NOIDA INTERNATIONAL UNIVERSITY

SCHOOL OF ENGINEERING & TECHNOLOGY

EVALUATION SCHEME & SYLLABUS

FOR

BACHELOR OF TECHNOLOGY
Civil Engineering

(4 Year Course)
W.E.F Session 2018-2019 onwards

PREFACE

There has been a concern about quality of technical education in India although in terms of access and equity, India has done very well. AICTE is mandated for planned and coordinated development of Technical Education; regulate proper maintenance of norms & standards and expansion of technical Education with Quality. Accordingly, AICTE in its 49th meeting of the Council held on 14.3.2017 approved a package of measures for improving quality of technical education in the country. Revision of Curriculum, Mandatory Internship and Induction Program were amongst the few major quality initiatives taken by AICTE. AICTE, in consultation with MHRD constituted subject-wise Heads of the Committees with a respective team of academic experts along with industry expert to draft the model curriculum of UG engineering courses along with Induction Program for students. During the meetings held for developing model curriculum for undergraduate engineering courses, a concern was shared that in the present system, the first year syllabus is heavily loaded and it is of utmost importance that the students entering into the first year of an engineering course should feel at ease by lowering the burden of syllabus and credits. This is necessary for a student to acclimatize to the new environment of a college and to create a bonding between the teacher and a student. An idea to introduce induction program in the curriculum to equip the students with communication skills, and get them acquainted with the culture of institution and human values was formalized. A student has to undergo this induction program after joining the institute and before the commencement of classes. Normal classes of the engineering program shall begin after the students have undergone a threeweeks induction program. The Induction program for students comprises of Physical activities; Learning an art form; Literature & Cinema; Social Awareness; Lectures &Visits; Universal Human Values; Familiarization to Department/Branch, College& Innovations. To sensitize on the need of induction program, one-day workshops for Principals/ Directors/ Promoters of Society/Trust/Institutions were held at Hyderabad, Bangalore, Mumbai, Kolkata and Delhi. Subsequently, five-day Teacher Training workshops for Student induction were also held at Hyderabad, Varanasi and Pune. Also, AICTE has made 6-8 weeks summer internships mandatory before completion of under graduation. This will equip the students with practical understanding and training about industry practices in a suitable industry or organization. A novel concept of Virtual Laboratories has also been introduced in the Model Curriculum. MHRD has successfully completed two phases of project under NPTEL, to develop Virtual Labs through a consortium headed by IIT Delhi. During these phases, more than 180 labs were developed, comprising of more than 1700 experiments, in different domains of engineering. These experiments are field tested through various nodal centres across the country. The Virtual Labs. essentially comprise of a user friendly graphical front. It would be a far enriching experience to use virtual labs and learn at one‟s own pace and time.

A student can even learn the skills which are not part of the curriculum but required as professionals to take up new challenges. A chapter on „Virtual Laboratories: A new way of Learning‟ is a part of this Model Curriculum. It was also felt that students should get holistic education which has components of sports, physical activities, values and ethics. The respective Heads of the Committees & teams discussed the existing system prevalent in engineering colleges, industry requirements and market trends, employability, problem solving approach, need for life long learning and after due deliberations, the scheme and syllabus for various engineering disciplines have been formalized. Salient features of this model curriculum are enumerated below:

i. Induction program has been made a part of this Model Curriculum.
ii. Model Curriculum has been designed in such a way that it encourages innovation and research as total number of credits has been reduced and many new courses have been incorporated in consultation with industry experts.
iii. The revised Model Curriculum has been designed where the students can understand the industry requirements and have hands-on experience. The students will develop a problem solving approach and will be able to meet the challenges of future.
iv. It is also understood that different engineering disciplines should have some flexibility in being different. All engineering disciplines cannot be made to conform to a fixed structure. Though, AICTE has compiled a common first year scheme and syllabi for engineering disciplines, the concerned Institution/ University may adjust the scheme and courses as per the requirement of particular Institute and local needs. However, the total credit structure of 160 credits should not be disturbed. The institutions/ universities in India are requested to adopt this "Model Curriculum" for various undergraduate degree engineering disciplines.
v. Courses on Constitution of India, Environment Science/Engg. and Essence of India Traditional Knowledge have also been included in the Curriculum.
vi. A novel concept of Virtual laboratories has been introduced in the model curriculum.
vii. Curriculum on Entrepreneurship is included to support AICTE‟s start-up policy.
viii. In some disciplines, courses have been mentioned in the scheme; it is left to the University/Institution to frame the detailed syllabus as per their need or can find the same in the AICTE model curriculum of some other disciplines in this booklet.
ix. AICTE will ensure the revision of the model curriculum on regular basis and this updation will certainly help students to achieve better employability; start-ups and other avenues for higher studies.

