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IES Campus Kalkheda, Ratibad Main Road, Bhopal (M.P.) –

PHD-102 SUBJECTS FOR CIVIL ENGINEERING

Ph.D. Civil Engineering Scholars

All research scholars admitted to the Doctor of Philosophy (Ph.D.) program in Civil Engineering under the Faculty of Engineering are required to select any one subject from the list of courses offered under PHD-102.

These subjects have been designed to strengthen the scholar's foundational and research-oriented understanding in specialized areas of Civil Engineering. The selected subject should align with the scholar's proposed area of research and must be approved by the Supervisor and the Departmental Research Committee (DRC).

The list of subjects offered under PHD-102 by the Department of Civil Engineering is as follows:

S. No.	Faculty	Department / Branch	Subject Code	Name of Subject
1	Engineering & Technology	Civil Engineering	PHD102CE01	Irrigation and Drainage Engineering
2	Engineering & Technology	Civil Engineering	PHD102CE02	Watershed Hydrology
3	Engineering & Technology	Civil Engineering	PHD102CE03	Open Channel Flow
4	Engineering & Technology	Civil Engineering	PHD102CE04	Theory of Plates and Shells
5	Engineering & Technology	Civil Engineering	PHD102CE05	Design of Earthquake Resistant Structures
6	Engineering & Technology	Civil Engineering	PHD102CE06	Reliability Based Civil Engineering
7	Engineering & Technology	Civil Engineering	PHD102CE07	FEM in Structural Engineering
8	Engineering & Technology	Civil Engineering	PHD102CE08	Advanced Concrete Technology
9	Engineering & Technology	Civil Engineering	PHD102CE09	Construction Equipment and Material Management
10	Engineering & Technology	Civil Engineering	PHD102CE10	Advanced Highway Construction
11	Engineering & Technology	Civil Engineering	PHD102CE11	Fluid Mechanics

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PHD-102 SUBJECTS FOR CIVIL ENGINEERING

Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Civil Engineering	**IRRIGATION AND DRAINAGE ENGINEERING**	**PHD102CE01**

Course Outcomes

1. Explain the importance and methods of irrigation and water resource utilization.
2. Design irrigation channels and conveyance systems based on hydraulic principles.
3. Analyze soil-water-plant relationships and calculate irrigation requirements.
4. Design surface and sub-surface drainage systems for agricultural lands.
5. Integrate irrigation and drainage principles for sustainable water management.

Unit-wise Content distribution

Unit	Contents
Unit-I	Purpose of irrigation, sources of irrigation water, present status of development and utilization of different water resources of the country; common irrigation terminology water distribution pattern and system of levying irrigation charges.
Unit-II	Measurement of irrigation water, weir, notches, flumes and orifices and other methods; water conveyance, design of irrigation field channels, Lacey's and Kennedy's theory, underground pipe conveyance system, irrigation structures, channel lining; land grading, different design methods and estimation of earth work and cost.
Unit-III	Soil water plant relationship, soil water movement, infiltration, evapo-transpiration, soil moisture constants, depth of irrigation, frequency of irrigation, irrigation efficiencies.
Unit-IV	Surface irrigation methods of water application, border, check basin, furrow and contour irrigation; sprinkler and drip irrigation method, merits, demerits, selection and design. Surface drainage, drainage coefficient, types of surface drainage, design of open channel.
Unit-V	Sub-surface drainage purpose and benefits, investigations of design parameters, hydraulic conductivity, drainable porosity, water table etc., types of use of subsurface drainage system, steady and unsteady state methods for drain depth and spacing, installation and cost estimation, drainage of salt affected soils and leaching requirement inter-relation of irrigation and drainage, canal command area, development programmes.

Textbooks/References:

1. S.K. Garg (2011) – *Irrigation Engineering and Hydraulic Structures*, Khanna Publishers, New Delhi.
2. R.S. Varshney, S.C. Gupta, and R.L. Gupta (2015) – *Theory and Design of Irrigation Structures*, Nem Chand & Bros., Roorkee.
3. H.M. Raghunath (2006) – *Irrigation Engineering and Hydraulic Structures*, New Age International Publishers, New Delhi.
4. K. Subramanya (2017) – *Engineering Hydrology*, Tata McGraw Hill Education, New Delhi.
5. S.N. Luthra (2009) – *Irrigation Engineering*, Metropolitan Book Co., New Delhi.

