



Ph.D. Programme in Civil Engineering
(Coursework Syllabus for Academic Year 2026)

This syllabus is framed for the Doctor of Philosophy (Ph.D.) Programme in Civil Engineering offered by the Department of Civil Engineering, Islamic University of Science & Technology (IUST), Awantipora. The syllabus is prepared in accordance with the provisions of the Ph.D. Ordinance of IUST and the applicable University Grants Commission (UGC) Regulations from time to time.

The objective of the Ph.D. coursework is to equip research scholars with a strong foundation in research methodology, ethics, and advanced subject knowledge relevant to their chosen area of research.

1 Structure of the Ph.D. Programme

The Ph.D. Programme shall consist of the following stages:

1. Coursework
2. Synopsis Submission
3. Research Work, Thesis Submission and Defense.

The coursework shall be a mandatory prerequisite for the award of the Ph.D. degree.

2 Ph.D. Coursework Requirement

The Ph.D. coursework shall comprise a minimum of **12 credits**, divided into two components as detailed below:

2.1 Component I (Compulsory Courses) – 6 Credits (Floated and Offered at School Level)

- (a) Research Methodology for Engineering and Technology – 4 Credits
- (b) Research and Publication Ethics – 2 Credits

2.2 Component II (Departmental Courses) – Minimum 6 Credits

Component II shall consist of Departmental Compulsory and Departmental Elective courses. All courses under this component shall be recommended by the Supervisor(s), vetted by the SRAC, and approved by the Departmental Research Committee (DRC).

(a) Departmental Compulsory Course:

- CEN-800: Seminar – 2 Credits

Departmental Compulsory Course (Component II)									
S. No	Course Code	Course Title	Course Category	Credits	Contact Hours	Per Week			
						L	T	P	S
1.	CEN-800	Seminar	Core/Compulsory	2	45	0	1	2	0

The seminar course is mandatory for all Ph.D. scholars registered in the Department of Civil Engineering.



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(b) Departmental Elective Courses

Scholars shall earn the remaining credits from approved departmental elective courses relevant to their research area.

Departmental Elective Courses									
S. No	Course Code	Course Title	Course Category	Credits	Contact Hours	Per Week			
						L	T	P	S
1.	CEN-801	Modelling, Simulation and Optimization	Elective	4	60	3	1	0	0
2.	CEN-802	Engineering Design Optimization and Reliability	Elective	4	60	3	1	0	0
3.	CEN-803	Theory of Elasticity	Elective	4	60	3	1	0	0
4.	CEN-804	Maintenance and Repair of Concrete Structures	Elective	4	60	3	1	0	0
5.	CEN-805	Characterisation of Construction Materials	Elective	4	60	3	1	0	0

Scholars shall choose departmental elective courses based on research relevance and as recommended by the Supervisor(s) and approved by the DRC.

3 Attendance and Passing Criteria

- Minimum attendance requirement shall be as per University norms.
- A minimum of 55% marks or equivalent grade shall be required to pass each course as per University policy.

4 General Notes

1. The coursework shall normally be completed within the first two semesters.
2. Course allocation shall be based on research area and DRC approval.
3. Any amendment shall be subject to approval by the BORS held from time to time.



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DETAILED SYLLABUS OF DEPARTMENTAL COMPULSORY COURSE

PROGRAMME	PhD Civil Engineering				
COURSE TITLE	Seminar				
COURSE CODE	CEN-800				
COURSE CATEGORY	Core/Compulsory				
CREDITS AND CONTACT HOURS					
CREDITS	L	T	P	S	TOTAL NO. OF CONTACT HOURS
2	0	1	2	0	45

COURSE OBJECTIVES	
1.	To enhance the Research Capabilities of PhD Scholars
2.	Improve the Presentation and Communication Skill of Scholars
3.	Provide a platform for Scholars to Discuss their research progress and receive feedback
4.	To Facilitate scholarly discussion and knowledge exchange among students and faculty

COURSE STRUCTURE	
S. No	Description
1.	Seminar Presentations: Each student will present a seminar on their research progress, recent advancements in their research area, or a related topic.
2.	Peer Review: Students will provide feedback on their peers' presentations, fostering a collaborative learning environment.
3.	Research Paper Discussions: Critical review and discussion of selected research papers in the field of civil engineering.

