Tripura University
(A Central University)

Curriculum

For

B. Tech in Civil Engineering
(3rd to 8th Semester)

2021

Curriculum Structure (Total Credit: 162)

COMMON SYLLABUS- FIRST SEMESTER

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Basic Science - 1	BS 101	Mathematics - I	3	1	0	4	4	100
2.	Basic Science - 2	BS 102	Physics	3	1	0	4	4	100
3.	Engineering Science - 1	ES 103	Basic Electrical Engineering	3	1	0	4	4	100
4.	Engineering Science - 2	ES 104	Engineering Graphics and Design	1	0	0	1	1	100
5.	Basic Science - 3	BS 105	Physics Laboratory	0	0	3	3	1.5	100
6.	Engineering Science - 3	ES 106	Engineering Graphics Practice	0	0	4	4	2	100
7.	Engineering Science - 4	ES 107	Basic Electrical Engineering Laboratory	0	0	2	2	1	100
8.	Mandatory Course - 1	MC 108	Induction Program	3 weeks in the beginning of the semester				0	100
			Total :	**10**	**3**	**9**	**22**	**17.5**	**800**

COMMON SYLLABUS- SECOND SEMESTER

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Contact Hours/ week	Credit	Full Marks
1.	Humanities Science - 1	HS 201	English	2	0	0	2	2	100
2.	Basic Science - 4	BS 202	Mathematics-II	3	1	0	4	4	100
3.	Basic Science - 5	BS 203	Chemistry	3	1	0	4	4	100
4.	Engineering Science - 5	ES 204	Programming for Problem Solving	3	0	0	3	3	100
5.	Engineering Science - 6	ES 205	Manufacturing Practices	1	0	0	1	1	100
6.	Humanities Science - 2	HS 206	Language Laboratory	0	0	2	2	1	100
7.	Basic Science - 6	BS 207	Chemistry Laboratory	0	0	3	3	1.5	100
8.	Engineering Science - 7	ES 208	Programming for Problem Solving Lab	0	0	4	4	2	100
9.	Engineering Science - 8	ES 209	Workshop on Manufacturing Practices	0	0	4	4	2	100
10.	Mandatory Course - 2	MC 210	Environmental Science	3	0	0	3	0	100
			Total :	**15**	**2**	**13**	**30**	**20.5**	**1000**

THIRD SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Humanities Science - 2	HS 301	Effective Technical Communication	3	0	0	3	3	100
2.	Basic Science - 7	BS 302	Mathematics-III	2	1	0	3	3	100
3.	Basic Science - 8	BS 303	Biology for Engineers	2	0	0	2	2	100
4.	Engineering Science - 5	ES 304	Engineering Mechanics	2	1	0	3	3	100
5.	Program Core - 1	PC CE 305	Materials, Testing and Evaluation	3	1	0	4	4	100
6.	Program Core - 2	PC CE 306	Surveying and Geomatics	3	1	0	4	4	100
7.	Program Core - 3	PC CE 307	Materials, Testing and Evaluation Lab.	0	0	2	2	1	100
8.	Program Core - 4	PC CE 308	Surveying Practice	0	0	2	2	1	100
9.	Program Core - 5	PC CE 309	Civil Engineering Drawing	0	0	2	2	1	100
10.	Mandatory Course - 3	MC 310	Indian Constitution	2	0	0	2	0	100
			Total :	**17**	**4**	**6**	**27**	**22**	**1000**

FOURTH SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Humanities Science - 3	HS 401	Engineering Economics and Accountancy	3	0	0	3	3	100
2.	Humanities Science - 4	HS 402	Universal Human Values-II: Understanding Harmony	2	1	0	3	3	100
3.	Program Core - 6	PC CE 403	Geotechnical Engineering	3	1	0	4	4	100
4.	Program Core - 7	PC CE 404	Solid Mechanics	3	1	0	4	4	100
5.	Program Core - 8	PC CE 405	Fluid Mechanics	3	0	0	3	3	100
6.	Program Core - 9	PC CE 406	Concrete Technology	3	0	0	3	3	100
7.	Program Core - 10	PC CE 407	Geotechnical Engineering Lab.	0	0	2	2	1	100
8.	Program Core - 11	PC CE 408	Solid Mechanics and Fluid Mechanics Lab.	0	0	2	2	1	100
9.	Program Core - 12	PC CE 409	Concrete Technology Lab.	0	0	2	2	1	100
10.	Mandatory Course - 4	MC 410	Essence of Indian Knowledge Tradition	2	0	0	2	0	100
			Total:	19	3	6	28	**23**	**1000**

