		Module 9: 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. Analysis of pipe networks: Hardy Cross method, water hammer in pipes and control measures, branching of pipes, three reservoir problem. **Module 10:** Computational Fluid Dynamics: Basic equations of fluid dynamics, Grid generation, Introduction to in viscid incompressible flow, Boundary layer flow as applicable to C.F.D. Hydro informatics: Concept of hydro informatics – scope of internet and web-based modeling in water resources engineering.
4	**Texts/References**	**1.** Hydraulics and Fluid Mechanics, P.M. Modi and S.M. Seth, Standard Book House **2.** Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill. **3.** Open channel Flow, K. Subramanya, Tata McGraw Hill. **4.** Open Channel Hydraulics, Ven Te Chow, Tata McGraw Hill. **5.** Burnside, C.D., "Electromagnetic Distance Measurement," Beekman Publishers, 1971.

1	**Title of the course** (L-T-P-C)	**Surveying and Geomatics Laboratory** **0-0-3-3**
2	**Pre-requisite courses(s)**	
3	**Course content**	**1.** Introduction to Survey Instruments **2.** Compass Traverse **3.** Theodolite Traverse **4.** Differential Levelling **5.** Profile and Cross Section Survey **6.** Trigonometric Levelling **7.** Tacheometric Surveying **8.** Total Station Surveying **9.** GPS Surveying **10.** Surveying & Mapping using Global Navigation Satellite System (GNSS)
4	**Texts/References**	**1.** B.C. Punmia, Ashok Kumar Jain, Ashok Kr. Jain, Arun Kr. Jain., Surveying I & II, Laxmi Publications, 2015 **2.** James, M Anderson & Edward M Mikhail., Surveying Theory and Practice, Tata Mc Graw Hill, 2012 **3.** Charles D. Ghilani, Elementary Surveying: An Introduction to Geomatics (15th Edition) Pearson Publishers. 2017

1	**Title of the course** (L-T-P-C)	**Structural Analysis** **(2-1-0-6)**
2	**Pre-requisite courses(s)**	Nill
3	**Course content**	1. **Method of consistent deformation**: Indeterminate beams - Propped cantilever, Fixed and Continuous beams - Analysis for shear force and bending moment - Clapeyron's theorem of three moments - Slope and deflection - effect of sinking of supports. 2. **Slope - Deflection Method**: Analysis and application to continuous beams - portal frames (single bay - Single storey). 3. **Moment-Distribution Method**: Analysis of continuous beams and portal frames (single storey single bay). 4. **Analysis of pin jointed frames** (one degree redundancy); Forces in indeterminate pin jointed frames due to temperature variation and lack of fit; 5. **Influence lines and Moving Loads for beams**: Maximum bending moment and shear force diagrams for simply supported spans traversed by single point load - two concentrated loads - Uniformly distributed load, shorter and longer than the span - enveloping parabola and equivalent uniformly distributed load, determination of maximum bending moment and shear force for a system of concentrated loads on simply supported girders - focal length of a girder - counter bracing. 6. **Influence lines and Moving Loads for trusses**: Influence lines for simple trusses, Muller - Breslau Principle, Influence lines for reactions, shear force at a point and bending moment at a section of beams with fixed ends and two span continuous beams.
4	**Texts/References**	**References:** 1. Hibbeler, R. C. (2016). Structural Analysis, 8th Edition, Pearson Education, London, United Kingdom. 2. Junarkar. S. B and Shah H.J. (2008). Mechanics of Structures, Vol 1 & Vol.2 – 27th Edition, Charotar Publishers, New York, United States. 3. Wang C.K. (2010). Intermediate Structural Analysis, Tata McGraw Hill, New York, United States. 4. Negi, L.S. (1997). Theory and Problems in Structural Analysis, Tata McGraw Hill Publishers, New York, United States. 5. Reddy, C. S. (2017). Basic structural analysis, 3rd Ed., Tata McGraw Hill Publishers, New York, United States.