Course Structure & Credit Distribution

A. Definition of Credit:

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week 2 Hours Practical(Lab)/week	0.5 credits 1 credit

B. Range of credits :

A range of credits from 150 to 160 for a student to be eligible to get Under Graduate degree in Engineering. A student will be eligible to get Under Graduate degree with Honors' or additional Minor Engineering, if he/she completes an additional 20 credits. These could be acquired through MOOCs.

C. Course code and definition

Course code	Definitions
BSC	Basic Science Courses
ESC	Engineering Science Courses
HSMC	Humanities and Social Sciences including Management courses

D. Credit distribution in the First year of Undergraduate Engineering program

	Lecture	Tutorial	Laboratory/Practical	Total credits
Chemistry-I	3	1	3	5.5
Physics	3	1	3	5.5
Mathematics-I	3	1	0	4
Mathematics –II	3	1	0	4
Programming for Problem Solving	3	0	4	5
English	2	0	2	3
Engineering Graphics	1	0	4	3
Workshop/ Practical	1	0	4	3
Basic Electrical Engineering	3	1	2	5
Environmental Studies	2	0	0	00

BASIC SCIENCE COURSES

Sr. No.	Course Code	Course Title	Hrs. /Week L: T: P	Credits
1	BSC 101	Mathematics – I	3:1:0	4
2	BSC 102	Physics	3:1:3	5.5
3	BSC 103	Mathematics – II	3:1:0	4
4	BSC 104	Chemistry-I	3:1:3	5.5
				19

ENGINEERING SCIENCE COURSES

Sr. No.	Course Code	Course Title	Hrs. /Week L: T: P	Credits
1	ESC 101	Programming for Problem Solving	3:0:4	5
2	ESC 102	Workshop/Manufacturing Practices	1:0:4	3
4	ESC 103	Engineering Graphics	1:0:4	3
5	ESC 104	Basic Electrical Engineering	3:1:2	5
		Total		16

HUMANITIES & SOCIAL SCIENCES COURSE

Sr. No.	Course Code	Course Title	Hrs. /Week L: T: P	Credits
1	HSMC 101	English	2:0:2	3

MANDATORY COURSE

Sr. No.	Course Code	Course Title	Credits
1	AECC01	Environmental Studies	00

Induction Program

Induction program (mandatory)	2 weeks duration
Induction program for students to be offered right at the start of the first year.	• Physical activity • Creative Arts • Universal Human Values • Literary • Proficiency Modules • Lectures by Eminent People • Visits to local Areas • Familiarization to Dept./Branch & Innovations

Bachelor of Technology-CE

SEVENTH SEMESTER

COURSE		Contact Hours/Week			Credit	% of Total Marks				
Code	**Course Title**	**L**	**T**	**P**		**CA**	**TA**	**Int. Total**	**Ext.**	**Total**
PEC-CEEL401	Elective V	3	0	0	3	20	20	40	60	100
PEC-CEEL403	Elective VI	3	0	0	3	20	20	40	60	100
OEC401	Open Elective-II Suggested (Metro Systems & Engineering)	3	0	0	3	20	20	40	60	100
	Generic Elective	3	0	0	3	20	20	40	60	100
	Online Course, NPTEL								100	100
	General Proficiency	-	-	-	-	-	-	-	-	50
PRACTICALS										
PROJ-CE401	Project-1 (Project work, seminar and internship in industry or at appropriate work place)	0	0	12	6	20	20	40	60	100
Total		**12**	**0**	**12**	**18**					

EIGHTH SEMESTER

COURSE		Contact Hours/Week			Credit	% of Total Marks				
Code	**Course Title**	**L**	**T**	**P**		**CA**	**TA**	**Int. Total**	**Ext.**	**Total**
PECCEEL-402	Elective VII	3	0	0	3	20	20	40	60	100
PECCEEL-402	Elective VIII	2	0	0	2	20	20	40	60	100
OEC- 403	Open Elective-III	3	0	0	3	20	20	40	60	100
OEC- 404	Open Elective-IV	2	0	0	2	20	20	40	60	100
	Generic Elective	3	0	0	3	20	20	40	60	100
	Online Course, NPTEL								100	100
	General Proficiency	-	-	-	-	-	-	-	-	50
PRACTICALS										
PROJ-CS80	Project-2(Continued from VI Semester, Project work, seminar and internship in industry or at appropriate work place)	0	0	12	6	100	100	200	300	500
Total		**13**	**0**	**12**	**19**					