FIFTH SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Humanities Science -5	HS 501	Professional Practice, Law and Ethics	2	0	0	2	2	100
2.	Program Core-13	PC CE 502	Structural Engineering	3	0	0	3	3	100
3.	Program Core-14	PC CE 503	Design of Structures-I	3	0	0	3	3	100
4.	Program Core-15	PC CE 504	Hydrology and Water Resources Engineering	3	0	0	3	3	100
5.	Program Core-16	PC CE 505	Transportation Engineering-I	3	0	0	3	3	100
6.	Program Core-17	PC CE 506	Environmental Engineering	3	0	0	3	3	100
7.	Program Core-18	PC CE 507	Structural Engineering Lab.	0	0	2	2	1	100
8.	Program Core-19	PC CE 508	Hydrology and Water Resources Engineering Lab.	0	0	2	2	1	100
9.	Program Core-20	PC CE 509	Environmental Engineering Lab.	0	0	4	4	2	100
10.	Summer Internship-1	SI CE 510	Industry Internship – I	0	0	0	0	1	100
			Total :	17	0	8	25	**22**	**1000**

SIXTH SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Total Marks
1.	Program Core-21	PC CE 601	Design of Structures-II	3	0	0	3	3	100
2.	Program Core-22	PC CE 602	Civil Engineering Estimation and Costing	3	0	0	3	3	100
3.	Program Core-23	PC CE 603	Foundation Engineering	3	0	0	3	3	100
4.	Program Core-24	PC CE 604	Transportation Engineering-II	3	0	0	3	3	100
5.	Program Core-25	PC CE 605	Foundation Engineering Lab.	0	0	2	2	1	100
6.	Program Core-26	PC CE 606	Transportation Engineering Lab.	0	0	2	2	1	100
7.	Program Core-27	PC CE 607	CAD in Civil Engineering	0	0	2	2	1	100

8.	Program Elective-1 (any one)	PE CE 608/1	Hydraulic Engineering	3	0	0	3	3	100
		PE CE 608/2	Construction Engineering and Management	3	0	0			
		PE CE 608/3	Prestressed Concrete	3	0	0			
9.	Project - 1	PR CE 609	Mini Project	0	0	6	6	3	100
			Total :	15	0	12	27	**21**	**900**

SEVENTH SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Program Elective-2 (any one)	PE CE 701/1	Design of Hydraulic Structures	3	0	0	3	3	100
		PE CE 701/2	Bridge Engineering	3	0	0			
		PE CE 701/3	Geotechnical Design	3	0	0			
2.	Program Elective-3 (any one)	PE CE 702/1	Rural Water Supply and Sanitation Systems	2	0	0	2	2	100
		PE CE 702/2	Traffic Engineering and Management	2	0	0			
		PE CE 702/3	Building Construction Practice	2	0	0			
3.	Open Elective-1	OE 703	See in Annexure-I	3	0	0	3	3	100
4.	Open Elective-2	OE 704	See in Annexure-II	2	0	0	2	2	100
5.	Project - 2	PR CE 705	Project Work Intermediate	0	0	12	12	6	200
6.	Summer Internship-2	SI CE-706	Internship – II	0	0	0	0	1	100
7.	Seminar - 1	SE CE 707	Seminar on Contemporary Engineering Topics - I	0	0	2	2	1	100
			Total :	10	0	14	24	**18**	**800**

EIGHTH SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Program Elective-4 (any one)	PE CE 801/1	Earthquake Engineering	3	0	0	3	3	100
		PE CE 801/2	Structural Dynamics	3	0	0			
		PE CE 801/3	Pavement Design	3	0	0			
2.	Program Elective-5 (any one)	PE CE 802/1	Remote Sensing and GIS	2	0	0	2	2	100
		PE CE 802/2	Ground Improvement and Ground Engineering	2	0	0			
		PE CE 802/3	Engineering Geology	2	0	0			
3.	Open Elective-3	OE 803	See in Annexure-III	3	0	0	3	3	100
4.	Open Elective-4	OE 804	See in Annexure-IV	2	0	0	2	2	100
5.	Project - 3	PR CE 805	Project Work Final	0	0	12	12	6	200
6.	Seminar - 2	SE CE 806	Seminar on Contemporary Engineering Topics - II	0	0	2	2	1	100
7.	Online Course	SW CE 807	SWAYAM Courses	0	0	0	0	1	100
			Total :	10	0	14	24	**18**	**800**

DETAILED SYLLABUS

THIRD SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Humanities Science - 2	HS 301	Effective Technical Communication	3	0	0	3	3	100
2.	Basic Science - 7	BS 302	Mathematics-III	2	1	0	3	3	100
3.	Basic Science - 8	BS 303	Biology for Engineers	2	0	0	2	2	100
4.	Engineering Science - 5	ES 304	Engineering Mechanics	2	1	0	3	3	100
5.	Program Core - 1	PC CE 305	Materials, Testing and Evaluation	3	1	0	4	4	100
6.	Program Core - 2	PC CE 306	Surveying and Geomatics	3	1	0	4	4	100
7.	Program Core - 3	PC CE 307	Materials, Testing and Evaluation Lab.	0	0	2	2	1	100
8.	Program Core - 4	PC CE 308	Surveying Practice	0	0	2	2	1	100
9.	Program Core - 5	PC CE 309	Civil Engineering Drawing	0	0	2	2	1	100
10.	Mandatory Course - 3	MC 310	Indian Constitution	2	0	0	2	0	100
			Total :	**17**	**4**	**6**	**27**	**22**	**1000**

