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

FIFTH SEMESTER

COURSE		Contact Hours/Week			Credit	% of Total Marks				
Code	**Course Title**	**L**	**T**	**P**		**CA**	**TA**	**Int. Total**	**Ext.**	**Total**
PCC-CE301	Mechanics of Materials	3	0	0	3	20	20	40	60	100
PCC-CE302	Hydraulic Engineering	2	0	0	2	20	20	40	60	100
PCC-CE303	Structural Engineering	2	1	0	3	20	20	40	60	100
PCC-CE304	Geotechnical Engineering	2	0	0	2	20	20	40	60	100
PCC-CE305	Hydrology & Water Resources Engineering	2	2	0	4	20	20	40	60	100
PCC-CE306	Environmental Engineering	2	2	0	4	20	20	40	60	100
PCC-CE307	Transportation Engineering	2	0	0	2	20	20	40	60	100
HSMC255	Professional Practice, Law & Ethics	2	0	0	2	20	20	40	60	100
MC-1	Constitution of Constitution of India/ Essence of Indian Traditional Knowledge	-	-	-	0	20	20	40	60	100
	Generic Elective	3	-	-	3	20	20	40	60	100
	Online Course, NPTEL								100	100
	General Proficiency	-	-	-	-	-	-	-	-	50
PRACTICALS										
PCC-CE302P	Hydraulic Engineering	0	0	2	1	20	20	40	60	100
PCC-CE304P	Geotechnical Engineering	0	0	2	1	20	20	40	60	100
PCC-CE307P	Transportation Engineering	0	0	2	1	20	20	40	60	100
PCC-CE303P	Structural Engineering	0	0	2	1	20	20	40	60	100
Total		**20**	**5**	**8**	**29**					

SIXTH SEMESTER

COURSE		Contact Hours/Week			Credit	% of Total Marks				
Code	**Course Title**	**L**	**T**	**P**		**CA**	**TA**	**Int. Total**	**Ext.**	**Total**
PCC-CE308	Construction Engineering &Management	2	1	0	3	20	20	40	60	100
PCC-CE309	Engineering Economics, Estimation & Costing	2	1	0	3	20	20	40	60	100
PEC-CEEL302	Elective I	3	0	0	3	20	20	40	60	100
PEC-CEEL304	Elective II	3	0	0	3	20	20	40	60	100
OEEL302	Open Elective-I (Humanities)	3	0	0	3	20	20	40	60	100
PEC-CEEL306	Elective-III	3	0	0	3	20	20	40	60	100
PEC-CEEL308	Elective-IV	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										
PCC-CE309P	Engineering Economics, Estimation & Costing	0	0	4	2	20	20	40	60	100
Total		**22**	**2**	**4**	**26**					

****The marks will be awarded on the basis of 06 weeks industrial training conducted after 4thsemester**

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 3rd-YEAR CURRICULUMCONTENTS

Undergraduate Degree in School Engineering &Technology

BRANCH/COURSE: CIVIL ENGINEERING

Semester V (Third year] Branch/Course Civil Engineering

Course Code: PCC-CE301 **Course Name: Mechanics of Materials**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

Course Objectives:

The objectives of this course is to impart knowledge of

- Resolution of forces, equilibrium of force systems consisting of static loads
- Obtaining centroids and moments of inertia for various regular and irregular areas.
- Various forces in the axial force members, and to analysis the trusses using various methods,
- Concept of friction for single and connected bodies.
- Basic concepts of dynamics, their behavior, analysis and motion bodies
- Work energy principles and impulse momentum theory and applications to problem solving

Course Description:

After completing this course, the student will be able to:

1. Apply the fundamental concepts of forces, equilibrium conditions for static loads.
2. Determine the centroid and moment of inertia for various sections.
3. Analyse forces in members of a truss using method of joints and method of sections, analyse frictionfor single and connected bodies.
4. Apply the basic concepts of dynamics, their behavior, analysis and motion bodies.
5. Solve problems involving work energy principles and impulse momentum theory.

Proposed Syllabus

Module 1: *Deformation and Strain covering* description of finite deformation, Infinitesimal deformation; Analysis of statically determinate trusses; Stability of dams, retaining walls and chimneys; Stress analysis ofthin, thick and compound cylinder;

Module 2: *Generalized state of stress and strain:* Stress and strain tensor, Yield criteria and theories of failure; Tresca, Von-Mises, Hill criteria, Heigh-Westerguard's stress space.

Module 3:*Momentum Balance and Stresses covering* Forces and Moments Transmitted by Slender Members, Shear Force and Bending Moment Diagrams, Momentum Balance, Stress States / Failure Criterion

Module 4:*Mechanics of Deformable Bodies covering* Force-deformation Relationships and Static Indeterminacy, Uniaxial Loading and Material Properties, Trusses and Their Deformations, Statically Determinate and Indeterminate Trusses,

Module 5:*Force-Stress-Equilibrium covering* Multiaxial Stress and Strain

Module 6: *Displacement – Strain covering* Multiaxial Strain and Multiaxial Stress-strain Relationships

Module 7: *Elasticity and Elasticity Bounds covering*Stress-strain-temperature Relationships and Thin-walled Pressure Vessels,Stress and strain Transformations and Principal Stress, Failure of Materials,

Module 8:*Bending: Stress and Strains; Deflections and Torsion covering* Pure Bending, Moment-curvature Relationship, Beam Deflection, Symmetry, Superposition, and Statically Indeterminate Beams, Shear and Torsion, Torsion and Twisting, Thermoelasticity, Energy methods, Variational Methods; Strain energy, elastic, complementary and total strain energy, Strain energy of axially loaded bar, Beam in bending, shear and torsion; General energy theorems, Castigliano's theorem, Maxwell Bettie's reciprocal theorem; Virtual work and unit load method for deflection, Application to problems of beams and frames.

Module 9:*Structural stability;* Stability of columns, Euler's formula, end conditions and effective length factor, Columns with eccentric and lateral load; Plasticity and Yield Design covering 1D-Plasticity – An Energy Approach, Plasticity Models, Limit Analysis and Yield Design

Text/Reference Books:

i) Norris, C.H. and Wilber, J. B. and Utku, S. "Elementary Structural Analysis" Mc Graw Hill, Tokyo, Japan.
ii) Timoshenko, S. and Young, D. H., "Elements of Strength of Materials", DVNC, New York, USA.
iii)Kazmi, S. M. A., 'Solid Mechanics" TMH, Delhi, India.
iv) Hibbeler, R. C. Mechanics of Materials. 6th ed. East Rutherford, NJ: Pearson Prentice Hall, 2004
v) Crandall, S. H., N. C. Dahl, and T. J. Lardner. An Introduction to the Mechanics of Solids. 2nd ed. New York, NY: McGraw Hill, 1979
vi) Gere, J. M., and S. P. Timoshenko. *Mechanics of Materials.* 5th ed. Boston: PWS Kent Publishing, 1970.
vii) Ashby, M. F., and D. R. H. Jones. *Engineering Materials, An Introduction to their Properties and Applications.* 2nd ed. Butterworth Heinemann.
viii) Collins, J. A. *Failure of Materials in Mechanical Design.* 2nd ed. John Wiley & Sons, 1993.
ix) Courtney, T. H. *Mechanical Behavior of Materials.* McGraw-Hill, 1990.
x) Hertzberg, R. W. *Deformation and Fracture Mechanics of Engineering Materials.* 4th ed. JohnWiley & Sons, 1996.
xi) Nash, W. A. *Strength of Materials.* 3d ed. Schaum's Outline Series, McGraw-Hill, 1994.

Course Learning Outcomes (CLOs): -

- an ability to apply knowledge of mathematics, science, and engineering
- an ability to design a system, component, or process to meet desired needs
- an ability to identify, formulate, and solve engineering problems
- the broad education necessary to understand the impact of engineering solutions in a global and societal context
- an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.
- an ability to apply principles of engineering, basic science, and math to model, analyze, design and realize physical systems, components or processes

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%**

Course Code: PCC-CE302 **Course Name: Hydraulic Engineering**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

Course Objectives:
The objectives of this course is to impart knowledge of

1. Study the concept of the flow through channels and economical design of channels.
2. Understand the boundary layer theory, concept of drag, lift of streamlined bodies
3. Understand the basics of dimensional analysis and development of non-dimensional equations
4. To understand the basic principles of the hydraulic turbines, pumps and their hydraulic design.

Course Description:
After completing this course, the student will be able to:

1. Ability to solve open channel flow problems through the selection and use of appropriate Equations
2. Knowledge of Boundary layer thickness and applications of Drag and lift on some case studies
3. Ability to perform dimensional analysis for problems in fluid mechanics and develop model studies.
4. Understanding of basics of the hydro-machinery and the components, functions and use of different types of turbines and pumps.
5. Able to prepare the characteristic curves and Assimilation of turbine/pump laws and constants for the hydraulic design

Module 1: Laminar Flow- Laminar flow through: circular pipes, annulus and parallel plates.Stoke's law, Measurement of viscosity.

Module 2: Turbulent Flow- Reynolds experiment, Transition from laminar to turbulent flow. Definitionof turbulence, scale and intensity, Causes of turbulence, instability, mechanism of turbulence and effect of turbulent flow in pipes. Reynolds stresses, semi-empirical theories of turbulence, Prandtl's mixing length theory, universal velocity distribution equation. Resistance to flow of fluid in smooth and rough pipes, Moody's diagram.

Module 3:Boundary Layer Analysis-Assumption and concept of boundary layer theory. Boundary-layer thickness, displacement, momentum & energy thickness, laminar and Turbulent boundary layers on a flat plate; Laminar sub-layer, smooth and rough boundaries. Local and average friction coefficients. Separation and Control.

Module 4: Dimensional Analysis and Hydraulic Similitude: Dimensional homogeneity, Rayleigh method, Buckingham's Pi method and other methods. Dimensionless groups. Similitude, Model studies, Types of models. Application of dimensional analysis and model studies to fluid flow problem.

Module 5: Introduction to Open Channel Flow-Comparison between open channel flow and pipe flow, geometrical parameters of a channel, classification of open channels, classification of open channel flow, Velocity Distribution of channel section.

Module 6: Uniform Flow-Continuity Equation, Energy Equation and Momentum Equation, Characteristics of uniform flow, Chezy's formula, Manning's formula. Factors affecting Manning's Roughness Coefficient "n .*Most economical section of ch*annel. Computation of Uniform flow, Normal depth.

Module 7 : Non-Uniform Flow- Specific energy, Specific energy curve, critical flow, discharge curve Specific force Specific depth, and Critical depth. Channel Transitions. Measurement of Discharge and Velocity – Venturi Flume, Standing Wave Flume, Parshall Flume, Broad Crested Weir. Measurement of Velocity- Current meter, Floats, Hot-wire anemometer. Gradually Varied Flow-Dynamic Equation of Gradually Varied Flow, Classification of channel bottom slopes, Classification of surface profile, Characteristics of surface profile. Computation of water surface profile by graphical, numerical and analytical approaches. Direct Step method, Graphical Integration method and Direct integration method.

Module 8: Hydraulic Jump- Theory of hydraulic jump, Elements and characteristics of hydraulic jump in a rectangular Channel, length and height of jump, location of jump, Types,applications and location of hydraulic jump. Energy dissipation and other uses, surge as a moving hydraulic jump. Positive and negative surges. Dynamics of Fluid Flow-Momentum principle, applications: Force on plates, pipe bends, momentsof momentum equation.

Module 9: Flow through Pipes: Loss of head through pipes, Darcy-Wiesbatch equation, minor losses, total energy equation, hydraulic gradient line, Pipes in series, equivalent pipes, pipes in parallel, flow through laterals, flows in dead end pipes, siphon, power transmission through pipes, nozzles. Analysis of pipe networks: Hardy Cross method, water hammer in pipes and control measures, branching of pipes, three reservoir problem.