Professional Elective Courses

I	**Transportation Engineering** 1. Pavement Materials 2. Pavement Design 3. Public Transportation Systems 4. Traffic Engineering and Management 5. Urban Transportation Planning. 6. Geometric Design of Highways 7. Airport Planning and Design 8. Railway Engineering 9. Intelligent Transportation Systems 10. Highway Construction and Management 11. Port and Harbour Engineering 12. High Speed Rail Engineering 13. Transportation Economics 14. Infrastructure Planning and Design	II	**Construction Engineering & Management** 1. Construction Productivity 2. Building Construction Practice 3. Construction Project Planning &Systems 4. Construction Cost Analysis 5. Sustainable Construction Methods 6. Construction Engineering Materials. 7. Contracts Management 8. Construction Equipment& Automation 9. Repairs & Rehabilitation of Structures
III	**Environmental Engineering** 1. Ecological Engineering 2. Environmental Systems 3. Transport of Water and Wastewater 4. Environmental Laws and Policy 5. Physico-Chemical Processes for Water and Wastewater Treatment 6. Biological Processes for Contaminant Removal 7. Rural Water Supply and Onsite Sanitation Systems 8. Water and Air Quality Modeling 9. Solid and Hazardous Waste Management 10. Air and Noise Pollution and Control 11. Environmental Impact Assessment and Life Cycle Analyses 12. Sustainable Engineering & Technology	IV	**Hydraulics** 1. Design of hydraulic structures/Irrigation Engineering 2. Pipeline Engineering 3. Open Channel flow 4. River Engineering 5. Hydraulic modelling 6. Basics of computational hydraulics 7. Transients in closed conduits 8. Urban Hydrology and Hydraulics 9. Groundwater
V	**Hydrology & Water Resources Engineering** 1. Water Quality Engineering 2. Surface Hydrology 3. Environmental Fluid Mechanics 4. Water Resources Field Methods	VI	**Structural Engineering** 1. Reliability Analysis of Structures 2. Engineering Risk & Uncertainty 3. Decision and Risk Analysis 4. Engineering Materials for Sustainability 5. Concrete Materials 6. Wood Structures 7. Masonry Structures 8. Structural Analysis-I 9. Structural Analysis-II 10. Advanced Structural Analysis 11. Structural Analysis by Matrix Methods 12. Structural Mechanics 13. Reinforced Concrete 14. Concrete Technology 15. Design of Concrete Structures-I

			16. Design of Concrete Structures-II 17. Prestressed Concrete 18. Design of Steel Structures 19. Metal Structure Behaviour- I 20. Metal Structure Behaviour- II 21. Bridge Engineering 22. Industrial Structures 23. Design of Structural Systems 24. Structural Dynamics 25. Earthquake Engineering 26. Civil Engineering Design-I 27. Civil Engineering Design-II 28. Geographic Information Systems and Science 29. Modelling and Analysis of Uncertainty 30. Systems Engineering & Economics
VII	**Geotechnical Engineering** 1. Soil Mechanics-I 2. Soil Mechanics-II 3. Foundation Engineering 4. Geotechnical Design 5. Structural Geology 6. Offshore Engineering 7. Rock Mechanics 8. Environmental Geo-technology		

Open Elective Courses [OEC]

I	Soft Skills and Interpersonal Communication
II	ICT for Development
III	Human Resource Development and Organizational Behavior
IV	Cyber Law and Ethics
V	Introduction to Philosophical Thoughts
VI	Comparative Study of Literature
VII	Indian Music System
VIII	History of Science & Engineering
IX	Introduction to Art and Aesthetics
X	Economic Policies in India
XI	Metro Systems and Engineering

DETAILED 4th-YEAR CURRICULUMCONTENTS

Undergraduate Degree in School Engineering &Technology

BRANCH/COURSE: CIVIL ENGINEERING

Semester VII (Fourth year] Branch/Course Civil Engineering

Professional Elective Course V

Course Code: PEC-CEEL401 **Course Name: Hydrology & Water Resources Engineering**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

1. **Water Quality Engineering**. Fundamental theory underlying the unit processes utilized in the treatment of water for domestic and industrial usage, and in the treatment of domestic and industrial wastewaters.