COURSE REQUIREMENTS	
S. No	Description
1.	Seminar Presentation: Each student is required to deliver a minimum of two seminar presentations, on two different topics.
2.	Participation: Active participation in discussions and peer review sessions is mandatory.
3.	Seminar Report: Submission of a detailed seminar report for each presentation, summarizing the key points, methodologies, results, and feedback received.

EVALUATION CRITERIA

1. Seminar Presentation: 40%

- Clarity and coherence of presentation
- Depth of research and understanding
- Ability to answer questions

2. Seminar Report: 40%

- Quality and comprehensiveness of the report
- Critical analysis and synthesis of feedback



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3. Participation and Peer Review: 10%

- Engagement in discussions
- Constructive feedback to peers

4. Attendance and Professionalism: 10%

- Regular attendance
- Professional conduct during seminars

COURSE OUTCOMES

Upon successful completion of the seminar course, the scholar will be able to critically review contemporary research literature, synthesize research gaps, and effectively present and defend research ideas with technical depth and scholarly rigor.

SUGGESTED READINGS

- Recent journal papers and conference proceedings related to the student's research area.
- Selected chapters from advanced textbooks in civil engineering.

RESOURCES

- Access to university library and online databases.
- Presentation tools and software provided by the department.





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DETAILED SYLLABUS OF DEPARTMENTAL ELECTIVE COURSES

PROGRAMME	PhD Civil Engineering				
COURSE TITLE	Modelling, Simulation and Optimization				
COURSE CODE	CEN-801				
COURSE CATEGORY	Elective				
SUBJECT AREA	Component I				
CREDITS AND CONTACT HOURS					
CREDITS	L	T	P	S	TOTAL NO. OF CONTACT HOURS
4	3	1	0	0	60
Exam Duration	2.5 Hrs				
Pre-Requisite	Nil				

COURSE OBJECTIVES	
1.	To develop a rigorous understanding of mathematical modelling and system representation techniques, including deterministic, stochastic, state-space, and distributed parameter models relevant to civil engineering systems.
2.	To impart advanced knowledge of statistical and computational tools such as regression analysis, time series modelling, probability theory, random variable analysis, and Monte Carlo simulation for analysis of engineering data and uncertainty.
3.	To integrate modelling and simulation frameworks with optimization techniques (classical, linear programming, and numerical methods) for solving complex civil engineering problems in hydrology, water resources, and infrastructure systems.

S. No.	Contents	Cont. Hours
1.	Systems and Models: Fundamentals of systemic approach, system modeling, classification of models, model structure, Linear, non-linear, time-invariant, time variant models, State-space models, Distributed parameter models, System Synthesis, Direct and inverse problems, Role of optimization, Role of computers, examples from hydrology/water resources engineering	12
2.	Regression Analysis: Linear and Multiple Regression analysis, analysis of residues, tests of goodness of fit, Parsimony criterion, role of historical data, examples from Spatial Distribution: Polynomial surfaces, Kriging, Spline functions, Cluster Analysis	12
3.	Time Series Analysis: Auto-cross correlation analysis, identification of trend, spectral analysis, identification of dominant cycles, smoothing techniques, Filters, time series of rainfall and stream flow.	12
4.	Random variables: Basic concepts, probability density distribution functions, Expectation and standard deviation of discrete and continuous random variables and their functions, covariance and correlation, commonly used theoretical probability distributions (uniform, normal, binomial,	12



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	poisson's and negative exponential), Fitting distributions to raw data, Chi-square and Kolmogrov-Smirnov;s tests of the goodness of fit, Central limit theorem, various algorithms for generation of random numbers	
5.	Monte Carlo simulation: basic concepts, generation of synthetic observations, statistical interpretation of output, Evaluation of definite integrals, Optimization: Introduction, Classical methods, Linear Programming	12

COURSE OUTCOMES

Upon successful completion of this course, the scholar will be able to formulate, simulate, and optimize deterministic and stochastic civil engineering systems using mathematical, statistical, and computational methods for research and advanced engineering applications.

