

## Scheme of Studies & Syllabus

Master of Technology  
Civil Engineering  
2023-24



Department of Multidisciplinary Engineering  
**SCHOOL OF ENGINEERING & TECHNOLOGY**

THE NORTHCAP UNIVERSITY, GURGAON

(Established under Haryana Govt. Notification No. Leg. 32/2006-HARYANA ACT No.25 of 2009)



The department of Multidisciplinary Engineering offers the following programmes during the academic year 2023-24.

- Master of Technology (M.Tech.) in Civil Engineering with specialization in
  - Structural Engineering
  - Construction Engineering & Management and
  - Environmental Engineering

M.Tech. in Civil Engineering programme for regular students/ working professionals will impart research-based knowledge in the selected disciplines of civil engineering. The M.Tech. programme will be of 2 years with 4 semesters. The programme has total credits of 70. Also, the student can exit after 1 year of M.Tech. programme with a PG diploma in respective specialization completing 50 credits in total. The curriculum is designed in such a way that there are core subjects relevant to overall civil engineering and program electives specific to the respective specializations. Specialization based seminar, minor project, and dissertation in structural engineering, Construction engineering and Management, and Environmental engineering completes the requirement of a Masters' degree in Civil Engineering domain.

**M.Tech. with 2 years exit**

Sem	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	L	T	P	Weekly Contact Hours	Credits
I	CEL501 Safety & Reliability Analysis 3-0-0 (3)	PE-1 3-0-2 (4)	PE-2 3-0-2 (4)	PE-3 3-0-2 (4)	CEC501 Seminar 0-0-4 (2)	CES500 Community Service	12	0	10	22	17
II	CEL502 Optimization Techniques in Civil Engineering 3-0-2 (4)	PE-4 3-0-2 (4)	PE-5 3-0-2 (4)	PE-6 3-0-2 (4)	CED502 Minor Project 0-0-10 (5)	CES502 Community Service (2)* (140 hours)	12	0	18	20	23
III	OE 2-0-2 (3)	MAL616 Research Methodology 2-1-0 (3)	PE-7 3-0-2 (4)	CED601 Dissertation-I 0-0-12 (6)		CES600 Community Service	7	1	16	12	16
IV	CED602 Dissertation-II 0-0-24 (12)					CES602 Community Service (2)* (140 hours)	0	0	24	--	14
<b>TOTAL CREDITS OF THE M.TECH. DEGREE PROGRAMME = 70</b>											<b>70</b>

\*Students can utilize the summer/winter break period to complete the remaining 140 Community Service hours every year

**PG Diploma with 1 year exit**

Sem	Subject 1	Subject 2	Subject 3	Subject 4	Subject 5	Subject 6	L	T	P	Weekly Contact Hours	Credits
I	CEL501 Safety & Reliability Analysis 3-0-0 (3)	PE-1 3-0-2 (4)	PE-2 3-0-2 (4)	PE-3 3-0-2 (4)	CEC501 Seminar 0-0-4 (2)	CES500 Community Service	12	0	10	22	17
II	CEL502 Optimization Techniques in Civil Engineering 3-0-2 (4)	PE-4 3-0-2 (4)	PE-5 3-0-2 (4)	PE-6 3-0-2 (4)	CED502 Minor Project 0-0-10 (5)	CES502 Community Service (2)* (140 hours)	12	0	18	20	23
Summer	CEV502 Skill Based Course (3)	CET502 Industrial Internship (7)									10
<b>EXIT OPTION: PG DIPLOMA in respective specialization; TOTAL CREDITS = 50</b>											50

\*Students can utilize the summer/winter break period to complete the remaining 140 Community Service hours every year

**Department of Multidisciplinary Engineering**

**Master of Technology in Civil Engineering**

Specialization in

1. Structural Engineering
2. Construction Engineering and Management
3. Environmental Engineering

Program Core			
1	Safety and reliability analysis		
2	Optimization techniques in civil engineering		
3	Research Methodology		
4	Seminar		
5	Minor Project		
6	Dissertation- I		
7	Dissertation- II		
Program Electives			
	Structural Engineering	Construction Engineering & Management	Environmental Engineering
1	Advanced Concrete Technology	Advanced Concrete Technology	Environmental Impact and Risk Assessment
2	Sustainable Built Environment	Construction and Contract Management	Environmental Chemistry
3	Advanced Design of Foundations	Infrastructure Development and Management	Water Supply Engineering
4	Design of Industrial Structures	Resource Management and Control in Construction	Industrial Waste Management
5	Prestressed Concrete Structures	Construction Economics and Finance	Geo-Environmental Engineering
6	Structural Health Monitoring-NDT	Shoring, Scaffolding and Formwork	Global Climate Change Adaptation and Mitigation
7	Earthquake Resistant Design of Structures	Quality & Safety in Construction	Wastewater Engineering
8	Finite Element Analysis	Strategic Technology Management	Environmental Policy, Legislation
9	Structural Dynamics	Flexible System Management	Advanced Wastewater Treatment
10	Theory of Elasticity & Plasticity	Advanced Methods for management research	Air Pollution and Control
11	Principles of Bridge Engineering	Project Planning and Control	Solid and Hazardous Waste Management
12	Matrix Methods of Structural Analysis	Organizational Management	Environmental Hydraulics and Hydrology
13	Prefabricated Structures	Construction Planning and Management	Environmental Modeling and Simulation
14	Theory of plates and shells	Contract Laws and Regulation	Environmental Remediation of Contaminated Sites
15	Design of Tall Structures	Functional Planning, Building Services, & Maintenance Management	Environment and Ecology
16	Advanced Design of Concrete Structures	--	--
17	Repair & Rehabilitation of Structures	--	--