2. **Surface Hydrology.** Study of descriptive and quantitative hydrology dealing with the distribution, circulation, and storage of water on the earth's surface; discusses principles of hydrologic processes and presents methods of analysis and their applications to engineering and environmental problems.

3. **Environmental Fluid Mechanics.** Incompressible fluid mechanics with particular emphasis on topics in analysis and applications in civil engineering areas; primary topics include principles of continuity, momentum and energy, kinematics of flow and stream functions, potential flow, laminar motion, turbulence, and boundary-layer theory.

4. **Water Resources Field Methods.** Scientific principles of measurement technologies and protocols used for water-resources measurements and experimental design of field-scale water-resources and environmental studies. Planning field studies; instruments and protocols for surface-water, ground-water, and water-quality sampling; description of data quality. One-half-day laboratory field trips to streamflow monitoring stations and groundwater monitoring wells nearby.

Assessment method: (Continuous Internal Assessment = 40%, Final Examination = 60%)

Assignment -1	- 05%
Assignment -2	- 05%
Assessment-3(Mid-Exam)	- 20%
Assignment-3/Quiz-1	- 05%
Assignment-4	- 05%
Total Internal Assessment	**- 40%**

Professional Elective Course- VI

Course Code: PEC-CEEL403 **Course Name: Structural Engineering**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

1. **Reliability Analysis of Structures.** Role of reliability in civil engineering; Historical background, random events, random variables, model uncertainty; Common probabilistic models; Important statistical parameters and their estimations, normal, lognormal, extreme value distribution; Fundamental concept of structural reliability; Derivation of stress-strength interface equation, graphical representation, Cornel reliability index, reliability and failure probability computations for simple linear functions; Second moment concepts, First order second moment theory, Hasofer-Lind transformation, Linear and non-linear limit state functions, Solution schemes, geometric interpretation of solution scheme, Rackwitz-Fiessler transformation, First order reliability method; Stochastic models for material strength and loads, Reliability assessment of structural componentand simple civil engineering structures. Prerequisite:

2. **Engineering Risk & Uncertainty.** Identification and modeling of non-deterministic problems in civil engineering design and decision making. Development of stochastic concepts and simulation models and their relevance to real design and decision problems in various areas of civil engineering.

3. **Decision and Risk Analysis.** Development of modern statistical decision theory and risk analysis, and application of these concepts in civil engineering design and decision making; Bayesian statistical decision theory, decision tree, utility concepts, and multi-objective decision problems; modeling and analysis of uncertainties, practical risk evaluation, and formulation of risk-based design criteria, risk benefit trade-offs, and optimal decisions.

4. **Engineering Materials for Sustainability.** Environmental impact of materials; life-cycle assessment; material selection to optimize performance; design, evaluation, and production of green construction materials.

5. **Concrete Materials.** Examines the influence of constituent materials (cements, aggregates and admixtures) on the properties of fresh and hardened concrete; Recycled aggregates recovered from construction and demolition wastes; M-Sand; Light-weight aggregates; Use of Fly Ash in concrete; Fibre-reinforced concrete with various types of metallic and non-metallic fibres; various types of concrete such as Self Compacting Concrete, High Performance Concrete, etc.; mix design; handling and placement of concrete; Effect of revibration of concrete; behavior of concrete under varioustypes of loading and environment; test methods. Laboratory practice is an integral part of the course.

6. **Wood Structures.** Mechanical properties of wood, stress grades and working stresses; effects of strength- reducing characteristics, moisture content, and duration of loading and causes of wood deterioration; glued- laminated timber and plywood; behavior and design of connections, beams, and beam-columns; design of buildings and bridges; other structural applications: trusses, rigid frames, arches, and pole-type buildings; and prismatic plates and hyperbolic paraboloids.

7. **Structural Dynamics.** Analysis of the dynamic response of structures and structural components to transient loads and foundation excitation; single-degree-of-freedom and multi-degree-of-freedom systems; response spectrum concepts; simple inelastic structural systems; and introduction to systems with distributed mass and flexibility.