1	**Title of the course** (L-T-P-C)	**Solid Mechanics Lab** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	Nill
3	**Course content**	**List of Experiments:** • Calibration of photoelastic material using a disk under diametral compression, a beam under four-point bending and a uni-axial tensile specimen; and SCF evaluation in a circular ring, acrane hook and a plate with hole. • Stresses in thin pressure vessels using strain gauges. • Deflection of curved beams – a ring, a semi-circular ring, a quadrant, and an angular davit • Stability of columns – To evaluate the buckling load for different materials (Steel, Copper,Aluminium and Brass) under different end conditions (Hinge-Hinge and Hinge-fixed condition) • Hardness test – Rockwell, Vickers, and Brinell Hardness test • Impact testing machine: Izod and Charpy test • Torsion testing machine Tests of UTM: Tension (Ductile and Brittle), compression (brittle and ductile), bending ofbeam, leaf spring characteristics
4	**Texts/References**	S. Crandall, N. Dahl, S. Lardner, An Introduction to Mechanics of Solids, Tata MGHill, 2012. E.P. Popov, Engineering Mechanics of Solids, Prentice Hall, 2012. Gere abd Goodno, Mechanics of Materials, 7th ed., Cengage Learning India, 2012.Gere and Timoshenko, Mechanical of Materials, CBS Publishers,1986.

1	**Title of the course** (L-T-P-C)	**Fluid Mechanics and Hydraulics Laboratory** **0-0-3-3**
2	**Pre-requisite courses(s)**	
3	**Course content**	**1.** Flow over circular cylinder. **2.** Measurement of jet forces **3.** Bernoulli's Principle **4.** Stability of floating bodies **5.** Horizontal flow from a tank **6.** Pipe friction for laminar and turbulent flow. **7.** Turbulent velocity profile in a circular pipe **8.** Calibration of orifice-meter and Venturimeter **9.** Performance characteristics of centrifugal pump **10.** Performance characteristics of Francis turbine **11.** Performance analysis of Pelton wheel **12.** Performance characteristics of reciprocating pump **13.** Performance characteristics of centrifugal pump in series and parallel configuration
4	**Texts/References**	**1.** YA Çengal, JM Cimbala, Fluid Mechanics: Fundamentals and Applications, McGraw-Hill, 2006 **2.** SL Dixon, and CA Hall, Fluid Mechanics and Thermodynamics of Turbomachinery, Elsevier, 2014.

1	**Title of the course** (L-T-P-C)	**Surveying and Geomatics Lab** **(0-0-3-3)**
2	**Pre-requisite courses(s)**	Nill
3	**Course content**	**1.** Introduction to Survey Instruments **2.** Compass Traverse **3.** Theodolite Traverse **4.** Differential Levelling **5.** Profile and Cross Section Survey **6.** Trigonometric Levelling **7.** Tacheometric Surveying **8.** Total Station Surveying **9.** GPS Surveying **10.** Surveying & Mapping using Global Navigation Satellite System (GNSS)
4	**Texts/References**	**1.** Punmia, B.C., et.al. (2015). Surveying I & II, 7th Ed., Laxmi Publications, India. **2.** Anderson J. M. & Mikhail E. M.(2012) Surveying Theory and Practice, 7th Ed., Tata Mc Graw Hill, New York, United States. **3.** Ghilani, C.D. (2017). Elementary Surveying: An Introduction to Geomatics, 15th Ed., Pearson Publishers, London, United Kingdom..

1	**Title of the course** (L-T-P-C)	**Environmental studies** **(3-0-0-6)**
2	**Pre-requisite courses(s)**	Nill
3	**Course content**	**Module A:** Natural Resources, Ecosystems, Biodiversity, and its conservation: Natural resources and ecosystems, Forest, grassland, desert and aquatic ecosystems, biodiversity at global, national and local levels, conservation of biodiversity **Module B:** Air Pollution Introduction to understanding air quality management, fundamental processes of meteorology, Air Pollutants – Gaseous and particulate, Criteria for pollutants, ambient and source standards, Aerosols: Characterisation of aerosols, size distributions, measurement methods; Transport behaviour: diffusion, sedimentation, inertia; Visibility; principles of particulate control systems. **Module C:** Water Treatment Discussion of water quality constituents and introduction to the design and operation of water and wastewater treatment processes. **Module D:** Solid Waste Management and Climate Change Different aspects of solid and hazardous waste management. Climate change and greenhouse gas emissions, technologies would reduce the greenhouse gas emissions. Climate change and its possible causes. **Module E:** Sociology/Environmentalism Description: Environmentalism in sociological tradition, Sustainability, North-South divide, Political economy approaches in environmental studies, Debates over environmental issues. **Module F:** Economics Energy economics and financial markets, Market dynamics, Energy derivatives, Energy Efficiency; Sustainable Development: Concept, Measurement & Strategies, Interaction between Economic Development, and the Environment **Module G:** Philosophy Environmental ethics, Deep ecology, Practical ecology, Religion and attitude towards environmental ethics, Ecofeminism and its evolution. **Module H:** Field work and project: visit to a local area to document environmental assets, case studies of a simple ecosystem and group discussions on current environmental issues.
4	**Texts/References**	**1.** Cunningham W.P. and Cunningham M.A. (2002), Principles of Environmental Science, Tata McGraw-Hill Publishing Company, New Delhi. **2.** Dasgupta, P. and Maler, G. (eds.), (1997), The Environment and Emerging Development Issues, Vol. I, Oxford University Press, New Delhi. **3.** Jackson, A.R.W. and Jackson, J.M. (1996), Environmental Sciences: The Environment and Human Impact, Longman Publishers.