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PHD-102 SUBJECTS FOR CIVIL ENGINEERING

Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engg & Tech	Civil engineering	**WATERSHED HYDROLOGY**	**PHD102CE02**

Course Outcomes

1. Understand the hydrologic cycle and measurement of rainfall, infiltration, and evapotranspiration.
2. Estimate runoff using empirical and analytical methods.
3. Develop and apply unit hydrograph and flood hydrograph techniques.
4. Analyze flood control, routing, drought classification, and watershed management principles.
5. Evaluate geomorphological parameters of watersheds for planning and development

Unit-wise Content distribution

Unit	Contents
Unit-I	Introduction; hydrologic cycle; precipitation - forms, rainfall measurement, mass curve,h ydrograph, mean rainfall depth, frequency analysis of point rainfall, plotting position, estimation of missing data, test for consistency of rainfall records; interception infiltration; evaporation; evapo-transpiration-estimation and measurement
Unit-II	Runoff - factors affecting, measurement; stage and velocity, rating curve, extension of rating curve; estimation of peak runoff rate and volume; rational method, Cook's method, SCS method, Curve number method.
Unit-III	Hydrograph; components, base flow separation, unit hydrograph theory. unit hydrograph of different durations, dimensionless unit hydrograph, distribution hydrograph, synthetic unit hydrograph, uses and limitations of unit hydrograph.
Unit-IV	Head water flood control - methods, retards and their location; flood routing – graphical methods of reservoir flood routing; hydrology of dry land areas - drought and its classification; introduction to watershed management and planning. Geomorphology of watersheds - stream number, stream length, stream area, stream slope and Horton's laws.

Textbooks/References:

1. Subramanya, K. (2017) – *Engineering Hydrology*, Tata McGraw Hill Education, New Delhi.
2. Raghunath, H.M. (2006) – *Hydrology: Principles, Analysis, and Design*, New Age International Publishers, New Delhi.
3. Chow, V.T., Maidment, D.R., and Mays, L.W. (1988) – *Applied Hydrology*, McGraw Hill International Edition, New York.
4. Shaw, E.M. (1994) – *Hydrology in Practice*, Chapman & Hall, London.
5. Garg, S.K. (2010) – *Hydrology and Water Resources Engineering*, Khanna Publishers, New Delhi.

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PHD-102 SUBJECTS FOR CIVIL ENGINEERING

Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engg & Tech	Civil engineering	**Open Channel Flow**	**PHD102CE03**

Course Outcomes

1. Explain basic concepts of open channel hydraulics and energy–momentum principles.
2. Analyze specific energy and critical flow relationships in prismatic channels.
3. Compute gradually varied and rapidly varied flows using analytical and numerical methods.
4. Measure flow using hydraulic structures like weirs, flumes, and gates.
5. Analyze spatially varied flow, design culverts, and evaluate transitions in open channel systems.

Unit-wise Content distribution

Unit	Contents
Unit-I	**Introduction:** Basic concepts of free surface flows, velocity and pressure distribution, Mass, energy and momentum principle for prismatic and non-prismatic channels, Review of Uniform flow: Standard equations, hydraulically efficient channel sections, compound sections.
Unit-II	Energy-depth relations: Concept of specific energy, specific force, critical flow, critical depth, hydraulic exponents, and channel transitions
Unit-III	**Gradually Varied Flow (GVF):** Equation of gradually varied flow and its limitations, flow classification and surface profiles, Control sections,Computation methods and analysis: Integration of varied flow equation by analytical, graphical and advanced numerical methods, Transitions of subcritical and supercritical flow, flow in curved channels. **Rapidly Varied Flow (RVF):** Characteristics of rapidly varied flow, Classical hydraulic jump, Evaluation of the jump elements in rectangular and non-rectangular channels on horizontal and sloping beds, Hydraulic jump in gradually and suddenly expanding channels, submerged hydraulic jump, rolling and sky jump, use of jump as an energy dissipate
Unit-IV	**Flow measurement:** by sharp crested and broad crested weirs, critical depth flumes, sluice gate, Free overfall.**Rapidly varied unsteady flow:** Equation of motion for unsteady flow, "Celerity" of the gravity wave, deep and shallow water waves, open channel positive and negative surge
Unit-V	**Spatially Varied Flow (SVF):** Basic principles, Differential SVF equations for increasing and decreasing discharge, Classifications and solutions, Numerical methods for profile computation, Flow over side-weir and Bottom-rack Flow in channel of non-linear alignment and non-prismatic channel sections, Design considerations for sub critical and super critical flows, Design of culvert