Effective Technical Communication

Course Code	HS 301
Course Title	Effective Technical Communication
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	1st year B. Tech
Course Category	Humanities Science (HS)
Number of classes	36 hours

Course Outcomes:

At the end of the course, the student will be able to -

CO Number	CO Description	K-level
CO-1	Understand the nature and objective of Technical Communication relevant for the work place as Engineers	K-2
CO-2	Utilize the technical writing for the purposes of Technical Communication and its exposure in various dimensions.	K-3
CO-3	Develop effective verbal and non-verbal communication skills.	K-3
CO-4	Analyze ethical, legal, cultural, and global issues affecting Technical Communication and Develop appropriate life skills.	K-4

Module 1: Essentials of Communication (09 hrs)

What is Communication, Process of Communication, Levels of communication, The flow of Communication: Downward, Upward, Lateral or Horizontal (Peer group) Communication Barriers to communication, Non-verbal Communication, , Technology Enabled communication, Impact of Technology, Selection of appropriate communication Technology, Importance of Technical Communication, Differences between general and technical communication.

Module 2: Technical Writing Skills (09 hrs)

Technical writing process – Choosing right words, phrases and sentence patterns, clarity of purpose, planning content, effective style of writing, formatting, proofreading.
Technical Reports & Proposals: Definition & importance; Thesis/Project writing: structure & importance; synopsis writing: Methods; Technical research Paper writing: Methods & style; Seminar & Conference paper writing; Writing of Reports & Proposals.
Business letters: Sales & Credit letters; Claim and Adjustment Letters; Letters of Enquiry, Order Placement letters.
Email Writing: Reasons for popularity; guiding principles for composition; some common pitfalls; maintaining common etiquette.

Module: 3 Workplace Communication (09 hrs)

Applying for a job: Skimming advertisements; Writing job applications; Preparing CV, Resume.
Group Discussions: Group Discussion types; GD as a part of selection process; Key skills to succeed in group discussions; Dos and Don'ts of group discussions; Use of body language in GDs.
Job Interviews: Objectives; Types; Stages of Interview, Face to face Interviews; Telephonic Interviews.
Effective Business Presentations: Importance in workplace communication; Planning, Preparing, Organizing, Rehearsing, and Delivering Oral presentations, Handling Questions; Visual aids in presentations; Power Point Presentations
Ethics in Communication: Communication challenges in culturally diverse workforce; Bias-free communication

Module: 4 Developing soft skills/ Life Skills (09 hrs)

Introduction to soft skills: Soft skills as a competitive weapon in today's changing workplace.
Classification of soft skills: Time management, Attitude, Responsibility, Ethics & Values, self-confidence, Teamwork and Interpersonal skills, Problem solving skills.
Personality Development: Developing Right personality to enhance Life Skills, Personality types; Personality attributes; and Leadership Qualities.
Body Language : Emotions displayed by body language: Aggressive, Submissive, Attentive, Nervous, Upset, Bored, Relaxed, Defensive; Hand Shake; Eye Contact; Posture and Positioning.
Personality traits and soft skills in early stages of career advancement and for future career advancement.

List of Software/Learning Websites

1. http://www.free-english-study.com/
2. http://www.english-online.org.uk/course.htm
3. http://www.english-online.org.uk/
4. http://www.talkenglish.com/
5. http://www.learnenglish.de/

References / Suggested Learning Resources:-

1) Sanjay Kumar & Pushp Lata Communications Skills , 2nd Edition,Oxford University Press
2) Meenakshi Raman & Sangeeta Sharma Technical Communication: Principles & Practice Oxford University Press
3) Barun Kumar Mitra, Personality Development and Soft Skills Oxford University Press.
4) Personality Development, Harold R. Wallace & L. Ann Masters, Cengage Learning, NewDelhi.
5) Effective Communication Skill, Kulbhusan Kumar, RS Salaria, Khanna Publishing House.
6) Communication Skills for Engineers and Scientists, Sangeeta Sharma et.al. PHI Learning Pvt. Ltd, 2011, New Delhi.
7) Business Correspondence and Report Writing by Prof. R.C. Sharma & Krishna Mohan, McGraw Hill & Co. Ltd., 2001, New Delhi.
8) A Text Book of Scientific and Technical Writing by S.D. Sharma; Vikas Publication, Delhi.
9) Skills for Effective Business Communication by Michael Murphy, Harward University, U.S

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Mathematics-III

Course Code	BS 302
Course Title	Mathematics-III
Number of Credits	3 (L: 2, T: 1, P: 0)
Prerequisites	B.Tech 1st Year Mathematics
Course Category	Basic Science (BS)
Number of classes	36 hours