		4. Nathanson, J.A., (2002), Basic Environmental Technology, Prentice Hall of India, New Delhi. 5. Redclift, M. and Woodgate, G. (eds.), (1997), International Handbook of Environmental Sociology 6. Srivastava, K.P. (2002), An Introduction to Environmental Study, Kalyani Publishers, Ludhiana. 7. Review articles from literature.

1	**Title of the course** (L-T-P-C)	**Water Resources Engineering** **2-1-0-6**
2	**Pre-requisite courses(s)**	
3	**Course content**	**Module 1:** Introduction - hydrologic cycle, water-budget equation, history of hydrology, world water balance, applications in engineering, sources of data. **Module 2:** Precipitation - forms of precipitation, characteristics of precipitation in India, measurement of precipitation, rain gauge network, mean precipitation over an area, depth-area-duration relationships, maximum intensity/depth-duration-frequency relationship, Probable Maximum Precipitation (PMP), rainfall data in India. **Module 3:** Abstractions from precipitation - evaporation process, evaporimeters, analytical methods of evaporation estimation, reservoir evaporation and methods for its reduction, evapotranspiration, measurement of evapotranspiration, evapotranspiration equations, potential evapotranspiration over India, actual evapotranspiration, interception, depression storage, infiltration, infiltration capacity, measurement of infiltration, modelling infiltration capacity, classification of infiltration capacities, infiltration indices. **Module 4:** Runoff - runoff volume, SCS-CN method of estimating runoff volume, flow-duration curve, flow-mass curve, hydrograph, factors affecting runoff hydrograph, components of hydrograph, base flow separation, effective rainfall, unit hydrograph surface water resources of India, environmental flows. **Module 5**: Ground water and well hydrology - forms of subsurface water, saturated formation, aquifer properties, geologic formations of aquifers, well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifers, aquifer tests. **Module 6:** Water withdrawals and uses – water for energy production, water for agriculture, water for hydroelectric generation; flood control. Analysis of surface water supply, Water requirement of crops-Crops and crop seasons in India, cropping pattern, duty and delta; Quality of irrigation water; Soil-water relationships, 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. **Module 7:** Distribution systems - canal systems, alignment of canals, canal losses, estimation of design discharge. Design of channels- rigid boundary channels, alluvial 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, types of lining. Drainage of irrigated lands: necessity, methods. **Module 8:** Dams and spillways - embankment dams: Classification, design considerations, estimation and control of seepage, slope protection. Gravity dams: forces on gravity dams, causes of failure, stress analysis, elementary and practical profile. Arch and buttress dams. Spillways: components of spillways, types of gates for spillway crests; Reservoirs- Types, capacity of reservoirs, yield of

		reservoir, reservoir regulation, sedimentation, economic height of dam, selection of suitable site.
4	**Texts/References**	**1.** K Subramanya, Engineering Hydrology, Mc-Graw Hill. **2.** K N Muthreja, Applied Hydrology, Tata Mc-Graw Hill. **3.** K Subramanya, Water Resources Engineering through Objective Questions, Tata Mc-Graw Hill. **4.** G L Asawa, Irrigation Engineering, Wiley Eastern **5.** L W Mays, Water Resources Engineering, Wiley. **6.** J D Zimmerman, Irrigation, John Wiley & Sons **7.** C S P Ojha, R Berndtsson and P Bhunya, Engineering Hydrology, Oxford.