Textbooks/References:

1. Chow, V.T., Open channel Hydraulics, McGraw Hill International
2. Henderson, F.M., Open Channel Flow, McGraw Hill International
3. Subramanya, K., Flow in Open Channels, Tata McGraw Hill
4. Ranga Raju, K.G., Flow through open channels, T.M.H.
5. M. Hanif Chaudhry, Open Channel Flow, PHI
6. French, R.H., Open channel Hydraulics, McGraw Hill International
7. Srivastava, Flow through Open Channels, Oxford University

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PHD-102 SUBJECTS FOR CIVIL ENGINEERING

Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Civil Engineering	**Theory of Plates and Shells**	**PHD102CE04**

Course Outcomes

1. Understand the theory and behavior of plates under different boundary conditions and loading.
2. Apply analytical and approximate methods for plate analysis.
3. Evaluate membrane and bending theories for cylindrical and spherical shells.
4. Analyze and solve shell structures subjected to different loading conditions.
5. Use energy methods and experimental techniques in the analysis of plates and shells.

Unit-wise Content distribution

Unit	Contents
Unit-I	Theory of Plates: Bearing of long rectangular plates to the cylindrical surface with different edge conditions. Pure bending of plates-Differential equations of equilibrium. Theory of small deflections of laterally loads plates. Boundary conditions, moment curvature relationship.
Unit-II	Analysis of rectangular plates, Navies' and levy solutions, exact theory of plates, symmetrical bending of circular plates, continuous rectangular plates
Unit-III	Special and approximate methods of theory of plates, singularities, use of influence surfaces, use of infinite integrals and transforms, strain energy methods, experimental methods.
Unit-IV	Theory of Shells: Classification of shells, Gaussian curvature, General theory of cylindrical shells, membrane theory and bending theory for cylindrical shells, long and short shells, shells, shells with and without edge beams, Fourier loading.
Unit-V	Equation of equilibrium for shells of surface of revolution, Reduction to two differential equations of second order. Spherical shells, membrane theory for shells of double curvature- syn-elastic and anti-elastic. Cylindrical shells, Hyperbolic-parabolic shells, funicular shells.

Textbooks/References:

1. S. Timoshenko & S. Woinowsky-Krieger (1959) – *Theory of Plates and Shells*, McGraw Hill Book Company, New York.
2. K. Chandrashekhara (2001) – *Theory of Plates*, Universities Press (India) Ltd., Hyderabad.
3. Ramaswamy, G.S. (2005) – *Design and Construction of Concrete Shell Roofs*, CBS Publishers & Distributors, New Delhi.
4. Ventsel, E. & Krauthammer, T. (2001) – *Thin Plates and Shells: Theory, Analysis, and Applications*, Marcel Dekker Inc., New York.
5. Szilard, R. (2004) – *Theory and Analysis of Plates: Classical and Numerical Methods*, Prentice Hall, USA.

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PHD-102 SUBJECTS FOR CIVIL ENGINEERING

Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Civil Engineering	**Design of Earth quake Resistant**	**PHD102CE05**

Course Outcomes

1. Evaluate seismic behavior of structures and methods for strengthening existing buildings.
2. Analyze torsional effects, rigidity, and lateral load distribution in buildings.
3. Apply IS code provisions for ductile detailing and seismic design of multi-storied buildings.
4. Understand engineering seismology and dynamic response of structures to earthquakes.
5. Design special earthquake-resistant structures like bridges, tanks, and dams.

Unit-wise Content distribution

Unit	Contents
Unit-I	Seismic Strengthening of Existing Buildings: Cases histories-Learning from earthquakes, seismic strengthening procedures.
Unit-II	Torsion & Rigidity: Rigid Diaphragms, Torsional moment, Center of mass and center of rigidity torsion effects. Lateral Analysis of Building Systems: Lateral load distribution with rigid floor diaphragms, moment resisting frames, shear walls, lateral stiffness of shear walls, shear wall- frame combination, examples
Unit-III	Concept of Earthquake Resistant Design: Objectives of seismic design , Ductility, Hysteric response & energy dissipation, response modifications factor, design spectrum, capacity design, classification of structural system, IS code provisions for seismic design of structures, multi- storied buildings, design criteria, P-A effects, storey drift, design examples ductile detailing of RCC structures
Unit-IV	Engineering Seismology: Basic terms, seismic waves, earthquake magnitude and intensity, ground motion, dynamic response of structures, normalized response spectra, seismic coefficients and seismic zone coefficients
Unit-V	Seismic Design of Special Structures: Elevated liquid storage tanks, Hydrodynamic pressure in tanks, stack like structures, IS-1893 code provisions for bridges; Superstructures, sub- structures, submersible bridges, dams; Hydrodynamic effect due to reservoir, concrete gravity dams.