SUGGESTED READINGS

S. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	Law, A.M. and Kelton, W.D., "Simulation Modeling and Analysis", Tata McGraw Hill.	2007
2.	Daniel, C. and Wood, P.S., "Fitting Equations to Data", John Wiley.	1980
3.	Ljung, L., "System Identification Theory for the Users", Prentice Hall.	1999
4.	Rao S. S., "Engineering Optimization, Theory and Practice", New Age International Publishers.	2012
5.	Deb, K., "Optimization for Engineering design", Prentice Hall of India.	2006
6.	Vedula S. and Mujumdar P. P. "Water Resources Systems", Tata McGraw Hill.	2005
7.	Stochastic Simulation: Algorithms and Analysis, Søren Asmussen and Peter W. Glynn, Springer.	2007
8.	Simulation Modeling and Analysis (5th Edition), Averill M. Law, McGraw-Hill Education,	2014
9.	Mathematical Modeling and Simulation: Introduction for Scientists and Engineers, Kai Velten, Wiley-VCH	2022
10.	Theory of Modeling and Simulation: Discrete Event and Iterative System Computational Foundations (3rd Edition), Bernard P. Zeigler, Alexandre Muzy, and Ernesto Kofman, Academic Press,	2019



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PROGRAMME	PhD Civil Engineering				
COURSE TITLE	Engineering Design Optimization and Reliability				
COURSE CODE	CEN-802				
COURSE CATEGORY	Elective				
SUBJECT AREA	Component I				
CREDITS AND CONTACT HOURS					
CREDITS	L	T	P	S	TOTAL NO. OF CONTACT HOURS
4	3	1	0	0	60
Exam Duration	2.5 Hrs				
Pre-Requisite	Nil				

COURSE OBJECTIVES: This course is designed to introduce students to concepts and applications of structural reliability and design optimization. Upon completion of this course, students will be able to:

1. Compute first and second-order estimates of failure probabilities of engineered systems;
2. Compute sensitivities of failure probabilities to assumed parameter values;
3. Measure the relative importance of the random variables associated with a system;

S. No.	Contents	Contact Hours
1	Introduction to Design Optimization; Optimal Design Problem Formulation; Graphical Optimization and Basic Concepts, Optimum Design Concepts: Optimality Conditions; Optimal Design with MATLAB.	12
2	Numerical Methods for Unconstrained Design Optimization; Numerical Methods for Constrained Design Optimization; Practical Applications of Optimization.	12
3	Genetic Algorithm for Optimum Design; Multi-objective Optimum Design Concepts and Methods.	12
4	Fundamentals of probability theory; Common probabilistic models. General component reliability; First-order second-moment methods; First and Second-order reliability method.	12
5	Importance measures and parameter uncertainty; Sampling techniques; Surrogate Modelling. Development of reliability-based design codes; System reliability.	12
	Total	60

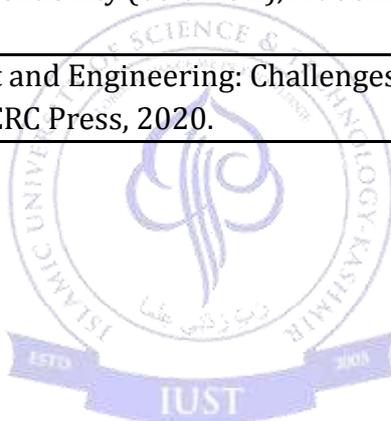
COURSE OUTCOMES

Upon successful completion of this course, the scholar will be able to formulate and solve engineering design optimization problems under uncertainty by integrating reliability analysis methods (FORM/SORM, sampling, surrogate modeling) to develop reliability-based optimal design solutions for structural systems.