Course Outcome:-

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

CO No	CO Description	K-level
CO-1	Solve problems in 1st and 2nd order linear Partial Differential Equations.	K-3
CO-2	Show fourier series expansion of a given function and solve PDEs by variables separable method.	K-3
CO-3	Identify mean and variance of a given probability distribution.	K-3
CO-4	Solve numerically algebraic/transcendental equation and ordinary differential equations.	K-3

Course Content:-

Module 1: Partial Differential Equations (10 hrs)

First order partial differential equations, solutions of first order linear and quasi-linear partial differential equation (Pp + Qq =R) by Lagrange method. Homogeneous and non-homogeneous type of second order linear differential equation with constant coefficients by complimentary function and particular integral method.

Module 2: Fourier series (08 hrs)

Expansion of a function in Fourier series for a given range - Half range sine and cosine expansions. One-dimensional wave equation and one-dimensional heat flow equation - method of separation of variables - Fourier series solution.

Module 3: Probability (08 hrs)

Classical and axiomatic definition of probability, conditional probability, Bayes' theorem, independent events, random variables, expectation and higher order moments, probability mass function and probability density function, distribution function, Sample space, Events, Random Variables; Definitions of probability, conditional Probability, examples of discrete and continuous distributions: Normal, Poisson, Binomial distributions.

Module 4: Numerical Analysis (10 hrs)

Numerical solution of algebraic and transcendental equations by Regula-Falsi method Newton-Raphson's method; Finite Differences - Newton's Forward, backward difference interpolation formulae - Lagrange

interpolation; Numerical Integration with Trapezoidal rule, Simpson's 1/3 rule, Simpson's 3/8 rule; Solving first order differential equations –Taylor's series method, Euler's method, modified Euler's method, Runge-Kutta method of 4th order.

References / Suggested Learning Resources:-

1. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 1965.
2. Rajnish Verma & H.K. Dass, Higher Engineering Mathematics, S Chand, 2014.
3. S. J. Farlow, Partial Differential Equations for Scientists and Engineers, Dover Publications, 1993
4. Jain, Iyengar and Jain, Numerical methods for Scientific and Engineering Computation, New Age International Publications, 2008.
5. Erwyn Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons, 8th Edition, 2008.

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Biology for Engineers

Course Code	BS-303
Course Title	Biology for Engineers
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	-
Course Category	Basic Science (BS)
Number of classes	26 hours

Course Outcome:

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

CO Number	CO Description	K-level
CO-1	Demonstrate the understanding of biology and its branches, major classifications of life, Cells, Cellular systems their functions and biological molecules.	K-2
CO-2	Illustrate the molecular basis of genetic information and the flow of genetic information from DNA to RNA to protein and the concept of mutations, re-combinations and its applications.	K-2
CO-3	Classify microorganisms, growth, nutrition with their various methods used for the isolation, identification, control and maintenance of microbial cultures.	K-4
CO-4	Explain the fundamental principles of energy transactions in physical and biological and physiological systems, basic metabolisms.	K-2

Course Content:

Module 1: Introduction to Biology, Classification and Biomolecules (8 hours)

Detailed content of the module: Introduction to Biology and its branches. Molecular taxonomy- three major kingdoms of life. Prokaroytic and Eukaryotic cells. Energy and Carbon utilization. Cells: Animal and Plant cell structures and functions. Cell cycle and Cell division. Transport across cell membrane. Cell signaling.

Molecules of life. Monomeric units and polymeric structures. Sugars, starch and cellulose. Lipids, Amino acids and proteins. Nucleotides, DNA and RNA. Proteins- structure and function. Proteins as enzymes, transporters, receptors and structural elements. Enzyme classification. Mechanism of enzyme action. Enzyme kinetics.

Module 2: Fundamentals of genetics and flow of informations (6 hours)

Detailed content of the module: General principles of genetics, Concept of segregation and independent assortment. Molecular basis of information transfer, molecular basis of coding and decoding genetic information. DNA as genetic material. Concept of genetic code. Define gene in terms of complementation and recombination. Mutation. Recombinant DNA technology. Gene mapping. Application of recombinant DNA technology, recombinant products available in the market and at laboratory scale.

Module 3: Microbiology and applications (6 hours)

Detailed content of the module: Microorganisms and environment: Identification and classification of microorganisms. Ecological aspects of single celled organisms. Microbial integrations. Growth, nutrition and reproduction. Growth kinetics. Isolation and identification of microorganisms. Pure cultures and their characteristics. Maintenance of cultures. Sterilization. Physical and chemical methods of control of microorganisms. Management of toxic industrial wastes.