Textbooks/References:

1. Ranganathan, R. Reliability Analysis and Design of Structures, TMH
2. Rao. S.S. Reliability Based Design , McGraw Hill Book CO. Inc.
3. Ghosh , D.I., A Primer of Reliability Theory, john Wiley , New York
4. Lewis, E.E., Introduction to Reliability Engineering , John Wiley New Y

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PHD-102 SUBJECTS FOR CIVIL ENGINEERING

Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Civil Engineering	**Reliability Based Civil Engineering**	**PHD102CE06**

Course Outcomes

1. Apply probability theory to civil engineering uncertainty modeling.
2. Analyze resistance and load variability using probabilistic concepts.
3. Perform structural reliability assessment using analytical and simulation methods.
4. Develop reliability-based design criteria for concrete and steel structures.
5. Evaluate system reliability and optimize safety factors in civil infrastructure design.

Unit-wise Content distribution

Unit	Contents
Unit-I	Probability Theory : Mutually exclusice events, set theory, sample points and sample spece, laws of probability, toal probability theorem, Bayes□ rule, random variablesdiscreate and continuous, jointly distributed discrete variables, marginal distribution, conditional distribution, jointly distributed continuous variables functions of random variables, moments and expectations, common probability distribution normal Lognormal, Gamma and Beta distributions, external distributions.
Unit-II	Resistance Distribution and Parameters: Statics of properties of concrete and steel, statics of strength of bricks and mortal, Characterization of variables, allowable stresses based on specified reliability. Probabilistic Analysis of loads: Load as a stochastic process, dead load, statistical analysis of live loads-maximum sustained load intensity model, maximum total load model, wind load-probability model for wind load.
Unit-III	Structural Reliability : General expression for reliability , expression for probability of failure: reliability when strength (S) and load (L) follow normal distribution, lognormal distribution, exponential distribution, extreme value distributions, factor of safety corresponding to a given reliability. Monte Carlo Study of Reliability: Monte Carlo Method-Inverse transformation technique, Application to columns beams and frames. Level 2 Reliability Method: Basic variables and failure surface, first order second moment methods-Hasofer and linds method, Non normal distributions; determination of reliability index of structural elements.
Unit-IV	Reliability Based Design: Determination of partial safety checking formats, development of reliability based criteria, optimal safety factors, calibration of IS 456 and IS 800.
Unit-V	Reliability of Structural Systems: System reliability, modeling of structural systems, bounds on system reliability, automatic generation of a mechanism, generation of dominant mechanisms , reliability analysis of R.C.C. and Steel Frames.

Textbooks/References:

1. Ranganathan, R. Reliability Analysis and Design of Structures, TMH
2. Rao. S.S. Reliability Based Design , McGraw Hill Book CO. Inc.
3. Ghosh , D.I., A Primer of Reliability Theory, john Wiley , New York
4. Lewis, E.E., Introduction to Reliability Engineering , John Wiley New Y

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PHD-102 SUBJECTS FOR CIVIL ENGINEERING

Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Civil Engineering	**FEM in Structural Engineering**	**PHD102CE07**

Course Outcomes

1. Understand the fundamentals and applications of the Finite Element Method in structural analysis.
2. Formulate and solve element characteristic matrices and system equations using appropriate interpolation functions
3. Apply FEM to solve equilibrium, eigenvalue, and propagation problems.
4. Use iso-parametric formulation and numerical integration in structural modeling.
5. Perform static analysis for trusses, frames, plane stress/strain problems, plates, and shells.

Unit-wise Content distribution

Unit	Contents
Unit-I	Introduction to Finite Element Method: General Applicability and Description of Finite Element Method Comparison with other methods.
Unit-II	General Procedure of Finite Element Method: Descretization of the domain, Selection of Shapes, Types and Number of elements, node numbering technique, Interpolation Polynomials, their selection and derivation in terms of global and local coordinates, Convergence requirements. Formulation of Element Characteristic matrices and vectors, Variation approach. Assembly of Element matrices and Vectors and Derivation system equations, computation of element resultants.
Unit-III	Solution of Finite Element Method: Solution of Equilibrium Problems, Eigen value problems, propagation problems, computer implementation of Gaussian eliminations, Choleskis decomposition, Jocobis and Ranga Kutta Method.
Unit-IV	Iso-parametric Formulation: Lagrange and Hermit interpolation functions, Isoperimetric Elements, Numerical Integration
Unit-V	Static Analysis: Formulation of equilibrium equation, Analysis of truss, Frames, Plane Stress and Plane Strain Problems Plates and Shells.