SUGGESTED READINGS

S. No.	Name of Authors/Books/Publishers
1.	Jasbir S. Arora, " <i>Introduction to Optimum Design</i> ", 3rd Ed., Academic Press (2012).
2.	Achintya Halder and Sankaran Mahadevan, " <i>Probability, Reliability, and Statistical Methods in Engineering Design</i> ", John Wiley (2000).
3.	O. Ditlevsen, and H. O. Madsen, " <i>Structural Reliability Methods</i> ", Internet Edition 2.3.7, John Wiley (2007).
4.	A.H.S. Ang and W. H. Tang, " <i>Probability Concepts in Engineering Planning and Design</i> ", Vol. I: Basic Principles, Wiley (1975).
5.	R. E. Melchers, " <i>Structural Reliability Analysis and Prediction</i> ", 2nd Ed., Wiley (1999).
6.	Jasbir S. Arora, " <i>Introduction to Optimum Design</i> ", 3rd Ed., Academic Press (2012).
7.	Engineering Design Optimization, Joaquim R. R. A. Martins & Andrew Ning, Cambridge University Press (2022).
8.	Reliability-Based Mechanical Design: Component Under Cyclic Load and Dimension Design With Required Reliability (Volume 2), Xiaobin Le, Springer Cham, 2020 (eBook 2022)
9.	Reliability Management and Engineering: Challenges and Future Trends, Harish Garg & Mangey Ram (Eds.), CRC Press, 2020.





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PROGRAMME	PhD Civil Engineering				
COURSE TITLE	Theory of Elasticity				
COURSE CODE	CEN-803				
COURSE CATEGORY	Elective				
SUBJECT AREA	Component II				
CREDITS AND CONTACT HOURS					
CREDITS	L	T	P	S	TOTAL NO. OF CONTACT HOURS
4	3	1	0	0	60
Exam Duration	2.5 Hrs				
Pre-Requisite	Nil				

COURSE OBJECTIVES	
1.	To develop rigorous understanding of stress-strain relationships, tensor formulation, and constitutive laws governing linear elastic behavior of materials.
2.	To formulate and solve boundary value problems in elasticity, including problems in flexure, thermo-elasticity, and complex variable methods relevant to engineering applications.
3.	To extend classical elasticity concepts to advanced topics, including photo-elasticity and introduction to nonlinear elasticity for research-oriented structural and material analysis.

S. No.	Contents	Contact Hours
1	Introduction, Introduction to Tensor, Concept of Stress and Strain.	12
2	Constitutive Relationships, Formulation of Boundary Value Problems.	12
3	Solution of Boundary Value Problems, Problems in Flexure.	12
4	Boundary Value Problems in Elasticity, Complex Variable Method.	12
5	Thermo-Elasticity, Photo-Elasticity, Introduction to non-linear elasticity.	12
	Total	60

COURSE OUTCOMES
Upon completion of this course, the scholar will be able to formulate and analytically solve elasticity problems using tensorial methods and boundary value approaches, and apply these principles to advanced structural and material research problems.

SUGGESTED READINGS

S. No.	Name of Authors/Books/Publishers
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1.	H. Jane Helena, " <i>Theory of Elasticity and Plasticity</i> ", PHI Learning Private Limited (2017).
2.	Stephen Timoshenko and J.N. Goodier, " <i>Theory of Elasticity</i> " (2017).
3.	Theory of Elasticity, T. G. Sitharam and L. Govindaraju, Springer, 2021.
4.	Theory of Elasticity and Plasticity: A Textbook of Solid Body Mechanics, Valentin Molotnikov and Antonina Molotnikova, Springer Nature, 2021.
5.	Solid Mechanics, Theory of Elasticity and Creep, Holm Altenbach, Suren Manuk Mkhitarian, Vahram Hakobyan, and Avetik Varazdat Sahakyan, Springer, 2023.