8. **Earthquake Engineering.** Theory of Vibrations; Concept of inertia and damping - Types of Damping - Difference between static forces and dynamic excitation - Degrees of freedom - SDOF idealization - Equations of motion of SDOF system for mass as well as base excitation Free vibration of SDOF system - Response to harmonic excitation - Impulse and response to unit impulse -Duhamel integral; Multiple Degree of Freedom System; Two degree of freedom system - Normal modes of vibration - Natural frequencies - Mode shapes - Introduction to MDOF systems - Decoupling of equations of motion - Concept of mode superposition (No derivations); Elements of Seismology; Causes of Earthquake - Geological faults - Tectonic plate theory - Elastic rebound – Epicentre; Hypocentre - Primary, shear and Raleigh waves - Seismogram - Magnitude and intensity of earthquakes - Magnitude and Intensity scales - Spectral Acceleration - Information on some disastrous earthquakes; Response of Structures to Earthquake;Response and design spectra - Design earthquake - concept of peak acceleration - Site specific response spectrum - Effect of soil properties and damping - Liquefaction of soils - Importance of ductility - Methods of introducing ductility into RC structures Design Methodology IS 1893, IS 13920 and IS 4326 - Codal provisions - Design as per the codes - Base isolation techniques - Vibration control measures - Important points in mitigating effects of earthquake on structures

9. **Industrial Structures.** Industrial steel building frames: Types of frames, bracing, crane girders and columns, workshop sheds, trussed bents, Pressed steel tank, circular tank; Transmission and Communication towers: Types and configuration, Analysis and design; Chimneys; Loads and stresses in chimney shaft, Earthquake and wind effect, Stresses due to temperature difference, combined effect of loads and temperature, temperature. Design of chimney; Silos and Bunkers; Jassen's theory, Airy's theory, Shallow and deep bins, Rectangular bunkers with slopping bottom, Rectangular bunkers with high side walls; Steel stacks; introduction, force acting on a steel stack, design consideration, design example of stacks; Concrete Shell Structures: Folded plate and cylindrical shell structures; Introduction, structural behaviour of long and short shells, beam and archaction, analysis and design of cylindrical shell structures, Analysis and design of folded plates; Machine foundations; introduction, machine vibration, structural design of foundation to rotary machines, impact machines, vibration characteristics, design consideration of foundation to impact machine, grillage, pile and raft foundation.

10. **Prestressed Concrete.** Study of strength, behavior, and design of prestressed reinforced concrete members and structures, with primary emphasis on pretensioned, precast construction; emphasis on the necessary coordination between design and construction techniques in prestressing.

11. **Design of Structural Systems.** The whole structural design process including definition of functional requirements, selection of structural scheme, formulation of design criteria, preliminary and computer- aided proportioning, and analysis of response, cost, and value.

12. **Bridge Engineering.** General; classification of bridges, site selection, geometric and hydraulic design consideration, loading standards for highway and railway bridges, general design consideration; optimum spans; Concrete bridges: culverts; Slab, T-beam, box girder bridges, balanced cantilever bridge, cable stayed bridge, extrados bridges; arch bridge; Special requirements for Prestressed Concrete bridges; Steel bridges: plate girder bridge, truss bridge, suspension cable bridge, cable stayed bridge; Substructures: design of piers and abutments, pile and well foundations, bearings and expansion joints, special wearing coats; seismic design considerations; Aerodynamic stability considerations; special durability measures; provisions for inspection and maintenance;

13. **Design of Concrete Structures-I.** Study of the strength, behavior, and design of indeterminate reinforced concrete structures, Load and stresses, load combinations, Working stress and limit state approach. Analysis and design of sections in bending – working stress and limit state method, Rectangular and T-sections, Beams with reinforcement in compression, One-way slab. Design for shear and bond, Mechanism of shear and bond failure, Design of shear using limit state concept, Development length of bars; Design of sections in torsion. Design of two-way slabs; Design of flat slab – direct method; Circular slab; Slab type staircase, Placement of reinforcement in slabs; Voided slab. Design of compression members, Short column, Columns with uni-axial and bi-axial bending; Long columns, use of design charts. Design of foundation; Wall footing, Isolated and combined footing for columns. All designs to be as per the most recent BIS standards as applicable Prerequisite:

14. **Design of Concrete Structures-II.** Design of continuous beams and building frames, Moment redistribution, Estimation of wind and seismic loads, Desirable features of earthquake resistant construction, Detailing for earthquake resistant construction – ductility criteria; Water tank and staging; Introduction, Design criteria, Design of rectangular and circular water tank, Design of Intze tank, Staging for overhead tank; Introduction to bridge engineering, Investigation for bridges, IRC loadings, Design of slab culvert; Design of Masonry walls and columns; Pre-stressed concrete, Introduction, pre-stressing system, losses in pre-stress, Design of simple span girders, Design of end block; Design of staircases; Design of cantilever and counter-forte type retaining wall; All design steps/process to as per the most recent BIS code of practices

15. **Reinforced Concrete.** Study of the strength, behavior, and design of reinforced concrete members subjected to moments, shear, and axial forces; extensive discussion of the influence of the material properties on behavior.