## **Brief Syllabus**

### **STRUCTURAL ENGINEERING**

#### **CEL501 Safety and Reliability Analysis (3-0-0) 3 Credits**

Fundamentals of set theory and probability, probability distribution, regression analysis, hypothesis testing. Stochastic process and its moments and distributions, Concepts of safety factors, Safety, reliability and risk analysis, first order and second order reliability methods, simulation-based methods, confidence limits and baysean revision of reliability, reliability based design, examples of reliability analysis of structures.

#### **CEL502 Optimization Techniques in Civil Engineering (3-0-2) 4 Credits**

Optimization Introduction – Formulation of LPP – Geometry of LPP and Graphical Solution of LPP – Solution of LPP: Simplex Method – Big M Method – Two Phase Method – Special cases in simple applications – Introduction to Duality Theory – Dual Simplex Method – Optimization of Transportation Problems – Project Management – Path Analysis

#### **CEL503 Advanced Concrete Technology (3-0-2) 4 Credits**

Concrete Making Materials Aggregates – Classification, IS specifications, Properties, Grading, Methods of combining aggregates, specified grading, Testing of aggregates. Cement Chemical composition, Hydration of cement, structure of hydrated cement, special cements, and water chemical admixtures. Concrete Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and Shrinkage, Variability of concrete strength. Mix Design Principles of concrete mix design, Methods of concrete mix design, testing of concrete. Special Concretes Light weight concrete, Fiber reinforced concrete, Polymer concrete, Super plasticized concrete, Properties and applications. Concreting Methods Process of manufacturing of concrete. Methods of Transportation, placing and curing. Extreme weather concreting, special concreting methods.

#### **CEL506 Sustainable Built Environment (3-0-2) 4 Credits**

Background terms; Smart Growth, smart city and New Urbanism and the Resistance to Change; Green Building Assessment; Green Building Index; Life Cycle Costing; The Setting/Green Roofs, Case Study; Energy and Buildings; Energy and Hydrologic Systems; Materials/Specifications; Interior Environments (lighting, air), GRIHA, LEEDs rating system, BEE Standards and guidelines.

#### **CEL507 Design of Industrial structures (3-0-2) 4 Credits**

Elementary Plastic Analysis and Design: Introduction, Scope of plastic analysis, ultimate load carrying capacity of tension members and compression members, flexural members, and simple portal frames and design Industrial Buildings- Loads, general arrangement and stability, design considerations, design of roof trusses, industrial building frames, Design of Water Tanks Stacks and Towers.

#### **CEL 508 Prestressed Concrete Structures (3-0-2) 4 Credits**

Theory and behavior – basic concept, methods of pre stressing, loss of pre stress, Analysis of prestress, calculations of deflections , crack width; design concepts – procedures as per codes, stress distributions, limit state design criteria; design of pre stressed concrete, Analysis and design of indeterminate prestress members, tanks, pipes and composites construction and elementary idea of pre stressed concrete bridge.

#### **CEL509 Finite Element Analysis (3-0-2) 4 Credits**

Introduction to Finite Element Method. Brief History of the Development. Advantages & Disadvantages of Finite Element Method. Finite Element Method- The Displacement Approach. Foundations of the FEM Energy Principles. One Dimensional Finite Element. Stiffness Matrix for the basic Bar & Beam Element. Element Stresses. Shape Functions & Interpolation Polynomials. Finite Elements for Two Dimensional Planar Bodies. Triangular Elements for Plane Stress or Strain Conditions. Rectangular Elements for Plane Stress or Strain Conditions. Finite Elements for Three-Dimensional Analysis. Tetrahedral Elements. The Iso-parametric Concept. Properties of Iso-

parametric Elements. Numerical Integration. Finite Elements For Plate Bending Analysis. Applications of FEA to field problems.

#### **CEL510 Structural Dynamics (3-0-2) 4 Credits**

Free and forced vibration of single degree of freedom (SDOF) system, response to harmonic, periodic, impulsive and general dynamic loading, response of SDOF to earthquake, Free vibration of lumped multidegree of freedom system, Approximate methods for obtaining natural frequencies and mode shapes, Frequency domain analysis of lumped multi-degree of freedom system using normal mode theory, Time domain analysis using numerical integration scheme, Free and forced vibration of continuous systems, Introduction to the dynamics of soil structure interaction problems.