Module 10: Computational Fluid Dynamics: Basic equations of fluid dynamics, Grid generation, Introduction to in viscid incompressible flow, Boundary layer flow as applicable to C.F.D. Hydro informatics: Concept of hydro informatics –scope of internet and web based modeling in water resources engineering.

Practical Work:

i) Flow Visualization
ii) Studies in Wind Tunnel
iii) Boundary Layer
iv) Flow around an Aerofoil / circular cylinder
v) Uniform Flow
vi) Velocity Distribution in Open channel flow
vii) Venturi Flume
viii) Standing Wave Flume
ix) Gradually Varied Flow
x) Hydraulic Jump
xi) Flow under Sluice Gate
xii) Flow through pipes
xiii) Turbulent flow through pipes
xiv) Flow visualization
xv) Laminar flow through pipes
xvi) Major losses / Minor losses in pipe

Text/Reference Books:

i) Hydraulics and Fluid Mechanics, P.M. Modi and S.M. Seth, Standard Book House
ii) Theory and Applications of Fluid Mechanics, K. Subramanya, Tata McGraw Hill.
iii) Open channel Flow, K. Subramanya, Tata McGraw Hill.
iv) Open Channel Hydraulics, Ven Te Chow, Tata McGraw Hill.
v) Burnside, C.D., "*Electromagnetic Distance Measurement*," Beekman Publishers, 1971.

Course Learning Outcomes (CLOs):

- The students will be able to apply their knowledge of fluid mechanics in addressing problems in open channels.
- They will possess the skills to solve problems in uniform, gradually and rapidly varied flows in steady state conditions.
- They will have knowledge in hydraulic machineries (pumps and turbines).

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%**

Course Code: PCC-CE303 **Course Name: Structural Engineering**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

Course Objectives:
The objectives of this course is to impart knowledge of

1. Know the IS codal provisions as applicable for the designs.
2. Understand the design philosophies and basics of RCC structural designs
3. Understand the design principles in flexure, shear and torsion.
4. Learn the design of various components of RCC structures.

Course Description:
The students will be able to

1. Apply their knowledge of structural mechanics in addressing design problems of structural engineering
2. They will possess the skills to solve problems dealing with different loads and Concrete and steel
3. They will have knowledge in structural engineering

Module 1: Introduction- concepts of energy principles, safety, sustainable development in performance; what makes a structure; principles of stability, equilibrium; what is a structural engineer, role of engineer, architect, user, builder; what are the functions' what do the engineers design, first principlesof process of design

Module 2: Planning and Design Process; Materials, Loads, and Design Safety; Behaviour and Properties of Concrete and Steel; Wind and Earthquake Loads

Module 3: *Materials and Structural Design Criteria:* Introduction to the analysis and design of structural systems. Analyses of determinate and indeterminate trusses, beams, and frames, and design philosophies for structural engineering. Laboratory experiments dealing with the analysis of determinate and indeterminate structures;

Module 4: *Design of Structural Elements;* Concrete Elements, Steel Elements, Structural Joints; Theories and concepts of both concrete and steel design and analysis both at the element and system levels. Approximate Analysis Methods as a Basis for Design; Design of Reinforced Concrete Beams forFlexure; Design of Reinforced Concrete Beams for Shear; Bond, Anchorage, and Serviceability; Reinforced Concrete Columns; Reinforced Concrete Slabs; Introduction to Steel Design; Tension Members and Connections; Bending Members; Structural Systems

Module 5: *System Design Concepts;* Special Topics that may be Covered as Part of the Design Project Discussions; Cable Structures; Prestressed Concrete Bridges; Constructability and Structural Control; Fire Protection

Text/Reference Books:

i) Nilson, A. H. *Design of Concrete Structures.* 13th edition. McGraw Hill, 2004

ii) McCormac, J.C., Nelson, J.K. Jr., *Structural Steel Design*. 3rd edition. Prentice Hall,N.J., 2003.

iii) Galambos, T.V., Lin, F.J., Johnston, B.G., *Basic Steel Design with LRFD*, PrenticeHall, 1996

iv) Segui, W. T., *LRFD Steel Design*, 2nd Ed., PWS Publishing, Boston.

v) Salmon, C.G. and Johnson, J.E., *Steel Structures: Design and Behavior*, 3rd Edition, Harper & Row, Publishers, New York, 1990.

vi) MacGregor, J. G., *Reinforced Concrete: Mechanics and Design*, 3rd Edition, Prentice Hall, New Jersey, 1997.

vii) Nawy, E. G., *Reinforced Concrete: A Fundamental Approach*, 5th Edition, PrenticeHall, New Jersey.

viii) Wang C-K. and Salmon, C. G., *Reinforced Concrete Design*, 6th Edition, Addison Wesley, New York.

ix) Nawy, E. G. *Prestressed Concrete: A Fundamental Approach*, Prentice Hall, NJ,(2003).
x) Related Codes of Practice of BIS
xi) Smith, J. C., *Structural Analysis*, Harpor and Row, Publishers, New York.
xii) W. McGuire, R. H. Gallagher and R. D. Ziemian. "Matrix Structural Analysis", 2nd Edition, John Wiley and Sons, 2000.
xiii) NBC, *National Building Code*, BIS (2017).
xiv) ASCE, *Minimum Design Loads for Buildings and Other Structures, ASCE 7-02*, American Society of Civil Engineers, Virginia, 2002.

Course Learning Outcomes (CLOs):

- The students will be able to apply their knowledge of structural mechanics in addressing design problems of structural engineering.
- They will possess the skills to solve problems dealing with different loads and concrete and steel
- They will have knowledge in structural engineering

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%**

Course Code: PCC-CE304 **Course Name: Geotechnical Engineering**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

Course Objectives
The objectives of this course is to impart knowledge of

1. Introduction of Particulate Mechanics further to the solid and fluid mechanics
2. Characterization and classification of soils based on laboratory and field experiments
3. Understand Seepage, Strength and Compressibility characteristics of soils and learn the analysis of applications involving them

Course Description:
After completing this course, the student will be able to:

1. Competence in understanding the soil and the mechanisms associated with it.
2. Ability to analyze the systems involving soil mechanics
3. Competence for application of principles of soil mechanics in Foundation Engineering to be learned in the next semester.

Module 1: *Introduction*–Types of soils, their formation and deposition, Definitions: soil mechanics, soil engineering, rock mechanics, geotechnical engineering. Scope of soil engineering. Comparison and difference between soil and rock. Basic Definitions and Relationships-Soil as three-phase system in terms of weight, volume, voids ratio, and porosity. Definitions: moisture content, unit weights, degree of saturation, voids ratio, porosity, specific gravity, mass specific gravity, etc. Relationship between volume weight, voids ratio- moisture content, unit weight- percent air voids, saturation-moisture content, moisture content-specific gravity etc. Determination of various parameters such as: Moisture content by oven dry method, pycnometer, sand bath method, torsional balance method,nuclear method, alcohol method and sensors. Specific gravity by density bottle method, pycnometer method, measuring flask method. Unit weight by water displacement method, submerged weight method, core-cutter method, sand-replacement method.

On completion of this module, the students must be able to:

- Understand the different types of soil based on their formation mechanism;
- Understand the various phase diagrams and derive various phase relationships of the soil;
- Perform various laboratory experiments to determine moisture content, specific gravity;
- Perform field experiments to estimate the field density of the soil mass.

Module 2: *Plasticity Characteristics of Soil* - Introduction to definitions of: plasticity of soil, consistency limits-liquid limit, plastic limit, shrinkage limit, plasticity, liquidity and consistency indices, flow & toughness indices, definitions of activity and sensitivity. Determination of: liquid limit, plastic limit and shrinkage limit. Use of consistency limits. Classification of Soils-Introduction of soil classification: particle size classification, textural classification, unified soil classification system, Indian standard soil classification system. Identification: field identification of soils, general characteristics of soil in different groups.
On completion of this module, the students must be able to:

- Understand the behaviour of soils based on their moisture contents;
- Perform laboratory experiments to estimate various Atterberg limits and evaluate index properties of soils;
- Classify any soils based on their particle size distribution and index properties;

Module 3: *Permeability of Soil* - Darcy's law, validity of Darcy's law. Determination of coefficient of permeability: Laboratory method: constant-head method, falling-head method.
Field method: pumping- in test, pumping- out test. Permeability aspects: permeability of stratified soils, factors affecting permeability of soil. Seepage Analysis- Introduction, stream and potential functions, characteristics of flow nets, graphical method to plot flow nets.
On completion of this module, the student must be able to:

- Determine the permeability of soils through various laboratory and field tests;

- Analytically calculate the effective permeability of anisotropic soil mass;
- Determine the seepage quantities and pore water pressures below the ground;
- Graphically plot the equipotential lines and flow lines in a seepage flow.

Module 4:*Effective Stress Principle* - Introduction, effective stress principle, nature of effective stress, effect of water table. Fluctuations of effective stress, effective stress in soils saturated by capillary action, seepage pressure, quick sand condition.

On completion of this module, the student must be able to:

- Understand the physical significance of effective stress and its relation with pore pressure;
- Plot various stress distribution diagrams along the depth of the soil mass;
- Understand the effect of capillary action and seepage flow direction on the effective stress ata point in the soil mass.

Module 5: *Compaction of Soil*-Introduction, theory of compaction, laboratory determination of optimum moisture content and maximum dry density. Compaction in field, compaction specifications and field control.

On completion of this module, the student must be able to:

- Perform laboratory test to determine the maximum dry density and optimum moisture contentof the soil;
- Variation in compaction curve with compaction effort and soil type;
- Determine the compactive effort required to obtain necessary degree of compaction in-situ;
- Differentiate among various field methods of compaction and their usage based on the type ofsoil.

Module 6:*Stresses in soils* – Introduction, stresses due to point load, line load, strip load, uniformly loaded circular area, rectangular loaded area. Influence factors, Isobars, Boussinesq's equation, Newmark's Influence Chart. Contact pressure under rigid and flexible area, computation of displacements from elastic theory.

On completion of this module, the student must be able to:

- Analytically compute the vertical stress in a semi-infinite soil mass due to various loadingconditions;
- Plot isobars due various loading conditions.

Module 7:*Consolidation of Soil* - Introduction, comparison between compaction and consolidation, initial, primary & secondary consolidation, spring analogy for primary consolidation, interpretation of consolidation test results, Terzaghi's theory of consolidation, final settlement of soil deposits, computation of consolidation settlement and secondary consolidation.

On completion of this module, the student must be able to:

- Understand the basic mechanism of consolidation of soil;
- Determine various consolidation parameters of soil through laboratory test;
- Evaluate ground settlements against time.

Module 8:*Shear Strength* - Mohr circle and its characteristics, principal planes, relation between major and minor principal stresses,Mohr-Coulomb theory, types of shear tests: direct shear test, merits of direct shear test, triaxial compression tests, test behaviour of UU, CU and CD tests, pore-pressure measurement, computation of effective shear strength parameters.unconfined compression test, vane shear test

On completion of this module, the student must be able to:

- Determine graphically and analytically the stress state in any plane of the soil mass;
- Perform various shear strength tests and appreciate the different field conditions which theysimulate;
- Understand the significance of shear strength parameters in various geotechnical analyses;
- Evaluate the stiffness of soil using shear strength parameters

Module 9:*Stability of Slopes* - Introduction, types of slopes and their failure mechanisms, factor of safety, analysis of finite and infinite slopes, wedge failure Swedish circle method, friction circle method, stability numbers and charts.

On completion of this module, the student must be able to:

- Differentiate various modes of slope failure;
- Evaluate factor of safety of infinite slopes based on different ground conditions; Understandvarious methods for computation of factor of safety for finite slopes.

Module 10:*Soil Exploration*- Introduction, methods of site exploration and soil investigation, methods of boring, soil samplers, sampling procedures, trail pits, borings, penetrometer tests, analysis of borehole logs, geophysical and advance soil exploration methods.