16. **Concrete Technology.** Concrete; Properties of ingredients, tests, Production of concrete, mixing, compaction curing, Properties of fresh concrete; Defects in Concrete, Concrete additives.; Behavior of concrete in tension and compression, shear and bond, Influence of various factors on test results, Time dependent behavior of concrete -creep, shrinkage and fatigue; Concrete mix design; Proportioning of concrete mixes, basic considerations, cost specifications, factors in the choice of mix proportion, different method of mix design. Quality control, Behavior of concrete in extreme environment; temperature problem in concreting, hot weather, cold weather and under water conditions, Resistance to freezing, sulphate and acid attack, efflorescence, fire resistance; Inspection and testing of concrete-Concrete cracking, types of cracks, causes and remedies Non-destructive tests on concrete; Chemical tests on cement and aggregates; Special concrete; types and specifications, Fibre reinforced and steel Fibre reinforced concrete, Polymer concrete, Use of admixtures; Deterioration of concrete and its prevention Repair and rehabilitation.

17. **Design of Steel Structures.** Properties of materials; loads and stresses, Design of semi-rigid, rigid and moment resistant connections; Built-up sections Design of tension members subjected to axial tension and bending, splicing of tension member, Design of compression members, Beam-column connections, Design of columns and their bases Design of flexural members and Plate girder; loads, specification and design Industrial buildings; loads, design of purlins, trusses, bracings; gantry girders; Introduction to Plastic analysis; Simple cases of beams and frames; All design steps/process to as per the most recent BIS code of practices Prerequisite:

18. **Metal Structure Behavior- I**. Introduction to the design of metal structures; behavior of members and their connections; and theoretical, experimental, and practical bases for proportioning members and their connections.

19. **Metal Structure Behavior-II.** Metal members under combined loads; connections, welded and bolted; moment- resistant connections; plate girders, conventional behavior, and tension field action.

20. **Structural Mechanics.** Beams under lateral load and thrust; beams on elastic foundations; virtual work and energy principles; principles of solid mechanics, stress and strain in three dimensions;static stability theory; torsion; computational methods.

21. **Advanced Structural Analysis.** Elasticity: Introduction, Components of strain and strain, Hooke's law, Plane stress and plane strain, Equations of equilibrium and compatibility, Boundary conditions, Two dimensional problems in rectangular and polar coordinates, Bending of simple and cantilever beams; Model Analysis: Structural similitude, Direct and indirect model analysis, Model material and model making, Measurement for forces and deformations; Introduction to Finite element method for structural analysis; Review of principle of virtual work, Ritz method, Discretization of domain, Basic element shape, Discretization process; Application of finite element method to one and two- dimensional plane stress strain elements.

22. **Structural Analysis-I.** Direct stiffness method of structural analysis; fundamentals and algorithms; numerical analysis of plane trusses, grids and frames; virtual work and energy principles; introduction to the finite element method for plane stress and plane strain.

23. **Structural Analysis-II.**Analysis of building frames; Kani's, moment distribution and other methods and Approximate methods; Stiffness matrix method; Application to simple problems of beams and frames; Flexibility matrix method; Application to simple problems of beams and frames; Moving loads for determinate beams; Different load cases, Influence lines for forces for determinate beams; Influence lines for pin-jointed trusses; Influence lines for indeterminate beams using Muller Breslau principle. Influence lines for Arches and stiffening girders.

24. **Structural Analysis by Matrix Methods.** Analysis of truss and frame structures using flexibility and stiffness methods of matrix analysis; computer applications.

25. **Masonry Structures.** Introduction to analysis, design and construction of masonry structures. Mechanical properties of clay and concrete masonry units, mortar, and grout. Compressive, tensile, flexural, and shear behavior of masonry structural components. Strength and behavior of unreinforced bearing walls. Detailed design of reinforced masonry beams, columns, structural walls with and without openings, and complete lateral-force resisting building systems.

26. **Civil Engineering Design -I.** Concept of design and its contribution to the quality of life; Civil Engineering Design, the role of geomatics, the environment, and scientific laws in design; Introduction to the design of buildings and Civil Engineering Infrastructure, site appraisal; Risk and vulnerability in design; Health and safety in Civil Engineering Design, environmental impact assessment; Civil Engineering drawing, CAD techniques, introduction to GIS techniques.

27. **Civil Engineering Design-II.**Innovation and creativity in conceptual design; sustainability; health and safety; investigative procedures. The use of analysis, synthesis and optimization in design; project planning, networks and graphs. Design of embankments, dams; drainage design; route location and alignment design of roads; assessment of natural hazard impacts and environmental impacts.