#### **CEL511 Advanced Design of Foundations (3-0-2) 4 Credits**

Introduction to Foundation Engineering, Soil Exploration, Classification of foundations, Bearing Capacity Theories, Scale Effect, Eccentrically loaded footing, Bearing capacity of- Interfering footings, Anisotropic foundations, Centric inclined load, Oblique loading, Design of Shallow Rigid Foundations, Flexible Design of Foundations: Beams on Elastic Foundation, Finite Difference Schemes and Expressions for various applied loadings and moments, Settlement and Contact pressures, Pile Foundations

#### **CEL512 Principles of Bridge Engineering (3-0-2) 4 Credits**

Introduction- Definition, components of bridge, classification of bridges, selection of site, economical span, aesthetics consideration, necessary investigations and essential design data; Standard specifications for roads and railways bridges: Indian Road Congress Bridge Code for specifications and loads,: Various types of R.C.C. bridges (brief description of each type), Design Consideration for R.C.C. Bridges and culverts.: Design of Tee beam bridge, Various types of steel bridges (brief description of each), Design Consideration for Steel Bridges design of plate girder bridges. Hydraulic & Structural Design of piers, abutments, wing wall and approaches: Brief descriptions of bearings, joints, articulation and other details. Bridge foundation-Variety types, necessary investigations and design criteria of well foundation.

#### **CEL518 Earthquake Resistant Design of Structures (3-0-2) 4 Credits**

Characteristics of earthquake, measurement of earthquake, dynamics of single degree of freedom system, earthquake response to single degree of freedom system, response spectrum, earthquake resistant design concepts, response reduction factor, stiffness and building configuration, lateral loads, IS 1893 provisions for buildings, active and passive vibration control, dampers.

#### **CEL 601 Theory of Elasticity and Plasticity (3-0-2) 4 Credits**

Concept of Elasticity - plane stress and plane strain analysis, two dimensional problems in rectangular coordinates - solution by polynomials - Saint- Venant's principle-determination of displacements-bending of simple beams: application of fourier series for two dimensional problems - gravity loading- Two dimensional problems in polar, analysis of stress and strain in three dimensions - differential equations of equilibrium - principle of super position - uniqueness of solution - the reciprocal theorem, torsion of prismatic bars - bars with elliptical cross sections – other elementary solution - membrane analogy - bending of prismatic bars, theory of plasticity - introduction concepts and assumptions - yield criterions.

#### **CEL602 Matrix Methods of Structural Analysis (3-0-2) 4 Credits**

General Introduction. A Few Historical Remarks. Matrix Methods of Analysis of Skeletal Structures. Methods of Analysis. Displacement Method: Stiffness Relationships. The Matrix Displacement Approach, Introduction, Stiffness Matrix of a Bar Element subjected to Axial Force. Co-ordinate Transformations. Global Stiffness Matrix. Application to Pin-Jointed Frames. Stiffness Matrix of a Beam Element. Application to Continuous Beams. Matrix Displacement Analysis of Planar Rigid-Jointed Frames. Neglect of Axial Strain in the Analysis of Planar Rigid-Jointed Frames. Other Kinds of Loading & Other Kinds of Frames. Co-ordinate Transformations. Element Stiffness

Matrix & its Application. Matrix Displacement Analysis of Three-Dimensional Structures. Co-ordinate Transformations. Application to Space Trusses & Space Frames.

#### **CEL603 Prefabricated Structures (3-0-2) 4 Credits**

Types of prefabrication, prefabrication systems and structural schemes- Disuniting of structures- Structural behaviour of precast structures. Handling and erection stresses - Application of prestressing of roof members; floor systems two way load bearing slabs, Wall panels, hipped plate and shell structures. Dimensioning and detailing of joints for different structural connections; construction and expansion joints. Production, Transportation & erection- Shuttering and mould design Dimensional tolerances- Erection of R.C. Structures, Total prefabricated buildings. Designing and detailing prefabricated units for 1) industrial structures 2) Multistorey buildings and 3) Water tanks, silos bunkers etc.,4) Application of prestressed concrete in prefabrication

#### **CEL604 Theory of Plates and Shells (3-0-2) 4 Credits**

Bending theory of flat plates: thin plates, Kirchoff theory - strain displacement relations, stresses and stress resultants, constitutive equations, equilibrium equations, boundary conditions, derivation of theory from principle of virtual work, rectangular plates-solution by double Fourier series, circular plates Classical theory of shells – Membrane theory of shells: equilibrium equations, applications to shells of revolution under axisymmetric loads, applications to cylindrical shells under asymmetric loads, strain-displacement relations , application in calculation of displacements; Bending theory of shells: kinematic assumptions and strain-displacement relations, stress measures and equilibrium

#### **CEL605 Design of Tall Structures (3-0-2) 4 Credits**

Design philosophy – Loading - Sequential loading, materials. High risk behaviour, Rigid frames, braced frames, infilled frames, shear walls, coupled shear walls, wall – frames, tubulars, cores, futrigger - braced and hybrid mega system. Approximate Analysis, Accurate Analysis and Reduction Techniques - Analysis of building for member forces - drift and twist - Computerised general three-dimensional analysis. Structural elements- design, deflection, cracking, prestressing, shear flow, Design for differential movements, creep and shrinkage effects, temperature effects and fire. Overall buckling analysis of frames, wall – frames–second order effects of gravity of loading– simultaneous first order and P-delta analysis Translational - torsional instability, out of plum effects

#### **CEL617 Advanced Design of RCC Structures (3-0-2) 4 Credits**

Determination of deflection and crack width of RCC beams and slabs, moment redistribution in RCC beams, moment curvature relationship for RCC sections, design and analysis of deep beams and voided slabs as per IS 456, design of plane concrete walls and shear walls, analysis of frames under horizontal and vertical loads, drift analysis for tall buildings, introduction to design loads other than the earthquake loads such as wind loads and cyclone loads.