Textbooks/References:

1. Weaver, Johnson, Finite element and structural analysis
2. HC Martin, Matrix structural analysis
3. CF Abel, CS Desai, Finite element methods
4. Buchanan, Finite element Analysis (schaum Outline S), TMH
5. Krishnamurthy, Finite element analysis, TMH)

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PHD-102 SUBJECTS FOR CIVIL ENGINEERING

Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Civil Engineering	**Advance Concrete Technology**	**PHD102CE08**

Course Outcomes

1. Analyze the properties and behavior of cement, fresh, and hardened concrete.
2. Evaluate strength, shrinkage, creep, and durability characteristics of concrete.
3. Understand the role of permeability and develop durable concrete mixes.
4. Identify and design special concretes such as high-performance and air-entrained concrete.
5. Design concrete mixes and perform non-destructive testing for quality control.

Unit-wise Content distribution

Unit	Contents
Unit-I	Cement & its properties, properties of fresh concrete compaction of concrete, curing of concrete
Unit-II	Properties of hardened concrete, strength characteristic, shrinkage, creep, durability, fattier**.**
Unit-III	Permeability & durability of concrete is detail. Special concrete and their properties
Unit-IV	Concrete at low & high temp. Air entrained concrete, high performance concrete.
Unit-V	Mix Design, Non destructive Testing of Concrete.

Textbooks/References:

1. A.M. Nobille, Concrete Technology , ELBS, London
2. M.L. Gambir, Concrete Technology, Tata Mc Graw Hill Book Co.
3. Peurifoy R.L., Construction Planning Equipment & Methods, TMH

4. Verma Nahesh, Construction Equipment and its Planning & Application, Metropoliton Book Company, New Delhi

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PHD-102 SUBJECTS FOR CIVIL ENGINEERING

Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Civil Engineering	**Construction Equipment and Material Management**	**PHD102CE09**

Course Outcomes

1. Plan and select suitable construction equipment for various projects.
2. Estimate production rates and match equipment capacity for efficient operation.
3. Evaluate economic aspects including depreciation, repair, and operational costs.
4. Apply management tools like CPM, assignment, and transportation models in equipment planning.
5. Implement effective material management systems including budgeting, ABC analysis, and inventory control.

Unit-wise Content distribution

Unit	Contents
Unit-I	Planning and Selection of Construction Equipment :Advantage of mechanization of Construction industry. Merits of Labour intensive construction. Planning for construction equipments. Analytical studies, equipment operation. Selection of construction machinery& equipments
Unit-II	Production Estimates, Sizing and Matching :Cycle time capacity ratings and output of Excavators, Power shovels, drag lines, scrapper, bulldozers, tractor shovels rippers, motor graders etc. Sizing and matching. Capacity ratings and output of compactors, aggregate processing plant concrete production plants etc.
Unit-III	Economics of Construction Equipment :Equipment working rates, Investment cost, Depreciation cost, major repair cost. Cost of fuel and lubricants. Cost of labour, servicing and field repairs, overheads. Recommendations of statutory bodies.
Unit-IV	Problems of equipment management. Application of CPM in equipment management. Application of the assignment model, transportation model and waiting line models in equipment management.
Unit-V	Materials planning and budgeting. Role and functions at different levels of management and budgeting variations. Stages of materials management. A.B.C. analysis. Advantages, mechanics purpose cautions, limitations and tabular analysis. Purchasing parameters and inter relationships. Time source quantity, price, quality, grading systems. Special purchasing systems. Obsolescence. Scrap disposal

Textbooks/References:

1.Construction Equipment by Peurify
2. CPM by L.S. Srinath
3. Construction Management by S. Seetharaman
4. CPM & PERT by Weist & Levy
5. Construction, Management & Accounts by Harpal Singh
6. Tendering & Contracts by T.A. Talpasa

Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Civil Engineering	**Advanced Highway Construction**	**PHD102CE10**

Course Outcomes

1. Understand the types and suitability of highway construction under Indian conditions.
2. Apply quality control measures and specifications in material and construction processes.
3. Execute cement concrete road construction including joints and reinforcement techniques.
4. Design reinforced and prestressed concrete pavements for durability.
5. Plan and manage highway projects using CPM and PERT techniques.