Module 4: Fundamentals of energy transaction and metabolism (6 hours)

Detailed content of the module: Thermodynamics –laws and its application in biological systems. Energy yielding and energy consuming biochemical processes.
Metabolism- Glycolysis & Krebs cycle, Role of ATP and concept of energy change. Equilibrium constant. Physiological steady-state, Living body as a thermodynamic system.
Fundamental aspects of analysis of living systems; quantitative aspects of physiology and engineering applications to clinical medicine based on body fluid balance, solute transport, basic endocrinology, reproduction physiology, neurophysiology, skeletal and smooth muscle physiology.

References / Suggested Learning Resources:

1. Biology: A global approach: Campbell, N. A.; Reece, J. B.; Urry, Lisa; Cain, M, L.; Wasserman, S. A.; Minorsky, P. V.; Jackson, R. B. Pearson Education Ltd. 12th Edition, 2020
2. Guyton and Hall, Medical Physiology, 14th Edition, Elsevier Saunders, 2020.
3. Principles of Biochemistry (V Edition), By Nelson, D. L.; and Cox, M. M.W.H. Freeman and Company.
4. Principles of Genetics, D. Peter Snustad and Michael J. Simmons. 7th Edition, Wiley Publisher, 2015
5. Prescott's Microbiology, Joanne Willey and Kathleen Sandman and Dorothy Wood, 2020. 11th Edition McGraw Hill.

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Engineering Mechanics

Course Code	ES 304
Course Title	Engineering Mechanics
Number of Credits	3 (L: 2, T: 1, P: 0)
Prerequisites	Nil
Course Category	Engineering Science (ES)
Number of classes	36 hours

Course Outcome:- After completion of the course, students will be able to:

CO No	CO Description	K-level
CO-1	Differentiate coplanar, concurrent & non-concurrent forces and their resultants and confidently tackle equilibrium equations and its applications.	K-3
CO-2	Explain centroid of simple figures, centre of gravity, moment of inertia of composite sections & mass moment of inertia of circular plates, cylinder, cone, sphere & hook.	K-2
CO-3	Analyze simple truss, compound truss, frame & virtual work.	K-4
CO-4	Understand and be able to apply other basic dynamics concepts - the Work-Energy principle, analyze D'Alembert's principle and differentiate longitudinal, transverse, torsional and damped vibrations.	K-2

Course Content:-

Module 1: Fundamentals of Engineering Mechanics: (9 Periods)

Introduction to Engineering Mechanics covering, Force Systems Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy. Friction covering, Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, screw jack & differential screw jack.

Module 2: Centre of Gravity & Moment of Inertia: (9 Periods)

Centroid and Centre of Gravity covering, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone, Sphere, Hook.

Module 3: Trusses, Frames & Virtual Work: (9 Periods)

Basic Structural Analysis covering, Equilibrium in three dimensions; Method of Sections; Method of Joints; How to determine if a member is in tension or compression; Simple Trusses; Zero force members; Beams & types of beams; Frames & Machines; Virtual Work and Energy Method- Virtual displacements, principle of virtual work for particle and ideal system of rigid bodies, degrees of freedom. Active force diagram, systems with friction, mechanical efficiency. Conservative forces and potential energy (elastic and gravitational),

energy equation for equilibrium. Applications of energy method for equilibrium. Stability of equilibrium.

Module 4: Dynamics & Mechanical Vibrations: (9 Periods)

Dynamics - Basic terms & General principles of dynamics, Types of motion, Instantaneous centre of rotation in plane motion, D'Alembert's principle and its application, Work energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation.
Vibration - Basic concepts of Longitudinal, Transverse and Torsional vibrations, Free & Forced vibration, Resonance and its effects, Damped vibration.

References / Suggested Learning Resources:-

1. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hall
2. F. P. Beer and E. R. Johnston (2011), Vector Mechanics for Engineers, Vol I - Statics, Vol II, –Dynamics, 9th Ed, Tata McGraw Hill
3. R.C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics, Pearson Press.
4. Andy Ruina and Rudra Pratap (2011), Introduction to Statics and Dynamics, Oxford University Press
5. Shanes and Rao (2006), Engineering Mechanics, Pearson Education,
6. Hibler and Gupta (2010),Engineering Mechanics (Statics, Dynamics) by Pearson Education
7. Reddy Vijaykumar K. and K. Suresh Kumar(2010), Singer's Engineering Mechanics
8. Bansal R.K.(2010), A Text Book of Engineering Mechanics, Laxmi Publications
9. Khurmi R.S. (2010), Engineering Mechanics, S. Chand & Co.
10. Tayal A.K. (2010), Engineering Mechanics, Umesh Publications
11. Hibler and Gupta (2010), Engineering Mechanics (Statics, Dynamics) by Pearson Education.
12. Bansal R.K. (2010), A Text Book of Engineering Mechanics by Laxmi Publications.
13. Irving, H.Shames, Engineering Mechanics-Statics and Dynamics, by Prentice-Hall of India.
14. Khurmi R. S. (2010), Engineering Mechanics, S. Chand & Co.
15. NPTEL web or video courses on Engineering Mechanics.
16. Timoshenko & D.H.Young, Engineerring Mechanics,Tata McGraw-Hill publishing Co. Ltd.