#### **CEL618 Repair and Rehabilitation of Structures (3-0-2) 4 Credits**

Corrosion of embedded metal bars in concrete, deterioration of cementitious systems, condition assessment of concrete structures, strategies and materials for surface repair, surface preparation and protective treatment, coatings on concrete infrastructures, waterproofing of concrete structures, structural strengthening & stabilization, injection grouts for concrete repair, case studies on structural repair, service life estimation.

#### **CEL619 Structural Health Monitoring-NDT (3-0-2) 4 Credits**

Introduction to structural health monitoring (SHM), necessity of SHM, components of SHM, challenges in SHM, advantages and components of SHM, SHM issues applied to concrete structures, uncertainties in SHM process, short term and long term SHM, local and global health monitoring, estimation of structural health using static SHM, SHM planning and management, SHM methods, damage identification using lumped mass and element modal stiffness, visual inspection method, NDT evaluation, sensor technologies, fiber optic sensors, acquisition





system and networking for SHM, Artificial Neural Network (ANN) in the SHM process, damage detection, application of SHM in Infrastructure engineering.

**MAL 616 Research Methodology (2-1-0) 3 Credits**

Foundations of Research, Scientific Research, Motivation, Research Objectives, Research Designs, Research Processes, Understanding Feasibility of Objectives and Processes, Qualitative and Quantitative Research Methods, Data Collection Processes, Biases in Data Collection, Data Pre-processing, Sampling Distribution and Confidence Intervals, Hypothesis Testing, Interpretation of Results, Literature Review, Technical Writing, Citations, Reference management software, Plagiarism, Software for Detection of Plagiarism.

**CEC501 Seminar (0-0-4) 2 Credits**

Independent study on any recent research area in the domain of Civil Engineering as per the specialization chosen by the student. Research papers on specialized topics will be collected from journals and presented. A report shall be submitted showing the literature reviewed by the student.

**CED502 Minor project (0-0-10) 5 Credits**

The minor project will be a design project (hardware/software) on a topic suggested by the course coordinator to be completed during the designated duration. It may be of practical and theoretical interest. It has to be done under the guidance of a faculty and students are expected to complete literature survey, feasibility testing, develop or implement the research work.

**CED 601 Dissertation Phase – I (0-0-12) 6 Credits**

Part-I of the dissertation will cover the problem identification followed by literature review, data collections and data generations and identification of the tool of analysis, simulation and modeling and hypothesis for the problem solving, some basic trail studies.

**CED 602 Dissertation Phase – II (0-0-24) 12 Credits**

Part-II of the dissertation will cover the actual detailed experimentation, simulation, modeling, result generation and reaching to the desired goal set in Part-I. Report writing and publication.

## CONSTRUCTION ENGINEERING & MANAGEMENT

### **CEL501 Safety and Reliability Analysis (3-0-0) 3 Credits**

Fundamentals of set theory and probability, probability distribution, regression analysis, hypothesis testing. Stochastic process and its moments and distributions, Concepts of safety factors, Safety, reliability and risk analysis, first order and second order reliability methods, simulation-based methods, confidence limits and baysean revision of reliability, reliability-based design, examples of reliability analysis of structures.

### **CEL502 Optimization Techniques in Civil Engineering (3-0-2) 4 Credits**

Optimization Introduction – Formulation of LPP – Geometry of LPP and Graphical Solution of LPP – Solution of LPP: Simplex Method – Big M Method – Two Phase Method – Special cases in simple applications – Introduction to Duality Theory – Dual Simplex Method – Optimization of Transportation Problems – Project Management – Path Analysis

### **CEL503 Advanced Concrete Technology (3-0-2) 4 Credits**

Concrete Making Materials Aggregates – Classification, IS specifications, Properties, Grading, Methods of combining aggregates, specified grading, Testing of aggregates. Cement Chemical composition, Hydration of cement, structure of hydrated cement, special cements, and water chemical admixtures. Concrete Properties of fresh concrete, Hardened concrete, Strength, Elastic properties, Creep and Shrinkage, Variability of concrete strength. Mix Design Principles of concrete mix design, Methods of concrete mix design, testing of concrete. Special Concretes Light weight concrete, Fiber reinforced concrete, Polymer concrete, Super plasticized concrete, Properties and applications. Concreting Methods Process of manufacturing of concrete. Methods of Transportation, placing and curing. Extreme weather concreting, special concreting methods.

### **CEL504 Shoring, Scaffolding and Formwork (3-0-2) 4 Credits**

Planning of construction work, site equipment required, Calculation of labour constants - Formwork hours - Labour Requirement - Overall programme - Detailed programme – Costing. Materials accessories proprietary products – finish materials, scaffolding material, design of forms – analysis of forces, building and erection of formwork, formwork for domes, tunnels etc.