On completion of this module, the student must be able to:

- Specify a strategy for site investigation to identify the soil deposits and determine the depth and spatial extent within the ground;
- Understand various site investigation techniques and their in-situ applications;
- Prepare a soil investigation report based on borehole log data and various in-situ tests like SPT, CPT,etc.

Practical Work: List of tests on-

i) Field Density using Core Cutter method.
ii) Field Density using Sand replacement method.
iii) Natural moisture content using Oven Drying method.
iv) Field identification of Fine Grained soils.
v) Specific gravity of Soils.
vi) Grain size distribution by Sieve Analysis.
vii) Grain size distribution by Hydrometer Analysis.
viii) Consistency limits by Liquid limit
ix) Consistency limits by Plastic limit
x) Consistency limits by Shrinkage limit.
xi) Permeability test using Constant-head test method.
xii) Permeability test using Falling-head method.
xiii) Compaction test: Standard Proctor test.
xiv) Compaction test: Modified Proctor test.
xv) Relative density.
xvi) Consolidation Test.
xvii) Triaxial Test (UU)
xviii) Vane shear test
xix) Direct Shear Test
xx) Unconfined Compression Strength Test.

Text/Reference Books:

i) Soil Mechanics by Craig R.F., Chapman & Hall
ii) Fundamentals of Soil Engineering by Taylor, John Wiley & Sons
iii) An Introduction to Geotechnical Engineering, by Holtz R.D. and Kovacs, W.D., PrenticeHall, NJ
iv) Principles of Geotechnical Engineering, by Braja M. Das, Cengage Learning
v) Principles of Foundation Engineering, by Braja M. Das, Cengage Learning

Course Learning Outcome(CLOs)-

- The students will gain an experience in the implementation of Geotechnical Engineering on engineering concepts which are applied in field Geotechnical Engineering
- The students will get a diverse knowledge of geotechnical engineering practices applied to real life problems of designing of structures.
- The students will learn to understand the theoretical and practical aspects of geotechnical engineering along with the design and management applications.

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%**

Course Code: PCC-CE305 **Course Name: Hydrology and water Resources Engineering**

Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

Course Objectives:

The objectives of this course is to impart knowledge of

1. Understanding the importance of Hydrology and its applications
2. Introduction to Hydrological processes and estimation of Design flood
3. Basic concepts and assessment of groundwater flows
4. Applications of statistical models in Hydrology
5. Introduction and assessment of soil-water-plant relationship

Course Description:

After completing this course, the student will be able to:

1. Estimation of Design flood for Water Resources structures
2. Computation of drawdown and yield in aquifers
3. Development of Rainfall – Runoff relationship
4. Determination of crop – water requirements

Module 1: *Introduction* - hydrologic cycle, water-budget equation, history of hydrology, worldwater balance, applications in engineering, sources of data.

Module 2: *Precipitation* - forms of precipitation, characteristics of precipitation in India, measurement of precipitation, rain gauge network, mean precipitation over an area, depth-area-duration relationships, maximum intensity/depth-duration-frequency relationship, Probable Maximum Precipitation (PMP), rainfall data in India.

Module 3:*Abstractions from precipitation* - evaporation process, evaporimeters, analytical methods of evaporation estimation, reservoir evaporation and methods for its reduction, evapotranspiration, measurement of evapotranspiration, evapotranspiration equations, potential evapotranspiration over India, actual evapotranspiration, interception, depression storage, infiltration, infiltration capacity, measurement of infiltration, modelling infiltration capacity, classification of infiltration capacities, infiltration indices.

Module 4:*Runoff* - runoff volume, SCS-CN method of estimating runoff volume, flow-duration curve, flow-mass curve, hydrograph, factors affecting runoff hydrograph, components of hydrograph, base flow separation, effective rainfall, unit hydrograph surface water resources of India, environmental flows.

Module 5: *Ground water and well hydrology* - forms of subsurface water, saturated formation, aquifer properties, geologic formations of aquifers, well hydraulics: steady state flow in wells, equilibrium equations for confined and unconfined aquifers, aquifer tests.

Module 6:*Water withdrawals and uses* – water for energy production, water for agriculture, water for hydroelectric generation; flood control. Analysis of surface water supply, Water requirement of crops-Crops and crop seasons in India, cropping pattern, duty and delta; Quality of irrigation water; Soil-water relationships, root zone soil water, infiltration, consumptive use, irrigation requirement, frequency of irrigation; Methods of applying water to the fields: surface, sub-surface, sprinkler and trickle / drip irrigation.

Module 7:*Distribution systems* - canal systems, alignment of canals, canal losses, estimation of design discharge. Design of channels- rigid boundary channels, alluvial channels, Kennedy's and Lacey's theory of regime channels. Canal outlets: non-modular, semi-modular and modular outlets. Water logging: causes, effects and remedial measures. Lining of canals, types of lining. Drainage of irrigated lands: necessity, methods.

Module 8: *Dams and spillways* - embankment dams: Classification, design considerations, estimation and control of seepage, slope protection. Gravity dams: forces on gravity dams, causes of failure, stress analysis, elementary and practical profile. Arch and buttress dams. Spillways: components of spillways, types of gates for spillway crests; Reservoirs- Types, capacity of reservoirs, yield of reservoir, reservoir regulation, sedimentation, economic height of dam, selection of suitable site.

Text/Reference Books:

i) K Subramanya, Engineering Hydrology, Mc-Graw Hill
ii) K N Muthreja, Applied Hydrology, Tata Mc-Graw Hill.
iii) K Subramanya, Water Resources Engineering through Objective Questions, Tata McGraw Hill.
iv) G L Asawa, Irrigation Engineering, Wiley Eastern
v) L W Mays, Water Resources Engineering, Wiley.
vi) J D Zimmerman, Irrigation, John Wiley & Sons
vii) C S P Ojha, R Berndtsson and P Bhunya, Engineering Hydrology, Oxford.

Course Learning Outcomes(CLO):

At the end of the course, students must be in a position to:

- Understand the interaction among various processes in the hydrologic cycle
- Apply the application of fluid mechanics and use of computers in solving a host of problems inhydraulic engineering
- Study types and classes of hydrologic simulation models and design procedures for safe and effective passage of flood flows for design of hydraulic structures
- Understand the basic aquifer parameters and estimate groundwater resources for different hydro-geological boundary conditions
- Understand application of systems concept, advanced optimization techniques to cover the socio-technical aspects in the field of water resources
- Apply the principles and applications of remote sensing, GPS and GIS in the context to hydrological extreme flood and drought events in water resources engineering

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%**

Course Code: PCC-CE306 **Course Name: Environmental Engineering**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

Course Objectives:

- To create awareness and impart basic knowledge about the environment and its allied problems.
- To know the functions of ecosystems.
- To understand importance of biological diversity.
- To study different pollutions and their impact on environment.
- To know social and environment related issues and their preventive measures.

Course Description:

After completing this course, the student will be able to:

1. Adopt environmental ethics to attain sustainable development.
2. Develop an attitude of concern for the environment.
3. Conservation of natural resources and biological diversity.
4. Creating awareness of Green technologies for nation's security.
5. Imparts awareness for environmental laws and regulations.

Module 1: *Water:* -Sources of Water and quality issues, water quality requirement for different beneficial uses, Water quality standards, water quality indices, water safety plans, Water Supply systems, Need for planned water supply schemes, Water demand industrial and agricultural water requirements, Components of water supply system; Transmission of water, Distribution system, Various valves used in W/S systems, service reservoirs and design.
Water Treatment: aeration, sedimentation, coagulation flocculation, filtration, disinfection, advanced treatments like adsorption, ion exchange, membrane processes

Module 2: *Sewage*- Domestic and Storm water, Quantity of Sewage, Sewage flow variations. Conveyance of sewage- Sewers, shapes design parameters, operation and maintenance of sewers, Sewage pumping; Sewerage, Sewer appurtenances, Design of sewerage systems. Small bore systems, Storm Water-Quantification and design of Storm water; Sewage and Sullage, Pollution due to improper disposal of sewage, National River cleaning plans, Wastewater treatment, aerobic and anaerobic treatment systems, suspended and attached growth systems, recycling of sewage – quality requirements for various purposes.

Module 3: *Air* - Composition and properties of air, Quantification of air pollutants, Monitoring of air pollutants, Air pollution- Occupational hazards, Urban air pollution automobile pollution, Chemistry of combustion, Automobile engines, quality of fuel, operating conditions and interrelationship. Air quality standards, Control measures for Air pollution, construction and limitations

Module 4: *Noise*- Basic concept, measurement and various control methods.

Module5:*Solid waste management*-Municipal solid waste, Composition and various chemical and physical parameters of MSW, MSW management: Collection, transport, treatment and disposal of MSW. Special MSW: waste from commercial establishments and other urban areas, solid waste from construction activities, biomedical wastes, Effects of solid waste on environment: effects on air, soil, water surface and ground health hazards. Disposal of solid waste-segregation, reduction at source, recovery and recycle. Disposal methods-Integrated solid waste management. Hazardous waste: Types and nature of hazardous waste as per the HW Schedules of regulating authorities.

Module 6: *Building Plumbing*-Introduction to various types of home plumbing systems for water supply and waste water disposal, high rise building plumbing, Pressure reducing valves, Break pressure tanks, Storage tanks, Building drainage for high rise buildings, various kinds of fixtures and fittings used.

Module 7: Government authorities and their roles in water supply, sewerage disposal. Solid waste management and monitoring/control of environmental pollution.

Practical Work: List of Experiments

i) Physical Characterization of water: Turbidity, Electrical Conductivity, pH
ii) Analysis of solids content of water: Dissolved, Settleable, suspended, total, volatile, inorganic etc.
iii) Alkalinity and acidity, Hardness: total hardness, calcium and magnesium hardness
iv) Analysis of ions: copper, chloride and sulfate
v) Optimum coagulant dose
vi) Chemical Oxygen Demand (COD)
vii) Dissolved Oxygen (D.O) and Biochemical Oxygen Demand (BOD)
viii) Break point Chlorination
ix) Bacteriological quality measurement: MPN,
x) Ambient Air quality monitoring (TSP, RSPM, SOx, NOx)
xi) Ambient noise measurement

Text/Reference Books:

i) Introduction to Environmental Engineering and Science by Gilbert Masters, Prentice Hall,New Jersey.
ii) Introduction to Environmental Engineering by P. Aarne Vesilind, Susan M. Morgan, Thompson /Brooks/Cole; Second Edition 2008.
iii) Peavy, H.s, Rowe, D.R, Tchobanoglous, G. *Environmental Engineering*, Mc-Graw - HillInternational Editions, New York 1985.
iv) MetCalf and Eddy. *Wastewater Engineering, Treatment, Disposal and Reuse*, Tata McGraw-Hill, New Delhi.
v) Manual on Water Supply and Treatment. Ministry of Urban Development, New Delhi.
vi) Plumbing Engineering. Theory, Design and Practice, S.M. Patil, 1999
vii) Integrated Solid Waste Management, Tchobanoglous, Theissen & Vigil. McGraw Hill Publication
viii) Manual on Sewerage and Sewage Treatment Systems, Part A, B and C. Central Public Healthand Environmental Engineering Organization, Ministry of Urban Development.

Course Learning Outcomes (CLOs):

After successfully studying this course, students will:

i) Understand the impact of humans on environment and environment on humans
ii) Be able to identify and value the effect of the pollutants on the environment: atmosphere, water and soil.
iii) Be able to plan strategies to control, reduce and monitor pollution.
iv) Be able to select the most appropriate technique for the treatment of water, wastewater solid waste and contaminated air.
v) Be conversant with basic environmental legislation.