Unit-wise Content distribution

Unit	Contents
Unit-I	Classification of types of highway construction, Suitability of each type under Indian conditions. Selection of base course and surface course. Selection of soils, construction of embankments, excavation and compaction equipments. Field and laboratory tests for quality control. Stone soling, brick soling, current practices. Construction of earth roads, gravel roads, soil stabilized roads, water bound macadam. Paved roads (i) bricks (ii) stones
Unit-II	Properties, requirements and specifications of materials, equipments and plants. Detailed construction procedure of each type. Field and laboratory tests for quality control. Choice of binders under different conditions. IRC, British, and MOST Specifications. Bituminous surface treatments, interface treatments-prime coat, and tack coat, surface dressing and seal coat, grouted or penetration macadam, bituminous bound macadam, Sheet asphalt, bituminous concrete, mastic asphalt, dense tar surfacing
Unit-III	Necessity of providing a base course under cement concrete road construction. Selection of materials, constructions methods, detailed construction procedure, Quality control tests (Lab. and Field). Construction equipments. Classification of various types of joints, necessity of providing each type, method of construction of joints, load transfer devices, dowel bars, tie bars. joints filler and sealer materials, IRC Specifications.
Unit-IV	Reinforced Cement Concrete Road Construction :Necessity of providing reinforcement in cement concrete pavements, continuously reinforced concrete pavements prestressed concrete pavements and fiber reinforced concrete pavements. Selection of the mix, compaction method and construction procedure for each type. Recommendations under Indian conditions.
Unit-V	Construction Planning and Management : CPM/PERT in Highway Construction.

Textbooks/References:

1. Highway Engineering by Gurucharan Singh
2. Principles of Pavement Design by E.J. Yoder & M.W. Witzech
3. Highway Engineering by O'Fleherty
4. Highway Engineering by S.K. Khanna & C.E.G. Justo
5.Highway Engg. By Hews & Oglesby
6. Highway Material by Walker

Program	Faculty	Branch/Specialization	Name of Subject	Subject Code
Ph.D	Engineering & Technology	Civil engineering	**Fluid Mechanics**	**PHD102CE11**

Course Outcomes

1. Explain fundamental fluid properties and analyze pressure forces and stability of bodies.
2. Analyze kinematics and dynamics of fluid flow using continuity and Bernoulli's equations.
3. Evaluate laminar and turbulent flow behavior in pipes and channels.
4. Calculate head losses, hydraulic gradients, and power transmission through pipes.
5. Apply dimensional analysis and model laws for hydraulic similitude and prototype studies.

Unit-wise Content distribution

Unit	Contents
Unit-I	Properties of fluids: Ideal and real fluid. Pressure and its measurement, Pascal's law, pressure forces on plane and curved surfaces, centre of pressure, buoyancy, metacentre and metacentric height, condition of floatation and stability of submerged and floating bodies
Unit-II	Kinematics of fluid flow: continuity equation, path lines, streak lines and streamlines, stream tube, stream function, velocity potential function, and flow net. Types of fluid flow, translation, rotation, circulation and vorticity, Vortex motion; Dynamics of fluid flow, Bernoulli's theorem, venturimeter, orifice-meter ,Introduction to orifice and notch.
Unit-III	Laminar flow: shear stress distribution and velocity distribution in circular pipes and two parallel plates; kinetic energy correction factor and momentum energy correction factor, average velocity, shear stress and pressure gradient; Turbulent flow in pipes, Darcy equation
Unit-IV	Minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient, siphon; power transmission through pipe and nozzle; water hammer
Unit-V	Dimensional analysis and similitude: Rayleigh's method and Buckingham's π-theorem, types of similarities, dimensionless numbers, model's law. Minor and major hydraulic losses through pipes and fittings, flow through network of pipes, hydraulic gradient and energy gradient, siphon; power transmission through pipe and nozzle; water hammer

Textbooks/References:

1. Fluid Mechanics - Modi & Seth - Standard Book house, Delhi
2. Open Channel Flow by Rangaraju - Tata Mc Graw - Hill Publishing Comp. Ltd., New Delhi
3. Fluid Mechanics - A.K. Jain - Khanna Publishers, Delhi
4. Fluid Mechanics, Hydraulics & Hydraulic Machanics - K.R. Arora - Standard Publishers Distributors 1705-