### **CEL513 Construction and Contract Management (3-0-2) 4 Credits**

Project cost estimation, rate analysis, overhead charges, bidding models and bidding strategies. Qualification of bidders, Owner's and contractor's estimate. Tendering and contractual procedures, Indian Contract Act 1872, Definition of Contract and its applicability, Types of contracts, international contracts, FIDIC, Conditions and specifications of contract. Contract administration, Claims, compensation and disputes, Dispute resolution techniques, Arbitration and Conciliation Act 1996, Arbitration case studies, Professional ethics, Duties and responsibilities of parties. Management Information systems

### **CEL514 Infrastructure Development and Management (3-0-2) 4 Credits**

Infrastructure overview. Private involvement in infrastructure - The Benefits and problems of Infrastructure Privatization. Challenges in Privatization – case study. Challenges to Successful Infrastructure Planning and Implementation- Mapping and Facing the Landscape of Risks in Infrastructure Projects. Strategies for Successful Infrastructure Project Implementation - Risk Management Framework for Infrastructure Projects, Shaping the Planning Phase of Infrastructure Projects to mitigate risks, Designing Sustainable Contracts, Innovative Design and Maintenance of Infrastructure Facilities, Infrastructure Modelling and Life Cycle Analysis Techniques.

### **CEL515 Resource Management and Control in Construction (3-0-2) 4 Credits**

Resource Planning, Procurement, Identification, Personnel, Planning for material, Labour, time schedule and cost control. Labour management-Systems approach, Characteristics of resources, Utilization, measurement of actual resources required, Tools for measurement of resources, Labour, Classes of Labour, Cost of Labour, Labour schedule, optimum use. Material and equipment-Time of purchase, quantity of material, sources, Transportation, Time Management-Personnel time, Management and planning, managing time on the project, forecasting the future, Critical path measuring the changes and their effects – Cash flow and cost control. Resource allocation and levelling Cumulative cost – Value Management.

### **CEL516 Construction Economics & Finance (3-0-2) 4 Credits**

Benefit-cost analysis, Replacement analysis, Break even analysis. Risks and uncertainties and management decision in capital budgeting. Taxation and inflation. Work pricing. Working capital management, financial plan and multiple source of finance. International finance, Budgeting and budgetary control, Practical problems and case studies, Project cash flow, Methods, Practice, Role of Lender's Engineer. Financial Planning, Budget – Budgetary control system.

**CEL517 Strategic Technology Management (3-0-2) 4 Credits**

Emerging technology-strategy relationship in the large corporation. Global technology comparison. Technology Information. Criticality of technology for growth, core competencies, R&D productivity, Generic competitive technology strategies. Corporate R&D, Strategic technology management process, relationship between technology strategy and corporate strategy. Strategic shifts and resource commitments, technology leadership. SWOT analysis for technology, Matching Business Portfolio and Technology Portfolio, Technology- Market matrix. Innovation and entry strategy.

**CEL527 Quality and Safety in Construction (3-0-2) 4 Credits**

Introduction to quality management. Planning and control of quality during design of structures. Quality assurance during construction. Inspection of materials and machinery. Preparation of quality manuals, check-list and inspection report. Establishing quality assurance system. Quality standards/codes in design and construction. Concept and philosophy of total quality management (TQM). Training in quality and quality management systems (ISO-9000). Concept of safety. Factors affecting safety: Site management with regard to safety recommendations. Training for safety awareness and implementation. Formulation of safety manuals. Safety legislation, standards/codes with regard to construction. Quality vs Safety. Case Studies

**CEL528 Functional Planning, Building Services & Maintenance Management (3-0-2) 4 Credits**

Domestic Water Supply- House connection, water services to multistory buildings, Pipe materials, Jointing, Valves and taps; Building Drainage and Refuse Handling- Building drainage systems, drainage pipe materials, Jointing and testing, types of fixtures and fittings; Collection of refuse from buildings, refuse bins and sacks; Air Conditioning, Heating & Ventilation- Mechanical Ventilation, Air-Conditioning units & their working principles, Different types of heating materials; Lifts- Classification & Types of lifts, lift codes and rules, traffic analysis and selection of lifts, car speed, fire safety, arrangement of lifts; Acoustics- noise reduction, classification & selection of acoustical materials, acoustics of auditorium, schools etc.; Functional Planning & Maintenance Management- Planning of Services, Maintenance of lifts, water supply system, sewerage system

**CEL529 Construction Planning and Management (3-0-2) 4 Credits**

Introduction- importance of construction management, tenders and contracts- network techniques -quality and safety in construction; General overview of civil engineering projects, Procurement and contract management, Estimation and rate analysis, Project planning and its implementation, Construction Technology, Use of IT in construction, Software Application

**CEL606 Flexible Systems Management (3-0-2) 4 Credits**

Emerging management paradigms: Total Quality Management, Business Process Reengineering, Learning Organisation, World Class Organisation, Flexibility in Management. Concept of systemic flexibility. Liberalisation, Globalisation and change. New Organisation forms. Concept and dimensions of Systemic flexibility. Managing paradoxes. Methodology and tools of flexible systems management. Underlying values, and guiding principles, Case Analysis using SAPLAP framework. SAP-LAP models and linkages