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%**

Course Code: PCC-CE307 **Course Name: Transportation Engineering**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

Course Objectives

The objectives of this course is to impart knowledge of

1. To study various signal design concepts
2. Emphasize the significance of traffic signs and road markings
3. To understand various techniques of pavement construction and maintenance
4. To know the concepts related to transport planning and economic analysis

Course Description:

After completing this course, the student will be able to:

1. Apply the concepts of signal design
2. Knowledge regarding construction techniques of flexible and rigid pavements
3. Understand concepts of transportation planning process • Perform economic analysis of transportation projects

Module 1: Highway development and planning-Classification of roads, road development in India, Currentroad projects in India; highway alignment and project preparation.

Module 2: Geometric design of highways-: Introduction; highway cross section elements; sight distance, design of horizontal alignment; design of vertical alignment; design of intersections, problems

Module 3:Traffic engineering & control- Traffic Characteristics, traffic engineering studies, traffic flow and capacity, traffic regulation and control; design of road intersections; design of parking facilities; highway lighting; problems

Module 4:Pavement materials- Materials used in Highway Construction- Soils, Stone aggregates, bituminous binders, bituminous paving mixes; Portland cement and cement concrete: desirable properties, tests, requirements for different types of pavements. Problems

Module 5: Design of pavements- Introduction; flexible pavements, factors affecting design and performance; stresses in flexible pavements; design of flexible pavements as per IRC; rigid pavements-components and functions; factors affecting design and performance of CC pavements; stresses in rigid pavements; design of concrete pavements as per IRC; problems

Text/Reference Books:

i) Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017
ii) Kadiyalai, L.R., ' Traffic Engineering and Transport Planning', Khanna Publishers.
iii) Partha Chakraborty, ' Principles Of Transportation Engineering, PHI Learning
iv) Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski,'Principles of Highway Engineeringand Traffic Analysis', 4th Edition, John Wiley
v) Srinivasa Kumar, R, Textbook of Highway Engineering, Universities Press, 2011.
vi) Paul H. Wright and Karen K. Dixon, Highway Engineering, 7th Edition, Wiley Student Edition, 2009.

Course Learning Outcomes (CLO):

On completion of the course, the students will be able to:

- carry out surveys involved in planning and highway alignment
- design the geometric elements of highways and expressways
- carry out traffic studies and implement traffic regulation and control measures andintersection design
- characterize pavement materials and
- design flexible and rigid pavements as per IRC

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%**

Course Code: HSMC255 **Course Name: Professional Practice, Law & Ethics**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

Basic elements of civil engineering professional practice are introduced in this course. Roles of all participants in the process-owners, developers, designers, consultants, architects, contractors, and suppliers
- are described. Basic concepts in professional practice, business management, public policy, leadership, and professional licensure are introduced. The course covers professional relations, civic responsibilities, and ethical obligations for engineering practice. The course also describes contracts management, and various legal aspects related to engineering. Further, the course familiarizes students with elementary knowledge of laws that would be of utility in their profession, including several new areas of law such as IPR, ADR.

The course is designed to address the following:

- To make the students understand the types of roles they are expected to play in the society as practitioners of the civil engineering profession
- To develop some ideas of the legal and practical aspects of their profession

Proposed Syllabus

Professional practice covering the respective roles of the various stakeholders in the profession of civil engineering and the factors governing the same; Professional ethics relating to civil engineering; Various aspects of contracts relating to construction and management of contracts; types of contractual and other disputes in the profession and methods of dispute resolution; legal aspects relating to employment and service conditions of labour; intellectual property rights and their legal framework

Modules:

Module 1 A- Professional Practice – Respective roles of various stakeholders: Government (constituting regulatory bodies and standardization organizations, prescribing norms to ensure safety of the citizens); Standardization Bodies (ex. BIS, IRC)(formulating standards of practice); professional bodies (ex. Institution of Engineers(India), Indian Roads Congress, IIA/ COA, ECI, Local Bodies/ Planning Authorities)(certifying professionals and offering platforms for interaction); Clients/ owners (role governed by contracts); Developers (role governed by regulations such as RERA); Consultants (role governed by bodies such as CEAI); Contractors (role governed by contracts and regulatory Acts and Standards); Manufacturers/ Vendors/ Service agencies (role governed by contracts and regulatory Acts and Standards)

Module 1 B- Professional Ethics – Definition of Ethics, Professional Ethics, Business Ethics, Corporate Ethics, Engineering Ethics, Personal Ethics; Code of Ethics as defined in the website of Institution of Engineers (India); Profession, Professionalism, Professional Responsibility, Professional Ethics; Conflict of Interest, Gift Vs Bribery, Environmental breaches, Negligence, Deficiencies in state-of-the-art; Vigil Mechanism, Whistleblowing, protected disclosures.

Module 2:*General Principles of Contracts Management: Indian Contract Act, 1972 and amendments* covering General principles of contracting; Contract Formation & Law; Privacy of contract; Various types of contract and their features; Valid & Voidable Contracts; Prime and sub-contracts; Joint Ventures & Consortium; Complex contract terminology; Tenders, Request For Proposals, Bids & Proposals; Bid Evaluation; Contract Conditions & Specifications; Critical /"Red Flag" conditions; Contract award & NoticeTo Proceed; Variations & Changes in Contracts; Differing site conditions; Cost escalation; Delays, Suspensions & Terminations; Time extensions & Force Majeure; Delay Analysis; Liquidated damages & Penalties; Insurance & Taxation; Performance and Excusable Non-performance; Contract documentation; Contract Notices; Wrong practices in contracting (Bid shopping, Bid fixing, Cartels); Reverse auction; Case Studies; Build-Own-Operate & variations; Public-Private Partnerships; International Commercial Terms;

Module 3 :*Arbitration, Conciliation and ADR (Alternative Dispute Resolution) system:* Arbitration – meaning, scope and types – distinction between laws of 1940 and 1996; UNCITRAL model law – Arbitration and expert determination; Extent of judicial intervention; International commercial arbitration; Arbitration agreements – essential and kinds, validity, reference and interim measures by court; Arbitration tribunal – appointment, challenge, jurisdiction of arbitral tribunal, powers, grounds of challenge, procedure and court assistance; Award including Form and content, Grounds for setting aside an award, Enforcement, Appeal and Revision; Enforcement of foreign awards – New York and Geneva Convention Awards; Distinction between conciliation, negotiation, mediation and arbitration, confidentiality, resort to judicial proceedings, costs; Dispute Resolution Boards; Lok Adalats

Module 4 :*Engagement of Labour and Labour & other construction-related Laws:* Role of Labour in Civil Engineering; Methods of engaging labour- on rolls, labour sub-contract, piece rate work; Industrial Disputes Act, 1947; Collective bargaining; Industrial Employment (Standing Orders) Act, 1946; Workmen's Compensation Act, 1923; Building & Other Construction Workers (regulation of employment and conditions of service) Act (1996) and Rules (1998); RERA Act 2017, NBC 2017

Module 5 : *Law relating to Intellectual property:* Introduction – meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; Law relating to Copyright in India including Historical evolution of Copy Rights Act, 1957, Meaning of copyright – computer programs, Ownership of copyrights and assignment, Criteria of infringement, Piracy in Internet – Remedies and procedures in India; Law relating to Patents under Patents Act, 1970 including Concept and historical perspective of patents law in India, Patentable inventions with special reference to biotechnology products, Patent protection for computer programs, Process of obtaining patent – application, examination, opposition and sealing of patents, Patent cooperation treaty and grounds for opposition, Rights and obligations of patentee, Duration of patents – law and policy considerations, Infringement and related remedies;

Text/Reference Books:

i) B.S. Patil, Legal Aspects of Building and Engineering Contracts, 1974.
ii) The National Building Code, BIS, 2017
iii) RERA Act, 2017
iv) Meena Rao (2006), Fundamental concepts in Law of Contract, 3rd Edn. Professional Offset
v) Neelima Chandiramani (2000), The Law of Contract: An Outline, 2nd Edn. Avinash Publications Mumbai
vi) Avtarsingh (2002), Law of Contract, Eastern Book Co.
vii) Dutt (1994), Indian Contract Act, Eastern Law House
viii) Anson W.R. (1979), Law of Contract, Oxford University Press
ix) Kwatra G.K. (2005), The Arbitration & Conciliation of Law in India with case law on UNCITRAL Model Law on Arbitration, Indian Council of Arbitration
x) Wadhera (2004), Intellectual Property Rights, Universal Law Publishing Co.
xi) T. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House
xii) Bare text (2005), Right to Information Act
xiii) O.P. Malhotra, Law of Industrial Disputes, N.M. Tripathi Publishers
xiv) K.M. Desai(1946), The Industrial Employment (Standing Orders) Act
xv) Rustamji R.F., Introduction to the Law of Industrial Disputes, Asia Publishing House
xvi) Vee, Charles & Skitmore, Martin (2003) Professional Ethics in the Construction Industry,Engineering Construction and Architectural management, Vol.10, Iss2,pp 117-127, MCB UP Ltd
xvii) American Society of Civil Engineers (2011) ASCE Code of Ethics – Principles Study and Application
xviii) Ethics in Engineering- M.W.Martin& R.Schinzinger, McGraw-Hill
xix) Engineering Ethics, National Institute for Engineering Ethics, USA
xx) www.ieindia.org
xxi) Engineering ethics: concepts and cases – C. E. Harris, M.S. Pritchard, M.J.Rabins
xxii) CONSTRUCTION CONTRACTS, http://www.jnormanstark.com/contract.htm

xxiii) Internet and Business Handbook, Chap 4, CONTRACTS LAW,
xxiv) http://www.laderapress.com/laderapress/contractslaw1.html
xxv) Contract&Agreements
xxvi) http://www.tco.ac.ir/law/English/agreements/General/Contract%20Law/C.htm
xxvii) Contracts, http://206.127.69.152/jgretch/crj/211/ch7.ppt
xxviii) Business & Personal Law. Chapter 7. "How Contracts Arise",
xxix) http://yucaipahigh.com/schristensen/lawweb/lawch7.ppt
xxx) Types of Contracts, http://cmsu2.cmsu.edu/public/classes/rahm/meiners.con.ppt
xxxi) IV. TYPES OF CONTRACTS AND IMPORTANT PROVISIONS,
xxxii) http://www.worldbank.org/html/opr/consult/guidetxt/types.html
xxxiii) Contract Types/Pricing Arrangements Guideline- 1.4.G (11/04/02),
xxxiv) http://www.sandia.gov/policy/14g.pdf

Goals & Outcomes:

i) To familiarise the students to what constitutes professional practice, introduction of various stakeholders and their respective roles; understanding the fundamental ethics governing the profession

ii) To give a good insight into contracts and contracts management in civil engineering, dispute resolution mechanisms; laws governing engagement of labour

iii) To give an understanding of Intellectual Property Rights, Patents.

iv) To make the students understand the types of roles they are expected to play in the society as practitioners of the civil engineering profession

v) To develop good ideas of the legal and practical aspects of their profession

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%**

Semester VI (Third year] Branch/Course Civil Engineering

Course Code: PCC-CE308 **Course Name: Construction Engineering & Management**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

Course Objectives
The objectives of this course is to impart knowledge of

1. Describe different techniques of construction management projects
2. Illustrate economics & resource allocation for construction projects
3. Understand the basic concepts of optimization
4. Study the Safety Engineering practices for construction management projects
5. Comprehend the preparation of contracts and construction equipment

Course Description:
After completing this course, the student will be able to:

1. Application of network analysis to construction projects
2. Ability in applying resource leveling and smoothing to various projects
3. Utilization of Optimization techniques for proper project management
4. Knowledge of accident rates and their estimation for various case studies
5. Acquaintance with types of contracts and application of construction equipment's

Module 1: *Basics of* Construction- Unique features of construction, construction projects-types and features, phases of a project, agencies involved and their methods of execution;

Module 2: Construction project planning- Stages of project planning: pre-tender planning, pre-construction planning, detailed construction planning, role of client and contractor, level of detail. Process of development of plans and schedules, work break-down structure, activity lists, assessment of work content, concept of productivities, estimating durations, sequence of activities, activity utility data; Techniques of planning- Bar charts, Gantt Charts. Networks: basic terminology, types of precedence relationships, preparation of CPM networks: activity on link and activity on node representation, computation of float values, critical and semi critical paths, calendaring networks.PERT- Assumptions underlying PERT analysis, determining three time estimates, analysis, slack computations, calculationof probability of completion.