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PROGRAMME	PhD Civil Engineering				
COURSE TITLE	Maintenance and Repair of Concrete Structures				
COURSE CODE	CEN-804				
COURSE CATEGORY	Elective				
SUBJECT AREA	Component II				
CREDITS AND CONTACT HOURS					
CREDITS	L	T	P	S	TOTAL NO. OF CONTACT HOURS
4	3	1	0	0	60
Exam Duration	2.5 Hrs				
Pre-Requisite	Nil				

COURSE OBJECTIVES	
1.	To develop advanced understanding of deterioration mechanisms in concrete structures, including corrosion of reinforcement, chemical attack, fire damage, freeze-thaw effects, shrinkage, creep, and environmental degradation, and their influence on structural performance and durability.
2.	To equip scholars with expertise in condition assessment and diagnostic techniques, including laboratory and in-situ testing, corrosion evaluation, service life estimation, and interpretation of structural health data for effective maintenance planning
3.	To critically evaluate and design appropriate repair, protection, strengthening, and stabilization strategies, including surface treatments, injection grouting, cathodic protection, and structural retrofitting of beams, slabs, columns, walls, joints, and prestressed systems.

S. No.	Contents	Contact Hours
1	Prologue: Corrosion of Embedded Metal, Significance and Fundamentals of Corrosion, Carbonation induced and Chloride Induced Corrosion, Corrosion of embedded metal, Types of Reinforcement i.e. Bare Steels, etc. Ring test for assessing the quality of TMT steel bars; Corrosion of metallic and non-metallic coated re-bars; corrosion in pre-stressed concrete.	12
2	Deterioration of Cementitious Systems: Introduction, Sulphate attack, bio-fouling and acid attack; deterioration of cementitious systems, freeze-thaw and alkali-silica reaction; Deterioration by Shrinkage and creep. Fire attack, abrasion and erosion; condition assessment of concrete structures: Exposure conditions, visual inspection and on-situ concrete testing. Testing of concrete in Laboratory; Mechanical and corrosion testing of re-bars, strategies and materials for concrete repair.	12
3	Surface preparation and Protective treatments: Coatings on concrete infrastructures, water-proofing of concrete structures.	12
4	Structural Strengthening & Stabilization: Load effects and Introduction to S&S; Structural Strengthening & Stabilization Beams and Slabs;	12



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	Structural Strengthening & Stabilization Columns & Walls, Joints and connections strengthening, Injection Grouts for concrete repair, Structural repair of pre-stressed concrete systems.	
5	Case studies: Case studies on structural repair (Right methodologies and systematic approach / case studies), Cathodic Protection in Concrete Structures Laboratory and field studies, Service life estimation.	12
	Total	60

COURSE OUTCOMES

Upon completion of this course, the scholar will be able to analyze deterioration mechanisms in concrete structures and design appropriate maintenance, repair, and strengthening strategies based on condition assessment and durability principles.

SUGGESTED READINGS

S. No.	Name of Authors/Books/Publishers
1.	Modi Poonam I. (Author), Patel Chirag N. (Author), " <i>Repair And Rehabilitation Of Concrete Structures</i> ", PHI (2016).
2.	D. Campbell-Allen (Author), Harold Roper (Author), Denison Campbell-Allen (Author), " <i>Concrete Structures: Materials, Maintenance and Repair (Concrete design & construction series)</i> " (1991).
3.	Steel-Reinforced Concrete Structures: Assessment and Repair of Corrosion (3rd Edition), Mohamed Abdallah El-Reedy, CRC Press, 2024
4.	Concrete Repair and Maintenance Illustrated: Problem Analysis, Repair Strategy, Techniques, 3rd Edition, Peter H. Emmons, RSMeans (Gordian), 2022
5.	Concrete Structures: Materials, Maintenance, and Repair (Concrete Design and Construction Series), Denison Campbell-Allen, McGraw-Hill, 2023.
6.	Concrete Repair: A Practical Guide, Michael G. Grantham (Editor), CRC Press, 2011