**CEL607 Project Planning and Control (3-0-2) 4 Credits**

Work study, work break down structure, time estimates, application of CPM/PERT, statical concepts, Man-Material-Machinery-Money optimization, scheduling, monitoring, updating. Cost function, time-cost trade off, resource planning-levelling and allocation. Resources – based network, crashing, master network, interface activities, and dependencies, line of balancing techniques, application of digital computer. Material management- purchase management and inventory control, ABC analysis. Human resource management

**CEL608 Advanced Methods for management research (3-0-2) 4 Credits**

Problem conceptualization and definition. Hypothesis formulation. Selection of Research Methods, Flexible Systems Methodology for preparing research design, Scaling, sampling methods, Managing oral evidence, Questionnaire design, validation and pretesting. Interview design, Case study, Field experiments, Quasi experiments. Qualitative research methods. Statistical techniques and implementation of research plan using statistical packages.

**CEL609 Organization Management (3-0-2) 4 Credits**

Manpower planning, organizing, staffing, directing. Organization -span of control, organization chart, development and operation of human resource, managerial staffing, recruitment, selection, placement, training. Human behavior – basic individual psychology, managing groups at work, leadership, behavioural aspects of decision making and communication for people management. Welfare measures – compensation, safety and health, GPF, EPF, group insurance. Management and development methods

**CEL617 Contract Laws and Regulations (3-0-2) 4 Credits**

Construction Contracts- Indian Contracts Ac, Elements of Contracts, Types of Contracts, Features, Suitability, Design of Contract Documents; Tenders- Prequalification, Bidding, Accepting, Evaluation of Tender from Technical, Contractual and Commercial Points of View, Contract Formation and Interpretation, Potential Contractual Problems; Arbitration- Comparison of Actions and Laws, Agreements, Subject Matter, Violations, Appointment of Arbitrators, Conditions of Arbitration; Legal Requirements- Insurance and Bonding, Laws Governing Sale, Purchase and Use of Urban and Rural Land, Land Revenue Codes, Tax Laws, Income Tax, Sales Tax, Excise and Custom Duties and their Influence on Construction Costs; Labour Regulations- Social Security, Welfare Legislation, Laws relating to Wages, Bonus and Industrial Disputes, Labour Administration, Insurance and Safety Regulation.

**MAL616 Research Methodology (2-1-0) 3 Credits**

Foundations of Research, Scientific Research, Motivation, Research Objectives, Research Designs, Research Processes, Understanding Feasibility of Objectives and Processes, Qualitative and Quantitative Research Methods, Data Collection Processes, Biases in Data Collection, Data Pre-processing, Sampling Distribution and Confidence Intervals, Hypothesis Testing, Interpretation of Results, Literature Review, Technical Writing, Citations, Reference management software, Plagiarism, Software for Detection of Plagiarism.

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**CED502 Minor project**

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**CED 601 Dissertation Phase - I**

Part-I of the dissertation will cover the problem identification followed by literature review, data collections and data generations and identification of the tool of analysis, simulation and modeling and hypothesis for the problem solving, some basic trail studies.

**CED 602 Dissertation Phase – II**

Part-II of the dissertation will cover the actual detailed experimentation, simulation, modeling, result generation and reaching to the desired goal set in Part-I. Report writing and publication.

## ENVIRONMENTAL ENGINEERING

### **CEL501 Safety and Reliability Analysis (3-0-0) 3 Credits**

Fundamentals of set theory and probability, probability distribution, regression analysis, hypothesis testing. Stochastic process and its moments and distributions, Concepts of safety factors, Safety, reliability and risk analysis, first order and second order reliability methods, simulation-based methods, confidence limits and bayesian revision of reliability, reliability based design, examples of reliability analysis of structures.

### **CEL502 Optimization Techniques in Civil Engineering (3-0-2) 4 Credits**

Optimization Introduction – Formulation of LPP – Geometry of LPP and Graphical Solution of LPP – Solution of LPP: Simplex Method – Big M Method – Two Phase Method – Special cases in simple applications – Introduction to Duality Theory – Dual Simplex Method – Optimization of Transportation Problems – Project Management – Path Analysis

### **CEL519 Environmental Impact & Risk Assessment (3-0-2) 4 Credits**

Planning and Management of Environmental Impact Studies. Impact indentation methodologies: base line studies, screening, scoping, checklist, networks, overlays. Prediction and assessment of impacts on the socio-economic environment. Environmental cost benefit analysis. Decision methods for evaluation of alternatives. Case Studies. Environmental impact assessment at project level, regional level, sectoral level, and policy level. Sustainable development: Environmental policy in planned, mixed and market economies; global environmentalism. Preventive environmentalism. Preventive environmental management