Module 3: Construction Methods basics: Types of foundations and construction methods; Basics of Formwork and Staging; Common building construction methods (conventional walls and slabs; conventional framed structure with blockwork walls; Modular construction methods for repetitiveworks; Precast concrete construction methods; Basics of Slip forming for tall structures; Basic construction methods for steel structures; Basics of construction methods for Bridges.

Module 4: Construction Equipment basics*:* Conventional construction methods Vs Mechanized methods and advantages of latter; Equipment for Earthmoving, Dewatering; Concrete mixing, transporting & placing; Cranes, Hoists and other equipment for lifting; Equipment for transportation of materials. Equipment Productivities

Module 5: Planning and organizing construction site and resources- Site: site layout including enabling structures, developing site organization, Documentation at site; Manpower: planning, organizing, staffing, motivation; Materials: concepts of planning, procurement and inventory control; Equipment: basic concepts of planning and organizing; Funds: cash flow, sources of funds; Histograms and S-Curves. Earned Value; Resource Scheduling- Bar chart, line of balance technique, resource constraints and conflicts; resource aggregation, allocation, smoothening and leveling. Common Good Practices in

Module 6:*Project Monitoring & Control*- Supervision, record keeping, periodic progress reports, periodical progress meetings. Updating of plans: purpose, frequency and methods of updating. Common causes of time and cost overruns and corrective measures. Basics of Modern Project management systems such as Lean Construction; Use of Building Information Modelling (BIM) in project management; Quality control: concept of quality, quality of constructed structure, use of manuals and checklists for quality control, role of inspection, basics of statistical quality control. Safety, Health and Environment on project sites: accidents; their causes, effects and preventive measures, costs of accidents, occupational health problems in construction, organizing for safety and health.

Module 7:*Contracts Management basics:* Importance of contracts; Types of Contracts, parties to a contract; Common contract clauses (Notice to proceed, rights and duties of various parties, notices to be given, Contract Duration and Price. Performance parameters; Delays, penalties and liquidated damages; Force Majeure, Suspension and Termination. Changes & variations, Dispute Resolution methods.

Module 8:*Construction Costs: Make- up of construction costs;* Classification of costs, time-cost trade-off in construction projects, compression and decompression.

Text/Reference Books:

i) Varghese, P.C., "*Building Construction"*, Prentice Hall India, 2007.
ii) *National Building Code,* Bureau of Indian Standards, New Delhi, 2017.
iii) Chudley, R., *Construction Technology*, ELBS Publishers, 2007.
iv) Peurifoy, R.L. Construction Planning, Methods and Equipment, McGraw Hill, 2011
v) Nunnally, S.W. Construction Methods and Management, Prentice Hall, 2006
vi) Jha, Kumar Neeraj., Construction Project management, Theory & Practice, Pearson Education India, 2015
vii) Punmia, B.C., Khandelwal, K.K., Project Planning with PERT and CPM, Laxmi Publications, 2016.

Course Learning Outcome(CLOs)-

On completion of the course, the students will have**:**

- An idea of how structures are built and projects are developed on the field
- An understanding of modern construction practices
- A good idea of basic construction dynamics- various stakeholders, project objectives, processes, resources required and project economics
- A basic ability to plan, control and monitor construction projects with respect to time and
- cost
- An idea of how to optimise construction projects based on costs
- An idea how construction projects are administered with respect to contract structures
- and issues.
- An ability to put forward ideas and understandings to others with effectivecommunication processes

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%**

S.No	Module (No of Lectures in brackets)	Tutorials
1	Basics of Construction (2)	
2	Construction Planning (6)	Develop a WBD structure for the construction of one storeyed building; Develop a bar chart for the construction of this building, including finishing activities, assuming reasonable activity durations.
3	Construction Methods basics (6)	Develop a CPM chart for a 5 span bridge on open foundations. Develop a comparative table for a 10-storeyed building constructed by at least three different methods, listing their pros and cons.
4	Construction Equipment Basics (3)	Develop a Gantt Chart for the construction of a two storeyed precast framed structure, including open foundations, along with list of equipment resources, assuming reasonable quantities and productivities. Develop a bar chart for concreting 1500 sq.m. of a 15cm. thick slab using various equipment for production to placing of concrete at 3m height above ground level; show all equipment resources required, along with a site layout.
5	Planning and Organizing Construction Site and Resources (4)	For the construction of a typical 3 storeyed, framed structure with 400 sq.m. area per floor develop the histograms for the various resources required, showing all intermediate calculations; also, draw S-curves for concrete placing and blockwork done over the period.
6	Project Monitoring and Control (4)	Write a 500-word note on the advantages of Lean Construction method over conventional project management systems. Write a 500-word note on the Safety and Health precautions you would take for a typical 3 storeyed building with 400 sq. m. plinth area.
7	Contract Management basics (3)	Assuming a 4 month delay in a construction contract of 24 months duration, form 3 groups for arguing the case for or against levying penalty on the contractor; Group A to formulate the contract conditions, Group B to act as Client and Group C to act as the Contractor. One person to act as Arbitrator/ Judge.
8	Construction Costs (2)	Refer to a Standard Schedule of Rates of any PWD (available on the Net), develop the approximate cost of a 3 storey, 400 sqm plinth area building.
	Total: 30 Lectures	15 Tutorials

Course Code: PCC-CE309 **Course Name: Engineering Economics, Estimation & costing**

Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

Course Objectives

The objectives of this course is to impart knowledge of

1. Understand the basic principles and specifications for estimations
2. Know the basic procedures for Tenders and Tender documents
3. Understand the detailed estimation of buildings, roads and Irrigation structures

Course Description:

1. Will be able to prepare tender documents
2. Will be able to prepare estimates for various engineering structures
3. Will be able to prepare schedule for civil engineering works

Module 1:Basic Principles and Methodology of Economics. Demand/Supply – elasticity – Government Policies and Application. Theory of the Firm and Market Structure. Basic Macro-economic Concepts (including GDP/GNP/NI/Disposable Income) and Identities for both closed and open economies. Aggregate demand and Supply (IS/LM). Price Indices (WPI/CPI), Interest rates, Direct and Indirect Taxes (3 lectures)

Module 2: Public Sector Economics –Welfare, Externalities, Labour Market. Components of Monetary and Financial System, Central Bank –Monetary Aggregates; Commercial Banks & their functions; Capital and Debt Markets. Monetary and Fiscal Policy Tools & their impact on the economy – Inflation and Phillips Curve. (2 lectures)

Module 3: Elements of Business/Managerial Economics and forms of organizations. Cost & CostControl –Techniques, Types of Costs, Lifecycle costs, Budgets, Break even Analysis, Capital Budgeting, Application of Linear Programming. Investment Analysis – NPV, ROI, IRR, Payback Period, Depreciation, Time value of money (present and future worth of cash flows). Business Forecasting – Elementary techniques. Statements – Cash flow, Financial. Case Study Method. (3 lectures)

Module 4: Indian economy - Brief overview of post-independence period – plans. Post reform Growth, Structure of productive activity. Issues of Inclusion – Sectors, States/Regions, Groups of people (M/F), Urbanization. Employment–Informal, Organized, Unorganized, Public, Private. Challenges and Policy Debates in Monetary, Fiscal, Social, External sectors. (2 lectures)

Module 5: *Estimation /* Measurements for various items- Introduction to the process of Estimation; Useof relevant Indian Standard Specifications for the same, taking out quantities from the given requirements of the work, comparison of different alternatives, Bar bending schedules, Mass haul Diagrams, Estimating Earthwork and Foundations, Estimating Concrete and Masonry, Finishes, Interiors, MEP works; BIM and quantity take-offs; adding equipment costs; labour costs; rate analysis; Material survey-Thumb rules for computation of materials requirement for different materials forbuildings, percentage breakup of the cost, cost sensitive index, market survey of basic materials. Use of Computers in quantity surveying (7 lectures)

Module 6: Specifications-Types, requirements and importance, detailed specifications for buildings, roads, minor bridges and industrial structures. (3 lectures)

Module 7: Rate analysis-Purpose, importance and necessity of the same, factors affecting, task work, daily output from different equipment/ productivity. (3 lectures)

Module 8: Tender- Preparation of tender documents, importance of inviting tenders, contract types, relative merits, prequalification. general and special conditions, termination of contracts, extra work and Changes, penalty and liquidated charges, Settlement of disputes, R.A. Bill & Final Bill, Payment of advance, insurance, claims, price variation, etc. Preparing Bids- Bid Price buildup: Material, Labour, Equipment costs, Risks, Direct & Indirect Overheads, Profits; Bid conditions, alternative specifications; Alternative Bids. Bid process management (6 lectures)

Module 9: Introduction to Acts pertaining to-Minimum wages, Workman's compensation, Contracts, Arbitration, Easement rights. (1 lecture)

Term Work Assignments may include:

a) Deriving an approximate estimate for a multi-storeyed building by approximate methods.
b) Detailed estimate for the following with the required material survey for the same.

a) Ground plus three storied RCC Framed structure building with blockwork walls
b) bridge with minimum 2 spans
c) factory building
d) road work
e) cross drainage work
f) Ground plus three storied building with load-bearing walls
g) Cost of finishes, MEP works for (f) above
h) Preparation of valuation report in standard Government form.
i) Assignments on rate analysis, specifications and simple estimates.
j) Detailed estimate of minor structure.
k) Preparation of Bar bending schedule.

Text/Reference Books:

i) Mankiw Gregory N. (2002), *Principles of Economics,* Thompson Asia
ii) V. Mote, S. Paul, G. Gupta(2004), *Managerial Economics,* Tata McGraw Hill
iii) Misra, S.K. and Puri (2009), *Indian Economy,* Himalaya
iv) Pareek Saroj (2003), *Textbook of Business Economics,* Sunrise Publishers
v) M Chakravarty, Estimating, Costing Specifications & Valuation
vi) Joy P K, Handbook of Construction Management, Macmillan
vii) B.S. Patil, Building & Engineering Contracts
viii) Relevant Indian Standard Specifications.
ix) World Bank Approved Contract Documents.
x) FIDIC Contract Conditions.
xi) Acts Related to Minimum Wages, Workmen's Compensation, Contract, and Arbitration
xii) Typical PWD Rate Analysis documents.
xiii) UBS Publishers & Distributors, Estimating and Costing in Civil Engineering: Theory andPractice including Specification and Valuations,2016
xiv) Dutta, B.N., Estimating and Costing in Civil Engineering (Theory & Practice), UBS Publishers, 2016

Course Learning Outcome(CLOs)-

On completion of the course, the students will:

- Have an idea of Economics in general, Economics of India particularly for public sector agencies andprivate sector businesses
- Be able to perform and evaluate present worth, future worth and annual worth analyses on one ofmore economic alternatives.
- Be able to carry out and evaluate benefit/cost, life cycle and breakeven analyses on one or moreeconomic alternatives.
- Be able to understand the technical specifications for various works to be performed for a project andhow they impact the cost of a structure.
- Be able to quantify the worth of a structure by evaluating quantities of constituents, derive their costrates and build up the overall cost of the structure.
- Be able to understand how competitive bidding works and how to submit a competitive bid proposal

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 Courses-I

Course Code: PEC-CEEL302 **Course Name: Transportation Engineering**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

Course Objectives
The objectives of this course is to impart knowledge of

1. Awareness about transportation engineering
2. Emphasize the significance of geometric design of highways with specifications and standards
3. Create the awareness of airport engineering basic things and railway engineering
4. Impart knowledge on pavement engineering traffic engineering, railway engineering and airport engineering.