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Materials, Testing & Evaluation

Course Code	PC-CE305
Course Title	Materials, Testing & Evaluation
Number of Credits	4 (L: 3, T: 1, P: 0)
Prerequisites	Nil
Course Category	Program core (PC)
Number of classes	48 hours

Course Outcomes: After completion of the course students will be able to-

CO No.	CO Description	K-level
CO-1	Identify the different engineering materials requirement for construction.	K-1
CO-2	Distinguish the properties and characteristics of different engineering materials.	K-2
CO-3	Choose the suitable material for different construction work.	K-3
CO-4	Judge the performance of different engineering materials by testing.	K-6

Course contents:-

Module 1: Building Materials (12 hours)

Classification of engineering materials, study of properties of materials: physical, mechanical, chemical, biological, aesthetical and other complex properties like durability, reliability, compatibility, and economic characteristics. Bricks- Types, Indian Standard classification, absorption, saturation factor, strength in masonry, influence of mortar strength on masonry strength. Tiles: ceramic tiles, paving blocks. Brick masonry, stone masonry and block masonry.

Module 2: Cement and Cement Concrete (12 hours)

Cement: Compounds of different types, setting times, strength. Cement Mortar: Ingredients, proportions, water demand, mortars for plastering and masonry. Concrete: Importance of W/C Ratio, Strength, ingredients including admixtures, workability, testing for strength, elasticity, Bitumen and asphaltic materials, Acoustical material and geo-textiles, rubber and asbestos, water proofing and sealing resins, adhesives.

Module 3: Timber, Paint and Varnishes (12 hours)

Timber: Different types and species of structural timber, defects, influence of defects on permissible stress, preservation, dry and wet rots, Glass and Plastics, Paints and Varnishes. Structural Steel and metal alloys: Products made of ferrous and non-ferrous metals.

Module 4: Standard Testing and Evaluation (12 hours)

Mechanical behavior and mechanical characteristics; Elasticity – principle and characteristics; Plastic deformation of metals; Tensile test – standards for different material (brittle, quasi-brittle, elastic and so on) True stress – strain interpretation of tensile test; tests; Bending and torsion test. Laboratory for mechanical testing; Discussion about mechanical testing; Naming systems for various irons, steels and nonferrous metals; Discussion about elastic deformation; Plastic deformation; Impact test and transition temperatures; Fracture mechanics – background; Fracture toughness – different materials; Fatigue of material; Creep.

References / Suggested Learning Resources:-

1. P.C.Varghese, Engineering Materials, 1st edition, PHI Learning.
2. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, ' Highway Materials and Pavement Testing', Nem Chand& Bros, Fifth Edition
3. Various related updated & recent standards of BIS, IRC, ASTM, RILEM, AASHTO, etc. corresponding to materials used for Civil Engineering applications
4. Kyriakos Komvopoulos (2011), Mechanical Testing of Engineering Materials, Cognella
5. E.N. Dowling (1993), Mechanical Behaviour of Materials,Prentice Hall International Edition
6. American Society for Testing and Materials (ASTM), *Annual Book of ASTM Standards* (post 2000)
7. Related papers published in international journals
8. Engineering Materials, Rangwala, Charotar Publication
9. Materials of Construction, Ghosh, Tata McGraw Hill Publications.

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Surveying and Geomatics

Course Code	PC CE 306
Course Title	Surveying and Geomatics
Number of Credits	4 (L: 3, T: 1, P: 0)
Prerequisites	Nil
Course Category	Program core (PC)
Number of classes	48 hours

Course Outcome: After completion of the course students will be able to-

CO Number	CO Description	K-Level
CO-1	Executing the importance of linear, angular and graphical methods involved in surveying to make a plan or map.	K-3
CO-2	Explain the importance of theodolite, traversing, traverse balancing and calculation of volume from a contour map.	K-2
CO-3	Understand the geodetic survey, taking accurate measurements using instruments and adjusting the traverse and curve setting.	K-2
CO-4	Implementing surveying techniques using advanced surveying equipments.	K-3

Course Content:

Module 1: Surveying and Levelling (12 hours)

Introduction and basic concepts: Introduction, classification of surveying, Principles, some basic terms, Scale, Precision, Accuracy and errors.
Linear Measurements: Different methods, Instruments, Ranging out Survey lines, Measurements of lengths by chain, tape, Error in chaining Tape corrections.
Chain Surveying: Principle, Definition of various terms, Instruments, offsets, basic problem in chaining, Obstacles in chaining
Compass Surveying: Principle, Prismatic compass, Bearings, Magnetic declination, Local attraction, Error in compass surveying, Precautions.
Plane Table Surveying: Principle, instruments, Methods, Two and Three point problems.
Levelling: Introduction, definition basic terms, instruments, Method of Levelling, Reciprocal Levelling.