### **CEL520 Environmental Chemistry (3-0-2) 4 Credits**

Aquatic Chemistry: Chemical equilibria and kinetics fundamentals; Acids and bases; Titrations; Acidity; Alkalinity; Buffers and buffer intensity; Chemical equilibrium calculations; pC-pH diagram. Precipitation and dissolution; Water softening and water conditioning; Langelier index; Solubility diagram; Coexistence of phases in equilibrium; Complexation of metal ions and organic complexes in natural water. Oxidation and reduction reactions stoichiometry; Redox couples; pE-pH diagrams; Redox control in natural systems; Basic concepts of organic and colloid chemistry. Soil Chemistry : Weathering reactions; Structure and surface reactions of clays and oxides; Forces at soil-water interfaces. Atmospheric Chemistry : Chemical equilibria and kinetics; Photo-dissociation and free radical reactions; Chemistry of precipitation; Acid rain

### **CEL521 Water Supply Engineering (3-0-2) 4 Credits**

Review of public water supply requirements. Sources of water-Surface and subsurface water sources Quality of water-I: physico-chemical parameters of water Quality of water-II: Water microbiology and biology Quality of water-III: water quality standards for chemical, physical and microbiological parameters, processes of treatment, Flow measurement devices - Venturi, Orifice meters, weirs, flumes and gates. Pipeline distribution system analysis and design.

### **CEL522 Industrial Waste Management (3-0-2) 4 Credits**

General Characteristics of Industrial Effluents, Effects on Environment - ISI tolerance limits for discharging industrial effluents into surface water, into public sewers and onto land for irrigation - Toxic chemicals from industry. Pretreatment of Industrial Wastewater: Necessity of pretreatment - Equalization - Segregation - Process Changes - Salvaging - By product Recovery. Removal by Reverse Osmosis, Ion Exchange, Electrodialysis, Solvent Extraction, Floatation.- Removal of Refractory Organics - Removal of Nitrogen and Phosphorus. Major Industrial Effluents: Sources, Characteristics and Treatment. Food Industries: Sugar, Dairy, Distilleries Chemical Industries: Paper and Pulp, Tanneries, Textiles, Fertilizers, Pharmaceuticals, Cement and Steel.

### **CEL523 Geo-Environmental Engineering (3-0-2) 4 Credits**

Sources and effects of subsurface contamination; Physical, chemical and biological characteristics of solid wastes; Soil waste interaction; Contaminant transport; Laboratory and field evaluation of permeability; Factors affecting permeability; Waste disposal on land case study; Landfills and impoundments types; Silting criteria; Waste containment principles; Types of barrier materials; Planning and design aspects relating to waste disposal in landfills; Soil exploration at contaminated site; Vertical cutoff walls; Cover system; Recovery well system; Bioremediation of soil ; In situ Bioremediation of ground water; Soil washing; Monitoring around landfills;

Detection, control and remediation of subsurface contamination; Reclamation of old waste dumps; Regulations; Case studies; Engineering properties and geotechnical reuse of waste materials.

#### **CEL524 Global Climate Change Adaptation and Mitigation (3-0-2) 4 Credits**

Introduction to global climate; Global climatic models; Methods of reconstructing climate; Quaternary climates, sea level changes, glacial/interglacial cycles; Geological records of climate change, sedimentology, stable isotopes, geochemistry; Geochronology – relative and numerical methods; Vegetation dynamics, migration history, response of vegetation to climatic reversals

#### **CEL525 Waste Water Engineering (3-0-2) 4 Credits**

Wastewater Characteristics, Standards of Disposal, Treatment Objective and, Strategies, Layouts of Primary, Secondary and Advanced Treatment Units. Design Of Preliminary And Primary Treatment Operations, Biological Treatment Processes: Types, Kinetics of Plug Flow and Completely Mixed Systems. Aerobic and Anaerobic Sludge Digestion Processes, Design of Digester Tank, Sludge Dewatering, Ultimate Disposal, Sludge Drying Beds, Other Methods of Sludge Treatment.

#### **CEL526 Environmental Policy and Legislation (3-0-2) 4 Credits**

Introduction: Economics and Environmental Policy Theory of externalities: Relevance. Externalities: definitions, significant types, and optimal pricing conditions, formal analysis Uncertainty and choice of policy instruments: price or quantity controls. Market imperfections and the number of participants. Detrimental externalities, and nonconvexities in the production set, optimal pricing of exhaustible resources Introduction to design of Environmental policy. Efficiency without optimality: the charges and standard approaches Marketable emission permits for the protection of the environment. Stochastic influences, direct controls, and taxes. Taxes vs subsidies: a partial analysis. Environment protection and the distribution of income International environmental issues, National and local standards for environmental quality

#### **CEL610 Advanced Wastewater Treatment (3-0-2) 4 Credits**

Microbiological concepts; cells, classification and characteristics of living organisms, characterization techniques, reproduction, metabolism, microbial growth kinetics and kinetics of biochemical operations; Modeling of suspended growth systems, techniques for evaluation of kinetic and stoichiometric parameters. Optimal selection of water and waste water treatment chain, engineered systems, concepts and principles of carbon oxidation, nitrification, denitrification, methanogenesis. Biological nutrient removal; Anaerobic treatment (process options, components of anaerobic reactions that influence process design); Attached growth reactors (process description, design and applications). Decentralized wastewater treatment systems; Low cost options, constructed wetlands. Reliability and cost effectiveness of wastewater systems.