Course Description:
After completing this course, the student will be able to:

1. Assimilation of the various concepts of highway geometric design
2. Application of concepts related to basic traffic engineering
3. Knowledge regarding the different types of thickness design of rigid and flexible pavements
4. Understand element of permanent way and application of principles of geometric design railway track
5. Understand basic element of airport engineering and application of basic design concepts of runway alignment

1. **Pavement Materials**. Soil - Classification, characteristics, compaction, evaluation of soil strength; stabilized pavement materials; Aggregates: requirements, properties and tests on road aggregates for flexible and rigid pavements. Bitumen: Origin, preparation, properties and tests, constitution of bituminous road binders; requirements; Criterion for selection of different binders.Bituminous Emulsions and Cutbacks: Preparation, characteristics, uses and tests,Bituminous Mixes: Mechanical properties: Resilient modulus, dynamic modulus and fatigue characteristics of bituminous mixes. bituminous mix design methods and specifications.Weathering and Durability of Bituminous Materials and Mixes.Performance based Bitumen Specifications; Superpave mix design method: design example problems. Cement Concrete for Pavement Construction: Requirements, and designof mix for CC pavement, IRC and IS specifications and tests, joint filler and sealer materials.

2. **Pavement Design.** Introduction: Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements.Stresses and Deflections in Flexible Pavements: Stresses and deflections in homogeneous masses. Burmister's two layer theory, three layer and multi-layer theories; wheel load stresses, various factors in traffic wheel loads; ESWL of multiple wheels. Repeated loads and EWL factors; sustained loads. Pavement behaviour under transient traffic loads.Flexible Pavement Design Methods For Highways and Airports: Empirical, semi-empirical and theoretical approaches, development, principle, design steps, advantages; design of flexible pavements as per IRC; Stresses in Rigid Pavements: Types of stresses and causes, factors influencing the stresses; general considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses.Rigid Pavement Design: Types of joints in cement concrete pavements and their functions, joint spacings; design of CC pavement for roads and runways as per IRC, design of joint details for longitudinal joints, contraction joints and expansion joints. IRC method of design by stress ratio method. Design of continuously reinforced concrete pavements; Maintenance, repair and rehabilitation of pavements including design of bituminous and concrete overlays as per IRC

3. **Geometric Design of Highways:**Introduction: Classification of rural highways and urban roads. Objectives and requirements of highway geometric design; Design Controls: Topography, vehicle characteristics and design vehicle, driver characteristics, speed, traffic flow and capacity, levels of service, pedestrian and other facilities, environmental factors; Design Elements: Sight distances, Horizontal alignment - design considerations, stability at curves, super elevation, widening,

transition curves; curvature at intersections, vertical alignment - grades, ramps, design of summit and valley curves, combination of vertical and horizontal alignment including design of hair pin bends, design of expressways, IRC standards and guidelines for design problems; Cross Section Elements: Right of way and width considerations, roadway, shoulders, kerbs traffic barriers, medians, frontage roads; Facilities for pedestrians, bicycles, buses and trucks, Pavement surface characteristics - types, cross slope, skid resistance, unevenness; Design Considerations: Design considerations for rural and urban arterials, freeways, and other rural and urban roads; Design Of Intersections: Characteristics and design considerations of at-grade intersections;; Rotary intersections; Grade separations and interchanges -; Design of Parking lots

4. **Airport Planning and Design**:Aircraft characteristics; Aircraft performance characteristics: Airport planning and air travel demand forecasting: Airport Site Selection; Geometric Design of the Airfield: Determination of Runway Capacity and Delay - Taxiway and Gate Capacity - Holding Aprons - Terminal Aprons – Airport drainage - Function of Airport Passenger and Cargo Terminal - Design of
   Air Freight Terminals - Airport access - Airport Landside planning - Capacity; Air Traffic Management: Navigational aids: ground based systems, satellite based systems – Air traffic control and surveillance facilities – Airfield lighting - air traffic management.

5. **Intelligent Transportation Systems:**Introduction to Intelligent Transportation Systems (ITS) – Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.Telecommunications in ITS – Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Vehicle – Road side communication
   – Vehicle Positioning System; ITS functional areas – Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS); ITS User Needs and Services – Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management; Automated Highway Systems - Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries.

6. **Railway Engineering**. Railway track gauge, alignment of railway lines, engineering surveys and construction of new lines, tracks and track stresses; rails, sleepers; ballast; subgrade and formation, rack fittings and fastenings, creep of rails, geometric design of track, curves and super-elevation, points and crossings, track junctions and simple track layouts; rail joints and welding of rails; track maintenance, track drainage; modern methods of track maintenance, rehabilitation and renewal of track; tractive resistance and power, railway stations and yards; railway tunneling; signaling and interlocking; maintenance of railways and high speed trains.

7. **High Speed Rail Engineering**. Development, engineering, design and construction of high-speed rail (HSR) passenger transport systems with particular emphasis on the unique engineering elements of HSR technology. Key elements of HSR systems and subsystems including: core systems (trains, power, signal, communication and control), track system and civil infrastructure (earthwork, bridges, viaducts and tunnels). Also covered are basic design and construction of HSR stations and rolling stock maintenance facilities.

8. **Urban Transportation Planning:**Urban morphology - Urbanization and travel demand – Urban activity systems and travel patterns – Systems approach – Trip based and Activity based approach - Urban Transportation Planning – Goals, Objectives and Constraints - Inventory, Model building, Forecasting and Evaluation - Study area delineation – Zoning - UTP survey; Trip generation models

– Trip classification - productions and attractions – Trip rate analysis - Multiple regression models - Category analysis - Trip distribution models – Growth factor models, Gravity model and Opportunity modes; Modal split models – Mode choice behavior – Trip end and trip interchange models - Probabilistic models - Utility functions - Logit models - Two stage model. Traffic assignment – Transportation networks – Minimum Path Algorithms - Assignment methods – All or Nothing assignment, Capacity restrained assignment and Multi path assignment - Route-choice behavior; Land use transportation models – Urban forms and structures - Location models - Accessibility – Land use models - Lowry derivative models - Quick response techniques - Non-Transport solutions for transport problems; Preparation of alternative plans - Evaluation techniques - Plan implementation - Monitoring - Financing of Project – urban development planning policy - Case studies.

9. **Pavement Construction and Management:** Flexible Pavement Construction: Earthwork, compaction and construction of embankments, specifications of materials, construction methods and field control checks for various types of flexible pavement materials in sub-base, base, binder and

   surface course layers and their choice; Cement Concrete Pavement Layers: Specifications and method of cement concrete pavement construction; Construction of interlocking block pavements, Quality control tests; Construction of various types of joints; Soil Stabilized Pavement Layers: Principles of gradation/proportioning of soil-aggregate mixes and compaction; Design factors, mix design, construction control and quality control checks for mechanical, soil-cement, soil-bitumen and soil-lime stabilization methods. Use of additives, Numerical problems on mix design and applications; Pavement Evaluation - Pavement Distress - Functional and structural condition of pavements, Pavement distress survey, Functional condition evaluation of pavements- Roughness, Skid Resistance. Structural evaluation of pavements - nondestructive testing, Benkelman beam and Falling Weight Deflectometer, Pavement strengthening based on deflection as per IRC, Maintenance and rehabilitation techniques; Pavement Management Systems - Pavement Management Systems- Components, structure, data requirements, Project level and Network level needs, Pavement performance prediction – concepts, modelling techniques– AASTHO, CRRI and HDM models, Budget forecasting for maintenance and rehabilitation, Ranking and optimization methodologies, lifecycle costing,

10. **Transportation Economics:** Introductory Concepts in Transportation Decision Making: Overall transportation project development, budgeting, financial planning, the process of transportation project development, models associated with transportation impact evaluation; Transportation costs -Classification of transportation costs, transportation agency costs, transportation user costs, general structure and behavior of cost functions and road pricing. Estimating Transportation Demand and Supply - supply equilibration, dynamics of transportation demand and supply, elasticity of travel demand and supply, classification of elasticity; Vehicle operating costs: Fuel costs - Maintenance and spares, Depreciation - Crew costs - Value of travel time savings - Accident costs. Economics of traffic congestion - Pricing policy; Economic analysis of projects - Methods of evaluation - Cost-benefit ratio, first year rate of return, net present value, and internal-rate of return methods; Indirect costs and benefits of transport projects; Financing of road projects - methods – Private Public Partnership (PPP) - Toll collection - Economic viability of Design-Build-Operate-Transfer Schemes
    – Risk Analysis – Value for Money analysis - Case Studies.

11. **Port and Harbour Engineering:** Harbour Planning: Types of water transportation, water transportation in India, requirements of ports and harbours, classification of harbours, selection of site and planning of harbours, location of harbour, traffic estimation, master plan, ship characteristics, harbour design, turning basin, harbour entrances, type of docks, its location and number, Site investigations – hydrographic survey, topographic survey, soil investigations, current observations, tidal observations; Docks and Repair Facilities: Design and construction of breakwaters, berthing structures - jetties, fenders, piers, wharves, dolphins, trestle, moles, Harbour docks, use of wet docks, design of wet docks, repair docks, lift docks, dry docks, keel and bilge

blocking, construction of dry docks, gates for dry docks, pumping plant, floating docks, slipways, locks, size of lock, lock gates, types of gates; Navigational Aids: Requirements of signals, fixed navigation structures, necessity of navigational aids, light houses, beacon lights, floating navigationalaids, light ships, buoys, radar; Dredging and Coastal Protection: Classification, types of dredgers, choice of dredger, uses of dredged materials, coastal erosion and protection, sea wall, revetment, bulkhead, coastal zone and beach profile; Port facilities: Port development, port planning, port building facilities, transit sheds, warehouses, cargo handling facilities, container handling terminal facilities, shipping terminals, inland port facilities. Inland waterways, Inland water transportation in India, classification of waterways, economics of inland waterways transportation, nationalwaterways.

12. **Traffic Engineering and Management:**Traffic Forecast: General travel forecasting principles, different methods of traffic forecast - Mechanical and analytical methods, Demand relationships, methods for future projection; Design Hourly Volume For Varying Demand Conditions: Concept of Design vehicle units and determination of PCU under mixed traffic conditions, Price-volume relationships, demand functions. Determination of design hourly volume; critical hour concept;Highway Capacity: Factors affecting capacity, level of service; Capacity studies - Capacity of different highway facilities including unsignalised and signalised intersections. Problems in MixedTraffic flow; Case studies; Accident Analysis: Analysis of individual accidents and statistical data; Methods of representing accident rate; Factors in traffic accidents; influence of roadway and traffic conditions on traffic safety; accident coefficients; Driver strains due to roadway and traffic conditions; Traffic Flow Theory: Fundamental flow relationship and their applications, Traffic flow theories and applications; Shock waves; Queuing theory and applications; Probabilistic Aspects Of Traffic Flow: Vehicle arrivals, distribution models, gaps and headway distribution models; gap acceptance merging parameters, delay models, applications; Simulation: Fundamental principle, application of simulation techniques in traffic engineering - formulation of simulation models, Case studies. Formulation of system models.

13. **Public Transportation Systems:**Public Transport: Definitions, modes of public transport and comparison, public transport travel characteristics, trip chaining, technology of bus, rail, rapid transit systems, basic operating elements; Transit Network Planning: Planning Objectives, principles, considerations, transit lines – types, geometry and characteristics, transit routes and their characteristics, timed transfer networks, prediction of transit usage, evaluation of network, accessibility considerations; Transit Scheduling: Components of scheduling process, determination of service requirements, scheduling procedure, marginal ridership, crew scheduling;Transit Agency and Economics: Organizational structure of transit agency, management and personnel, transit system statistics, performance and economic measures, operations, fare structure; Design of Facilities: Design of bus stops, design of terminals – principles of good layout, types of layout, depotlocation, twin depot concept, crew facilities and amenities.