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PROGRAMME	PhD Civil Engineering				
COURSE TITLE	Characterisation of Construction Materials				
COURSE CODE	CEN-805				
COURSE CATEGORY	Elective				
SUBJECT AREA	Component II				
CREDITS AND CONTACT HOURS					
CREDITS	L	T	P	S	TOTAL NO. OF CONTACT HOURS
4	3	1	0	0	60
Exam Duration	2.5 Hrs				
Pre-Requisite	Nil				

COURSE OBJECTIVES	
1.	To develop advanced understanding of microstructural, mineralogical, thermal, and electrochemical characterization techniques used for construction materials such as cement, concrete, and composite binders.
2.	To enable interpretation and critical analysis of experimental data obtained from techniques like XRD, calorimetry, thermal analysis, microscopy, surface area measurement, and impedance spectroscopy for material performance evaluation.
3.	To apply characterization tools in research-oriented investigations to establish relationships between material structure, hydration mechanisms, durability, and long-term performance of sustainable construction materials.

S. No.	Contents	Cont. Hours
1	Characterization of Construction Materials: An Introduction; Structure of Construction Materials: An Overview; Calorimetry: Introduction and types of Calorimeter, Calorimetry: Sample preparation, Practical note and Heat of hydration, Calorimetry: Applications of calorimetry.	12
2	X Ray diffraction: Introduction to X Rays and crystallography, X Ray diffraction: Crystal systems and History of XRD, X Ray diffraction: Diffractogram, X Ray diffraction: Diffractogram – Calculations; X Ray Diffraction: Qualitative Phase Analysis, X Ray Diffraction: Sample Preparation and Application in study of cements	12
3	Thermal Analysis, Application of thermal analysis to study construction materials, Surface Area Measurement: Sampling and particle size distribution, Surface Area Measurement: Different techniques, Surface Area Measurement: calculation and applications, Porosity and pore structure - Introduction, significance of pore distribution, Porosity and pore structure - Working of mercury intrusion porosimeter.	12
4	Optical and Scanning Microscopy- Introduction and specimen preparation, Optical and Scanning Microscopy- Features and functions, Types of optical microscopy, Scanning electron microscope Part 1- Parts and Functioning; Scanning electron	12



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	microscope Part 2- Working Principles; Scanning electron microscope Part 3 - Analysis of cementitious systems	
5	Application of characterization techniques to assess composite binder with limestone-calcined clay: what, why and how? Image analysis - Introduction and image mapping, Image analysis - Basic operations, Spectroscopy Techniques; Electrical Impedance analysis - Principle and different methods, Electrical Impedance analysis - Deliverables and Interpretation, Electrochemical testing (Corrosion) using Electrochemical Impedance Spectroscopy (EIS)	12
	Total	60

COURSE OUTCOMES

Upon successful completion of this course, the scholar will be able to **select, apply, and critically interpret advanced characterization techniques to evaluate the microstructure, phase composition, durability, and performance of construction materials for research and sustainable engineering applications.**

SUGGESTED READINGS

S. No.	Name of Authors/Books/Publishers	Year of Publication/ Reprint
1.	“Materials Characterization Techniques” by Sam Zhang et al, CRC Press	2009
2.	Yang Leng, “Materials Characterization: Introduction to Microscopic and Spectroscopic Methods” Wiley	2020
3.	Principles of Materials Characterization and Metrology, Kannan M. Krishnan, Oxford University Press.	2021
4.	Advanced Materials Characterization: Basic Principles, Novel Applications, and Future Directions, Ch. Sateesh Kumar, M. Muralidhar Singh & Ram Krishna, CRC Press	2023
5.	Non-Destructive Material Characterization Methods, edited by Akira Otsuki, Seiko Jose, Manasa Mohan & Sabu Thomas, Elsevier.	2023