#### **CEL611 Air Pollution and Control (3-0-2) 4 Credits**

Sources & Classification of Air Pollutants, Global effects, Sampling of Pollutants in ambient air, Meteorology and Air Pollution, Control of Particulate Pollutants, Design and operation of settling chambers, cyclones, wet dust scrubbers, fabric filters & ESP, Control of Gaseous Pollutants, Automobile Pollution and Control, Other Management controls, AP Legislation.

#### **CEL612 Solid and Hazardous Waste Management (3-0-2) 4 Credits**

Municipal Solid Waste: Generation, Rate Variation, characteristics (Physical, Biological and Chemical); Management Options for Solid Waste, Waste Reduction at the Source, Collection techniques, Materials and Resources Recovery / Recycling. Transport of Municipal Solid Waste, Routing and Scheduling, Treatment, Transformations and Disposal Techniques (Composting, Vermi Composting, Incineration, Refuse Derived fuels, Landfilling). Norms, Rules and Regulations. Economics of the on-site v/s off site waste management options. Integrated waste management.

#### **CEL613 Environmental Hydraulics and Hydrology (3-0-2) 4 Credits**

Basic concepts of open channel flows, conservation laws, continuity equation, momentum equation, Application of momentum and energy equations Critical flow, its properties and application; location of critical flow and its computation Uniform flow, flow resistance, equations of flow resistance, computation of normal depth, Gradually varied flow, governing equations classification of water surface profiles Rapidly varied flow, application of conservation laws, channel transition, supercritical flow, Hydraulic Jump Hydrologic cycle and its

interaction with human activity, Hydrologic processes, Hydrologic analysis, Hydrologic statistics. Transport processes, diffusion phenomena, Fick's 1st and 2nd Laws of diffusion, Advection diffusion equation, Turbulent diffusion and dispersion mixing in rivers Porous medium flow, Approximation of Dupuit, Contaminant transport, Saltwater intrusion into aquifers, Non aqueous phase liquid (NAPL) in groundwater, aspects of numerical modelling

**CEL614 Environmental Modeling and Simulation (3-0-2) 4 Credits**

Sources and effects of water pollutants, introduction to principles of water quality modeling, distribution of water quality in rivers, estuaries and lakes, contaminant transport in groundwater, water quality modeling applications and discussion of case studies. Sources and effects of air pollutants, air quality standards, and emission inventory, meteorological aspects related to air pollution, air quality modeling and its application, trans-boundary air pollution.

**CEL615 Environmental Remediation of Contaminated Sites (3-0-2) 4 Credits**

The course details the usual remediation techniques practiced worldwide and provide an understanding of the relevant theoretical concepts. Hazardous waste law and risk assessment approaches-deterministic and stochastic, remediation of contaminated ground water by different techniques with relevant case studies – plume contaminants, Javandel et al approach, pump and treat, permeable reactive barrier. Natural attenuation mechanism with case studies, factors affecting the process, soil/ sediment contamination and remediation techniques – solidification and stabilization, TCLP approach, chemical treatment methods– insitu and ex-situ, phytoremediation techniques.

**CEL616 Environment & Ecology (3-0-2) 4 Credits**

Environment and its concepts - nature of environment and components of environment, understanding of environment and ecology, methodological approaches for environment and ecology. Types of environment– micro level environment, natural resources conservation, man-made environment, natural environment. Environment ecology and quality of life. Environment economics – environmental crises, natural resource economics, social cost benefit analysis, sustainable development. Environment and ethics – globalization and environmental issues, ideologies for environmental management. Sustainable development – development and environment, ecological behaviour. Ecology, environment and management issues – corporate social responsibility, policy consideration. Environment and ecology – agenda for future.

**MAL616 Research Methodology (2-1-0) 3 Credits**

Foundations of Research, Scientific Research, Motivation, Research Objectives, Research Designs, Research Processes, Understanding Feasibility of Objectives and Processes, Qualitative and Quantitative Research Methods, Data Collection Processes, Biases in Data Collection, Data Pre-processing, Sampling Distribution and Confidence Intervals, Hypothesis Testing, Interpretation of Results, Literature Review, Technical Writing, Citations, Reference management software, Plagiarism, Software for Detection of Plagiarism.

**CEC501 Seminar (0-0-4) 2 Credits**

Independent study on any recent research area in the domain of Civil Engineering as per the specialization chosen by the student. Research papers on specialized topics will be collected from journals and presented. A report shall be submitted showing the literature reviewed by the student.

**CED502 Minor project (0-0-10) 5 Credits**

The minor project will be a design project (hardware/software) on a topic suggested by the course coordinator to be completed during the designated duration. It may be of practical and theoretical interest. It has to be done under the guidance of a faculty and students are expected to complete literature survey, feasibility testing, develop or implement the research work.

**CEC601 Dissertation Phase – I (0-0-12) 6 Credits**

Part-I of the dissertation will cover the problem identification followed by literature review, data collections and data generations and identification of the tool of analysis, simulation and modeling and hypothesis for the problem solving, some basic trail studies.



**CED602 Dissertation Phase – II (0-0-24) 12 Credits**

Part-II of the dissertation will cover the actual detailed experimentation, simulation, modeling, result generation and reaching to the desired goal set in Part-I. Report writing and publication.