Module 2: Contouring, Theodolite Surveying and Calculation of Area and Volume (12 hours)

Contouring– Definition, uses, characteristics, Method of contouring, Contour Gradient,
Theodolite Surveying – Introduction, Types of Theodolite, Definitions of Terms, Temporary adjustments, Measurement of various angels, Fundamental lines and desire relations, Sources of Error in theodolite work. Traversing, balancing of traverse, Calculation of traverse area.
Area and Volumes: Area from field measurements, Area from plans, Planimeter. Area of cross section, Measurement of volumes, Mass diagram.

Module 3: Curves, Tacheometry and Trigonometrical Levelling (12 hours)

Curve- Introduction, Classification, Elements of curves and notation, Designation of curve, Formula for various elements of curve, setting of horizontal and vertical curve, Field problem in setting out work. Adjustment of Survey instruments.

Tacheometry – Introduction, Use of tacheometry, Different types of Tacheometric measurements, Principle of stadia method, Anallatic lens, Determination of contents, Measurements of horizontal and vertical distance, Substance bar.
Trigonometrical levelling – Introduction, Base of the object accessible, Base of the object inaccessible.

Module 4: Advanced Surveying (12 hours)

Hydrographic Surveying – Introduction, Methods, Sounding, Locating the sounding, Reduction of soundings, the capacity of a reservoir or lake, Stream gauging.
Mordern field survey systems: Electromagnetic distance measurement (EDM) – Principle – Types – Total station, Advantages and application,field procedure for total station survey,Errors
Remote sensing (RS) - basics, platform and sensors, visual image interpretation; Applications of RS. Basics and applications of Geographical Information System (GIS) and Global Positioning System (GPS).

References / Suggested Learning Resources:-

1. Duggal, S.K. Surveying Vol. I and II, Tata McGraw Hill, 2004.
2. Punmia, B.C. Surveying Vol.I and II, Standard Publishers, 1994.
3. Arora, K. R. Surveying Vol. I and II, Standard Book House, 1996.
4. Subramanian. R. Surveying and Levelling, Oxford University Press, 2012
5. N.N. Basak, Surveying and Levelling, Tata Mcgraw Hill
6. Concepts and Techniques of GIS, Lo C.P.Yeung A K W, Prentice Hall, India
7. Introduction to GIS, Kang-tsung Chang, Tata McGraw Hil
8. Remote sensing and GIS, K. Anjali Rao , BS Publication.

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Materials, Testing & Evaluation Lab.

Course Code	PC-CE307
Course Title	Materials, Testing & Evaluation Lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Program core (PC)
Number of classes	24 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Operate various types of testing machines	K-3
CO-2	Configure a testing machine to measure tension or compression behavior.	K-2
CO-3	Compute engineering values (e.g. stress or strain) from laboratory measures.	K-3
CO-4	Analyze a stress versus strain curve for modulus, yield strength and other related Attributes.	K-6

CO-5	Identify modes of failure.	K-2

List of Experiments (*Minimum 6 experiments are to be performed. Use of virtual laboratory to perform few experiments may be explored, if available****):***

- Gradation of coarse and fine aggregates
- Tensile Strength of materials & concrete composites
- Compressive strength test on aggregates
- Tension I - Elastic Behaviour of metals & materials
- Tension II - Failure of Common Materials
- Direct Shear - Frictional Behaviour
- Concrete I - Early Age Properties
- Concrete II - Compression and Indirect Tension
- Torsion test
- Hardness tests (Brinnel's and Rockwell)
- Tests on closely coiled and open coiled springs
- Tests on unmodified bitumen and modified binders with polymers.

References / Suggested Learning Resources:-

1. P.C.Varghese, Engineering Materials, 1st edition, PHI Learning.
2. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, ' Highway Materials and Pavement Testing', Nem Chand& Bros, Fifth Edition
3. Various related updated & recent standards of BIS, IRC, ASTM, RILEM, AASHTO, etc. corresponding to materials used for Civil Engineering applications
4. Kyriakos Komvopoulos (2011), Mechanical Testing of Engineering Materials, Cognella
5. E.N. Dowling (1993), Mechanical Behaviour of Materials,Prentice Hall International Edition
6. American Society for Testing and Materials (ASTM), *Annual Book of ASTM Standards* (post 2000)

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Surveying Practice

Course Code	PC CE 308
Course Title	Surveying Practice
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Program core (PC)
Number of classes	20 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Apply the procedures involved in field work and to work as a surveying team.	K-3
CO-2	Check the accurate measurements, field booking, plotting and adjustment of errors can be understood.	K-5
CO-3	Execute conventional surveying tool such as chain/tape, compass, plane table and leveling in the field of civil engineering applications.	K-3
CO-4	Implement surveying techniques using advanced surveying equipments.	K-3

List of Practical (*Minimum 6 practical or more are to be performed. Use of virtual laboratory to perform few experiments may be explored, if available****):***

1. Chain surveying, Chain traverse.
2. Compass surveying - Compass traverse-open and close traverse.
3. Plane table surveying- Radiation, intersection-Traverse- Resection.
4. Leveling: Profile leveling and cross sectional leveling.
5. Theodolite surveying.
6. Determination of Tacheometric Constants.
7. Setting out of curves.
8. Total station.