28. **Geographic Information Systems and Science.** Investigation of geographic information systems (GIS) and science (GIScience) including theory and applications areas. A major portion of the course will be based on use of a current widely-used GIS computer software system. Aspects of geographic data entry and editing, spatial analysis, and map development and display will be considered. Relationship of GIS to the Global Positioning System (GPS) and satellite generated data will be addressed.

29. **Modeling and Analysis of Uncertainty.** Appreciation and understanding of uncertainties and the conditions under which they occur, within the context of the engineering problem-solving pedagogy of measurements, models, validation, and analysis. Problems and concerns in obtaining measurements; tabular and graphical organization of data to minimize misinformation and maximize information; and development and evaluation of models. Concepts will be supported with computer demonstration. Applications to problems in engineering are emphasized.

30. **Systems Engineering & Economics:** Introduction to the formulation and solution of civil engineering problems. Major topics are: engineering economy, mathematical modeling, and optimization. Techniques, including classical optimization, linear and nonlinear programming, network theory, critical path methods, simulation, decision theory, and dynamic programming are applied to a variety of civil engineering problems.

Assessment method: (Continuous Internal Assessment = 40%, Final Examination = 60%)

Assignment -1	- 05%
Assignment -2	- 05%
Assessment-3(Mid-Exam)	- 20%
Assignment-3/Quiz-1	- 05%
Assignment-4	- 05%
Total Internal Assessment	**- 40%**

Open Elective-II

Course Code: OEC-401 **Course Name: Metro Systems and Engineering**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

GENERAL: Overview of Metro Systems; Need for Metros; Routing studies; Basic Planning and Financials

CIVIL ENGINEERING-Overview and construction methods for: Elevated and underground Stations; Viaduct spans and bridges; Underground tunnels; Depots; Commercial and Service buildings. Initial Surveys & Investigations; Basics of Construction Planning & Management, Construction Quality & Safety Systems. Traffic integration, multimodal transfers and pedestrian facilities; Environmental and social safeguards; Track systems-permanent way. Facilities Management

ELECTRONICS AND COMMUNICATION ENGINEERING- Signalling systems; Automatic fare collection; Operation Control Centre (OCC and BCC); SCADA and other control systems; Platform Screen Doors.

MECHANICAL & TV + AC: Rolling stock, vehicle dynamics and structure; Tunnel Ventilation systems; Air conditioning for stations and buildings; Fire control systems; Lifts and Escalators

ELECTRICAL: OHE, Traction Power; Substations- TSS and ASS; Power SCADA; Standby and Back-up systems; Green buildings, Carbon credits and clear air mechanics

Assessment method: (Continuous Internal Assessment = 40%, Final Examination = 60%)

Assignment -1	- 05%
Assignment -2	- 05%
Assessment-3(Mid-Exam)	- 20%
Assignment-3/Quiz-1	- 05%
Assignment-4	- 05%
Total Internal Assessment	**- 40%**

Professional Elective Course- VII

Course Code: PEC-CEEL402 **Course Name: Geotechnical Engineering**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

1. **Soil Mechanics-I.** Composition and structure of soil; water flow and hydraulic properties; stress in soil; compaction and compressibility of soils; consolidation characteristics, settlement analysis; shear strength of soils; basics of unsaturated soils; experimental measurements.

Reference books:

1. Soil Mechanics by Craig R.F., Chapman & Hall
2. Principles of Geotechnical Engineering, by Braja M. Das, Cengage Learning

On successful completion of this course, the students:

- Should be able to assess soil behavior with the mineralogy present and advanced soil testingof soils such as in thermal, chemical, magnetic fields.
- Should be able to do seepage analysis for finding discharge calculation and stability ofstructure.

Should have knowledge about stress paths and get introduced to critical state soilmechanics

- Should be in a position to do various laboratory experiments to determine design parametersaccording field application.

2. **Soil Mechanics-II.** Application of soil mechanics to determine earth pressures, analysis of retaining walls, cuts & excavations and sheet piles, stability of slopes, instrumentation. Prerequisite:

Reference books:

1. Soil Mechanics by Craig R.F., Chapman & Hall
2. Principles of Geotechnical Engineering, by Braja M. Das, Cengage Learning

On successful completion of this course, the students:

- Should be able design retaining wall subjected to various loads with the knowledge of earthpressure theories.
- Should be able to design sheet pile wall with different methods.
- Should get familiarized with different construction practices for excavation with advantagesand disadvantages of each method.
- Should be able to determine the safety analysis for slopes with different methods proposed inthe syllabus.
- Should get introduced with the commercial softwares for analyzing the stability of slopes andretaining walls.