14. **Infrastructure Planning and Management:** Introduction: Definition of basic terminologies, role of infrastructure in economic development, types of infrastructure, measurement of infrastructure capacity, bases for quantification of demand and supply of various types of infrastructure, Indian scenario in respect of adequacy and quality. Infrastructure Planning: Goals and objectives of infrastructure planning; Identification and quantification of the casual factors influencing the demandfor infrastructure; review and application of techniques to estimate supply and demand for infrastructure; use of econometric, social and land use indicators and models to forecast the demand and level of service of infrastructure and its impact on land use; critical review of the relevant forecasting techniques; infrastructure planning to identify and prioritize preferred areas for development; Integration of strategic planning for infrastructure at urban, regional and national levels; case studies in infrastructure planning. Infrastructure Management: Concepts, Common aspects of urban and rural infrastructure management systems; pavement and bridge management systems, Integrated infrastructure management, Case studies; Emerging trends in infrastructure: Overview of Public-Private Sector Participation in infrastructure projects, Understanding stakeholders' concerns, regulatory framework, risk management in infrastructure projects, public policy for infrastructure Sectoral Overview: Highways, railways, waterways, airports, urban and rural infrastructure: roads, housing, water supply, sanitation – case study examples.

Course Learning Outcome(CLOs)-

- An ability to apply knowledge of math, science, and engineering
- An ability to design and conduct experiments, as well as to analyze and interpret data
- An ability to function on multi-disciplinary teams
- An ability to identify, formulate, and solve engineering problems
- An understanding of ethical and professional responsibility
- An ability to communicate effectively
- The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
- A recognition of need for, and an ability to engage in life-long learning
- A knowledge of contemporary issues
- An ability to use techniques, skills and modern engineering tools necessary for engineering practice

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 Courses-II

Course Code: PEC-CEEL304 **Course Name: Construction Engineering & Management**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

1. **Construction Productivity.** Definition of Productivity, Impact of productivities on construction duration and costs; Measuring productivities of construction equipment, Staff and Labour and typical benchmarks for the same; Productivity analysis from Daily Progress Reports; Lean Construction concepts of Value Adding activities, Non-Value Adding Activities and Non-Value Adding butNecessary Activities; Productivity measurements by special Lean Construction-oriented field methods such as Work Sampling, Takt time analysis, Foreman Delay Surveys; Productivity improvement measures such as Value Stream Mapping, Location-Based management Systems, 5S, good Housekeeping, etc.; use of specialist software such as Vico for productivity studies.

2. **Building Construction Practice.** Specifications, details and sequence of activities and construction co-ordination – Site Clearance – Marking – Earthwork - masonry – stone masonry – Bond in masonry - concrete hollow block masonry – flooring – damp proof courses – construction joints – movement and expansion joints – pre cast pavements – Building foundations – basements – temporary shed – centering and shuttering – slip forms – scaffoldings – de-shuttering forms – Fabrication and erection of steel trusses – frames – braced domes – laying brick — weather and water proof – roof finishes – acoustic and fire protection; Sub Structure Construction- Techniques of Box jacking – Pipe Jacking -under water construction of diaphragm walls and basement-Tunnelling techniques – Piling techniques - well and caisson - sinking cofferdam - cable anchoring and grouting-driving diaphragm walls, sheet piles - shoring for deep cutting - well points - Dewatering and stand by Plant equipment for underground open excavation; Super Structure Construction- Launching girders, bridge decks, off shore platforms – special forms for shells - techniques for heavydecks – in-situ pre-stressing in high rise structures, Material handling - erecting light weight components on tall structures - Support structure for heavy Equipment and conveyors - Erection of articulated structures, braced domes and space decks;

3. **Construction Equipment & Automation*:***Conventional construction methods Vs Mechanized methods and advantages of latter; Equipment for Earthmoving, Dewatering; Concrete mixing, transporting & placing; plastering machines; Prestressing jacks and grouting equipment; Cranes, Hoists and other equipment for lifting; Equipment for transportation of materials. Equipment Productivities; Use of Drones for spread out sites; Use of robots for repetitive activities

4. **Contracts Management. Contract Management** – Introduction, Importance of Contracts, Overview of Contract Management, Overview of Activities in Contract Management; Planning and People- Resource Management; Types of Contracts, Parties to a Contract; Contract Formation, Formulation of Contract, Contract Start-Up, Managing Relationships; Common contract clauses (Notice to proceed, rights and duties of various parties, notices to be given, Contract Duration and Price. Performance parameters; Delays, penalties and liquidated damages; Force Majeure, Suspension and Termination. Changes & variations, Notices under contracts; Conventional and Alternative Dispute Resolution methods. Various Acts governing Contracts; Contract Administration and Payments- Contract Administration, Payments; Contract Various Situations-Contract Management in NCB Works, Contract Management in ICB Works Contracts, Contract of Supply of Goods-Design, Supply and Installation Contracts, Contract Management in Consultancy,; Managing Risks and Change- Managing Risks, Managing Change; Contract Closure and Review-Ending a Contract, Post-Implementation Review; Legal Aspects in Contract Management-Contract Management Legal View, Dispute Resolution, Integrity in Contract Management; Managing Performance- Introduction, Monitoring and Measurement

5. **Construction Project Planning& Systems.** Definition of Projects; Stages of project planning: pre- tender planning, pre-construction planning, detailed construction planning, role of client andcontractor, level of detail. Process of development of plans and schedules, work break-down structure, activity lists, assessment of work content, concept of productivities, estimating durations, sequence of activities, activity utility data; Techniques of planning- Bar charts, Gantt Charts. Networks: basic terminology, types of precedence relationships, preparation of CPM networks:activity on link and activity on node representation, computation of float values, critical and semi critical paths, calendaring networks.PERT-Assumptions underlying PERT analysis, determining three time estimates, analysis, slack computations, calculation of probability of completion. Allocation of Resources- materials, equipment, staff, labour and finance; resource levelling and optimal schedules; Project organisation, documentation and reporting systems. Control & monitoring; Temporary Structures in Construction; Construction Methods for various types of Structures; Major Construction equipment; Automation & Robotics in Construction; Modern Project management Systems; Advent of Lean Construction; Importance of Contracts Management; Planning and organizing construction site and resources- Site: site layout including enabling structures, developing site organization, Documentation at site; Manpower: planning, organizing, staffing, motivation; Materials: concepts of planning, procurement and inventory control; Equipment: basic concepts of planning and organizing; Funds: cash flow, sources of funds; Histograms and S-Curves. Earned Value; Resource Scheduling- Bar chart, line of balance technique, resource constraints and conflicts; resource aggregation, allocation, smoothening and levelling. Common Good Practices in Construction; *Project Monitoring & Control*- Supervision, record keeping, periodic progress reports, periodical progress meetings. Updating of plans: purpose, frequency and methods of updating. Common causes of time and cost overruns and corrective measures. Basics of Modern Project management systems such as Lean Construction; Use of Building Information Modelling (BIM) in project management; Quality control: concept of quality, quality of constructed structure, use of manuals and checklists for quality control, role of inspection, basics of statistical quality control. Safety, Health and Environment on project sites: accidents; their causes, effects and preventive measures, costs of accidents, occupational health problems in construction, organizing for safety and health.

6. **Construction Cost Analysis.** Introduction to the application of scientific principles to costs and estimates of costs in construction engineering; concepts and statistical measurements of the factors involved in direct costs, general overhead costs, cost markups and profits; and the fundamentals of cost recording for construction cost accounts and cost controls.

7. **Repair & Rehabilitation of Structures**. Maintenance and Repair Strategies Maintenance, Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance, Various aspects of Inspection, Assessment procedure for evaluating a damaged structure, causes of deterioration; Strength and Durability Of Concrete- Quality assurance for concrete – Strength, Durability and Thermal properties, of concrete – Cracks, different types, causes – Effects due to climate, temperature, Sustained elevated temperature, Corrosion – Effects of cover thickness; Special Concretes- Polymer concrete, Sulphur infiltrated concrete, Fibre reinforced concrete, High strength concrete, High performance concrete, Vacuum concrete, Self-compacting concrete, Geopolymer concrete, Reactive powder concrete, Concrete made with industrial wastes; Techniques for Repair and Protection Methods- Non-destructive Testing Techniques, Epoxy injection, Shoring, Underpinning, Corrosion protection techniques – Corrosion inhibitors, Corrosion resistant steels, Coatings to reinforcement, cathodic protection; Repair, Rehabilitation and Retrofitting of Structures- Evaluation of root causes; Underpinning & shoring; some simple systems of rehabilitation of structures; Guniting, shotcreting; Non-Destructive testing systems; Use of external plates, carbon fibre wrapping and carbon composites in repairs.Strengthening of Structural elements, Repair of
structures distressed due to corrosion, fire, Leakage, earthquake – Demolition Techniques – Engineered demolition methods – Case studies.

8. **Sustainable Construction Methods**. Types of foundations and construction methods; Basics of Formwork and Staging; Common building construction methods (conventional walls and slabs; conventional framed structure with blockwork walls); Modular construction methods for repetitive works; Precast concrete construction methods; Basics of Slip forming for tall structures; Basic construction methods for steel structures; Basics of construction methods for Bridges; Identification of cutting edge sustainable construction materials, technologies, and

project management strategies for use in the construction industry and evaluation of their potential to reduce the negative environmental impacts of construction activity. Examination of the current LEED for New Construction rating system, and case study analysis of highly successful recent "green construction projects" through student team assignments and presentations. Preparation for the LEED Green Associate professional licensing exam

9. **Construction Engineering Materials.** Design, production, application, specification, and quality control of construction materials unique to civil engineering. Stones, bricks, mortars, Plain, Reinforced & Prestressed Concrete, Construction Chemicals; Structural Steel, High Tensile Steel, Carbon Composites; Plastics in Construction; 3D printing; Recycling of Construction & Demolition wastes

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 Courses-III

Course Code: PEC-CEEL306 **Course Name: Environmental Engineering**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

1. **Ecological Engineering**. Characteristics of rivers and lakes which affect the management of domestic and industrial wastewaters; chemical hazards assessment, surveillance and biomonitoring, and review of regulations governing effluents.

2. **Stream Ecology**. Description of physical, chemical, and biological characteristics in streams and rivers including an integrated treatment of the environmental factors affecting the composition and distribution of biota; emphasizes the application of ecological engineering principles in aquatic ecosystem protection.

3. **Environmental Systems**. Introduction to the concepts and applications of environmental systems analysis. Application of mathematical programming and modeling to the design, planning and management of engineered environmental systems, regional environmental systems, and environmental policy. Economic analysis, including benefit-cost analysis and management strategies. Concepts of tradeoff, non- inferior sets, single and multi-objective optimization. Practical application to case studies to convey an understanding of the complexity and data collection challenges of actual design practice.

4. **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.

5. **Transport of water and wastewater.** The objective of the course is to make students gain insight into how the water and wastewater gets transported through conduits and open channels, and use the same for the design, operation and maintenance of these systems. Water Supply Systems: Storage requirements, impounding reservoirs, intake structures, pipe hydraulics, design of distribution systems, distribution and balancing reservoirs, pipe materials, appurtenances, design for external loads, maintenance and operation. Sanitary Sewerage Systems: Flow estimation, sewer materials, hydraulics of flow in sewers, sewer lay out, sewer transitions, materials for sewers, appurtenances, manholes, sewer design, conventional and model based design, sewage pumps and pumping stations, corrosion prevention, operation and maintenance, safety. Storm water Drainage Systems: Drainage layouts, storm runoff estimation, hydraulics of flow in storm water drains, materials, cross sections, design of storm water drainage systems, inlets, storm water pumping, operation and maintenance

6. **Environmental Laws and Policy.** Overview of environment, nature and eco system, Concept of laws and policies, Origin of environmental law, Introduction to environmental laws and policies, Environment and Governance, sustainable development and environment, understanding climate change, carbon crediting, carbon foot print etc., Introduction to trade and environment. International environmental laws, Right to Environment as Human Right, International Humanitarian Law and Environment, environment and conflicts management, Famous international protocols like Kyoto.

7. **Physico-Chemical Processes for water and wastewater treatment.** The Objective of this course is to provide an in depth understanding of physical and physico-chemical processes used for water and wastewater treatment systems and to provide capability to design such systems. Water purification in natural systems, physical processes, chemical processes and biological processes. Primary, secondaryand tertiary treatment. Unit operations, unit processes. Aeration and gas transfer**.** Sedimentation, different types of settling, sedimentation tank design. Coagulation and flocculation, coagulation

processes, stability of colloids, destabilization of colloids, destabilization in water and wastewater treatment, transport of colloidal particles, design aspects. Filtration: filtration processes, Hydraulics of flow through porous media, Rate control patterns and methods, Filter effluent quality parameters,

mathematical model for deep granular filters, slow sand filtration, rapid sand filtration, pre-coat filtration, design aspects. Disinfection: Types of disinfectants, Kinetics of disinfection, chlorination and its theory, Design of Chlorinators. Precipitation: Hardness removal, Iron, Mn, and heavy metal removal; Adsorption, adsorption equilibria and adsorption isotherm, rates of adsorption, Sorption kinetics in batch reactors, continuous reactors, factors affecting adsorption. Ion Exchange-exchange processes, materials and reactions, methods of operation, Application, design aspects. Membrane Processes, Reverse osmosis, Ultrafiltration, Electrodyalisis

8. **Biological processes for contaminant removal.**Understanding of basics of microbiology, metabolism and energetic, bio kinetic parameter, reactors and reactor analyses. Characterization of waste. Aerobic, anaerobic and anoxic systems. Suspended and attached growth biological systems. Activated Sludge processand process modifications, Process design considerations, Treatment Ponds and aerated Lagoons, aerobic pond, facultative pond, anaerobic ponds, polishing ponds, constructed wet lands etc. Attached Growth Biological Treatment Systems, Trickling Filters, Rotating Biological Contactors, Activated Biofilters, Moving bed biological reactor (MBBR), Sequential Batch reactors (SBR), Membrane Biological Reactors (MBR) etc. Anaerobic processes, Process fundamentals, Standard, high rate and hybrid reactors, Anaerobic filters, Expanded /fluidized bed reactors, Upflow anaerobic sludge blanket reactors, Performance and design aspects, Expanded granular bed reactors, Two stage/phase anaerobic reactors. Sludge Digestion, anaerobic digestion, aerobic digestion

9. **Rural water supply and onsite sanitation systems.** Attributes of water supply systems, drinking water quality. Relationships between diseases and water quality, hygiene and sanitation. Need for water treatment. Point of use water treatment systems, filters, bio-sand filters, disinfection systems for rural areas, chlorination, Solar disinfection systems, removal of arsenic, fluoride and iron.Onsite sanitation systems: Nexus between water quality and sanitation. Importance of hydrogeology on selection of onsite sanitation systems, Design of Septic tanks, single pit and double pit toilets. Small bore systems, bio digesters, reed beds, constructed wetlands, sludge/septage management systems.

10. **Air and Noise Pollution Control.** Air pollutants, Sources, classification, Combustion Processes and pollutant emission, Effects on Health, vegetation, materials and atmosphere, Reactions of pollutants in the atmosphere and their effects-Smoke, smog and ozone layer disturbance, Greenhouse effect. Air sampling and pollution measurement methods, principles and instruments, Ambient air quality and emission standards, Air pollution indices, Air Act, legislation and regulations, control principles, Removal of gaseous pollutants by adsorption, absorption, reaction and other methods. Particulate emission control, settling chambers, cyclone separation, Wet collectors, fabric filters, electrostatic precipitators and other removal methods like absorption, adsorption, precipitation etc. Biological air pollution control technologies, Indoor air quality. Noise pollution: Basics of acoustics and specification of sound; sound power, sound intensity and sound pressure levels; plane, point and line sources, multiple sources; outdoor and indoor noise propagation; psychoacoustics and noise criteria, effects of noise on health, annoyance rating schemes; special noise environments: Infrasound, ultrasound, impulsive sound and sonic boom; noise standards and limit values; noise instrumentation and monitoring procedure. Noise indices. Noise control methods

11. **Solid and hazardous waste management.** Solid Wastes: Origin, Analysis, Composition and Characteristics. Integrated Solid Waste Management System: Collection, Storage, Segregation, Reuse and Recycling possibilities, Transportation, Treatment / Processing and Transformation Techniques, Final Disposal. Management of: Municipal, Biomedical, Nuclear, Electronic and Industrial Solid Wastes and the rules and regulations. Introduction to Hazardous wastes, Definition of Hazardous waste, The magnitude of the problem; Hazardous waste: Risk assessment,

Environmental legislation, Characterization and site assessment, Waste minimization and resource recovery, Transportation of hazardous waste, Physical, chemical and biological treatment, Ground water contamination, Landfill disposal, Current Management Practices, Environmental audit, Pollution Prevention, Facility Development and operation, Site Remediation: Quantitative risk assessment, site and subsurface characterization, Containment, remedial alternatives.

12. **Water and Air Quality Models.** Introduction to Mathematical Models: water quality model development, calibration and verification cost: benefit analysis using models, Model requirements and limitations. D.O. Models for Streams: Dissolved oxygen model for streams sources and sinks of dissolved oxygen estimation of system parameters Streeter Phelps model oxygen 'sag' curve-determination of deoxygenation and re-aeration coefficients- Benthal oxygen demand mass transport mechanisms- Models for Estuary and Lakes: Physical chemical and biological processes in estuaries; Air quality models: Micrometeorological processes, wind rose, dispersion, coefficients and stability classes, Gaussian and dispersion model, Stack height computation, Regional air quality models, Source inventories and significance .

13. **Environmental impact assessment and life cycle analyses.** Evolution of EIA: Concepts of EIA methodologies, Screening and scoping; Rapid EIA and Comprehensive EIA; General Framework for Environmental Impact Assessment, Characterization and site assessment. Environmental Risk Analysis, Definition of Risk, Matrix Method. Checklist method, Fault tree analysis, Consequence Analysis; Socioeconomic aspects, measures of effectiveness of pollution control activities; Environmental Legislation; Introduction to Environmental Management Systems; Environmental Statement - procedures; Environmental Audit: Cost Benefit Analysis; Life Cycle Assessment; Resource Balance, Energy Balance & Management Review; Operational Control; Case Studies on EIA.

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 Courses-IV

Course Code: PEC-CEEL308 **Course Name: Hydraulics**
Course Credit Hour: 4hr **Total Contact Hour: 40hrs**

1. **Hydraulic Structures/Irrigation Engineering:** This course should discuss key issues in designing irrigation channels and hydraulic structures used in irrigation systems Estimation of crop water requirement; Design of lined and unlined channels; Analysis for surface and sub-surface flow at hydraulic structures; Design of barrages and weirs; Design of Head and cross regulators; Design of canal falls, transitions and cross drainage works; Design principles for gravity and earthen dams

2. **Pipeline Engineering:** The course should cover key issues for designing and operating pipelines for transmission and distribution of water; Analysis of flow in water transmission and water distribution systems (pump & gravity); optimal design and operation of systems for achieving different goals (including latest tools available for optimization); Extended period simulations, Software for WDN analysis and design, Rehabilitation of pipeline systems; Water auditing, online monitoring and control, leak and burst detection; transient analysis and surge protection; Appurtenances (valves / flow meters etc.); Selection of pipe material; Jointing details; Pipe laying and testing; Structural design for buried and surface mounted pipes
   Pre-Requisite: Basic course in Hydraulic Engineering

3. **Unsteady Open Channel Flow:** This course should discuss how to analyze for unsteady flows in open channels; Derivation of 1-D and 2-D shallow water flow equations; Consideration for non-hydrostatic pressure distribution; Basics of numerical methods: Finite-Difference and Finite Element Methods; Latest shock capturing Finite Volume methods for solving 1-D and 2-D shallow water flow equations; Dambreak flow; Flood routing in large channel networks, Flood routing in compound channels; Flood routing in channels with flood plains, Surface irrigation flow modeling
   Pre-Requisite: Basic course in Hydraulic Engineering

4. **River Engineering:** Knowledge about river behavior is essential for practicing hydraulic and water resources engineers. River Morphology (Bars; Bends and Meanders, Thalweg; Braiding; Bifurcations etc.); Sediment Transport Mechanics (Bed forms, Bed Load transport, Transport of suspended sediment, Critical Shear stress, Sediment Transport Equations); Aggradation and Degradation; Local Scour at Bridge Piers and other Hydraulic Structures. Measurements in Rivers (Stage measurements, Channel geometry, Discharge, Sediment samplers and suspended and bed load measurement), Physical river Models (fixed and movable bed models; sectional models, distorted Models), Mathematical models for aggradations, degradation and local scour, River Protection and Training Works (Revetments, Dikes, Gabions, Spurs, Bank Protective measures and Bed control structures), Design of river training and flood protection structures, Diversion and Cofferdams; Riverregulations systems; Dredging and Disposal, River restoration

5. **Hydraulic Modeling:** The main objective of this course is to introduce various concepts which will help in designing physical hydraulic models. Basics of Hydraulic Modelling (similarity mechanics, model laws, distinction between numerical and hydraulic models, classification of hydraulic modelling, materials used in the model, scale effect, design, construction, operation and interpretation of the results); Role of instrumentation and data processing; Gravity dominated models (modelling of energy dissipaters, overflow spillways, siphon spillways, bridge piers, vortex formation, cavitation, flow induced vibrations); Gravity friction models: (pumped flow models, ship models, surge tank models); Friction dominated models; River models with fixed and mobile bed; Basin and reservoir models; Tidal models with fixed and mobile bed; estuarine models; harbor and breakwater models, models of offshore structures; Hybrid and Analogue models; Scope and limitations of hydraulic modelling, complementary aspects of numerical and hydraulic modelling.

6. **Basics of Computational Hydraulics.** Derivation of governing equations for flow and transport in surface and sub-surface (saturated and unsaturated flow); Equations for reactive transport; Coupled

surface and sub-surface flow models; Basics of finite difference, finite element and finite volume methods (consistency, stability, convergence, order of accuracy, computational efficiency); application of numerical methods for solving flow and transport equations, fully coupled and iteratively coupled models; Model simplification, Parameter estimation (Model calibration and validation), Computational Fluid Dynamics (CFD) software for three-dimensional turbulent flow modeling, Software for sub-surface flow simulation

7. **Transients in Closed Conduits:** This course should cover key issues for understanding the unsteadyflow in pipes (water hammer) and designing for surge protection**;** Differential equations for unsteady pipe flow; Characteristic method for solution; Formulation of boundary conditions; transients in pumping mains (power failure; pump start up); transients in penstocks of hydro-electric schemes; analysis for transient control using surge tanks; air chambers; air valves; pressure regulating valves etc.; Emphasis should be on development of computer programs for transient analysis; awareness about commercially available software for transient analysis
   Pre-Requisite: Basic course in Hydraulic Engineering

8. **Groundwater Engineering**: The main objective is to provide sufficient knowledge to the students about the groundwater hydrology, well hydraulics and well construction, geo-physical explorations, groundwater quality and management of groundwater resources; Problems and perspectives regarding groundwater in India; Hydrogeology: Darcy's Equation; flow characteristics; general flow equations; unsaturated flow; Well Hydraulics: Steady and unsteady radial flows in aquifers; partially penetrating wells; multiple well systems; characteristic well losses; specific capacity, Surface and Subsurface investigations (Geologic methods; remote sensing; geophysical explorations; electrical resistivity and seismic refraction), Water Wells: Construction; completion, development, protection and rehabilitation of wells; Groundwater quality; Groundwater Management: Basin management, investigations, conjunctive use, modeling, artificial recharge; Saline water intrusion

9. **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.

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%**