3. **Geotechnical Design.** Subsurface site evaluation; integrated design of retaining walls, foundations, pavements, and materials for airports, highways, dams, or other facilities. Prerequisite:

Reference books:

1. Analysis and Design of Substructures: Limit State Design by Swami Saran

Upon completion of the course, the student would be:

- Well acquainted with the various investigation specifications as per the infrastructure to be buildon the proposed site.
- knowing about the properties of materials required for the constructing a desired infrastructure
- familiar with design concepts of various foundation systems familiar with design of transportation facilities

4. Structural Geology. Description, classification, and origin of earth structures. Ways in which the continental crust can deform; link scales of structure from the field, outcrops, hand specimen, thin section by integrating analytical techniques with practical examples. Theoretical and meso to microscale analysis of structures developed through a linked series of lectures and practicals; practical 2D strain analysis; 3D strain concepts; incremental strain, kinematics and polyphase deformations; fold construction and classes; fault evolution and section balancing; fault rock microstructures; fault and fold mechanics, current concepts in plate tectonics, cross-section construction techniques, structural interpretation of seismic data, structural styles in different tectonic settings (thrust and fold belts, rifts, strike and slip, gravity tectonics, inversion), structural geology of reservoir units.

Reference books:

1. Ghosh, S.K., Structural Geology: Fundamentals and Modern Developments, Elsevier; First edition

On successful completion of this course the students will be able to:

- Acquire knowledge on the geometry and type of structures present in earth.
- Understand and describe the features formed in rocks when subjected to stress.
- Understand the impact of structural geology to active tectonic settings
- Understand micro and macro scale deformation mechanisms (viz., brittle, ductile).Portray 2D and 3D strain analysis for various deformation behaviours.
- Interpret graphs and models used in structural geology to understand and demonstratepoly phase deformations.

5. **Offshore Engineering.** Introduction to offshore structures, codes of practice, offshore project management, deep water, offshore site investigations, geophysical methods; offshore sediment sampling, in-situ testing, geological aspects; development of design stratigraphies.

6. **Rock Mechanics.** Determination of physical properties of rocks, failure criterion, rock mass classification, stress around mine openings, strain and displacement of the rock mass, rock reinforcement and support, subsidence.

Reference books:

1. Engineering Rock Mechanics: An Introduction to the Principles by J. A. Hudson and J. P.Harrison
2. Rock Mechanics: For Underground Mining by Barry H.G. Brady
3. Fundamentals of Rock Mechanics, 4th Edition, John Conrad Jaeger, Neville G. W. Cook, RobertZimmerman

On successful completion of this course the students will be able to:

- Define the properties (viz., physical, mechanical) of rocks and failure criterion of rock mass.
- Use engineering rock mass classification (RMR, Q-system, RQD)
- Analyse the stress distribution insitu and around an opening in underground structures (viz.,mine openings, tunnels).
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- Determine the relation between strain and displacement components of rock mass.
- Perform field Instrumentation techniques and laboratory studies.
- Understand the fundamentals of ground subsidence.

7. **Foundation Engineering.** Analysis and design of foundations, types of foundations, bearing capacity and settlement of foundations; ground movements due to construction; analysis and design of excavations, retaining walls, cuts & excavations and sheet piles, slopes and underground structures.

Reference books:

1. A. Singh, Modern Geotechnical Engineering, 3rd Ed., CBS Publishers, New Delhi, 1999.
2. B.M. Das, Principles of Foundation Engineering, 5th Ed., Thomson Asia, Singapore, 2003.
3. N. Som, Theory and Practice of Foundation Design, Prentice Hall, New Delhi, 2003.

After successful completion of this course, the students would:

- learn about types and purposes of different foundation systems and structures. Havean exposure to the systematic methods for designing foundations.
- Be able evaluate the feasibility of foundation solutions to different types of soil conditionsconsidering the time effect on soil behaviour.
- have necessary theoretical background for design and construction of foundation systems.

Assessment method: (Continuous Internal Assessment = 40%, Final Examination = 60%)

Assignment -1	- 05%
Assignment -2	- 05%
Assessment-3(Mid-Exam)	- 20%
Assignment-3/Quiz-1	- 05%
Assignment-4	- 05%
Total Internal Assessment	**- 40%**