References / Suggested Learning Resources:-

1. Duggal, S.K. Surveying Vol. I and II, Tata McGraw Hill, 2004.
2. Punmia, B.C. Surveying Vol.I and II, Standard Publishers, 1994.
3. Arora, K. R. Surveying Vol. I and II, Standard Book House, 1996.
4. Subramanian. R. Surveying and Levelling, Oxford University Press, 2012
5. N.N. Basak, Surveying and Levelling, Tata Mcgraw Hill
6. Concepts and Techniques of GIS, Lo C.P.Yeung A K W, Prentice Hall, India

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Civil Engineering Drawing

Course Code	PC CE 309
Course Title	Civil Engineering Drawing
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Program core (PC)
Number of classes	20 hours

Course Outcome: After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Develop understanding of the brick size, types of closers and brick bonds.	K-3
CO-2	Develop line diagram, section, elevation, key plan, layout and sectional Plan of buildings.	K-6
CO-3	Produce working drawings for reinforcement details of building parts.	K-3
CO-4	Develop hand drafting of any parts of a building and implement the regulations for layout of a plan.	K-3

List of Drawings/ Practical (*Minimum 6 drawings/ practices are to be performed. Use of virtual laboratory to perform few experiments may be explored, if available****):***

1. Brick-Traditional and Modular, Types of Closers & Bats- King Closer, Queen Closer, Bevelled Closer, Metred Closer, Half Bat, Three-Quarter Bat, Bevelled Bat, Squint Bat.
2. English and Flemish Bond- 1×1 brick wall, ½ x ½ brick wall (header and stretcher course), Zig-zag Bond, Diagonal Bond, Herring-Bone Bond.
3. Plan, Elevation and Sectional Elevation of a single storeyed residential building .
4. Plan, Elevation and Sectional Elevation (framed structure) of a two storeyed residential building
5. Plan, Elevation and Sectional Elevation (framed structure) of a public building such as School Building/ Office Building/ Market/ Library.
6. Sectional Elevation of RCC column with footing, slab , beam and Stair case.
7. Plan and section of a Septic Tank.
8. Introduction to Auto CAD- Draw Commands, Editing Commands, Drawing Aids, Creating Text, Basic Dimensions, Inquiry Commands, Editing Dimensions, Hatching and Blocks.

References / Suggested Learning Resources:

1. M. Chakraborti, Civil Engineering Drawing, Bhaktivedanta Book Trust, 2003.
2. B. N. Dutta, Civil Engineering Estimating & Costing.
3. Shah. M.G. Kale, CM, Patki, S.Y., Building Drawing, Mcgraw Hill Publishing company Ltd. New Delhi.
4. Malik and Mayo, Civil Engineering Drawing, Computech Publication Ltd New Asian Publishers, New Delhi.
5. Sikka, V.B (2013), A course in civil Engineering Drawing, S.K. Kataria & Sons,

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Indian Constitution

Course Code	MC 310
Course Title	Indian Constitution
Number of Credits	0 (L: 2, T: 0, P: 0)
Prerequisites	Nil
Course Category	Mandatory Course (MC)
Number of classes	25 hours

Course Outcome:-

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

CO Number	CO Description	K-level
CO-1	Explain about framing and nature of Indian Constitution.	K2
CO-2	Identify the fundamental rights and duties of individual and demonstrate the knowledge on Directive Principles of State Policy.	K3
CO-3	Outline the Federal Structure, Centre- State relation, Union Executive and Amendment Procedure	K2
CO-4	Demonstrate the meaning of local self govt., types of local self govt. in rural and urban areas.	K2

Course Content:

Module 1: Constitutional Framework (05 hours)

1. Meaning of Constitutional Law and Constitutionalism.
2. Historical perspective of the Constitution of India.
3. Salient features of the Constitution of India.

Module 2: Fundamental Rights, Duties and Directive Principles of State Policy (06 hours)

1. Fundamental Rights- Articles 14, 19 and 21.
2. Fundamental Duties.
3. Directive Principles of State Policy; Its Legal Status and Significance

Module 3: Nature of India's Political system (07 hours)

1. Federal structure, Distribution of Legislative and Financial Powers between the Union and States.
2. Parliamentary Form of Government- Powers and Position of President of India.
3. Emergency Provisions.
4. Amendment Procedures of the Constitution of India.

Module 4: Rural and Urban Local Self Govt. (07 hours)

1. 73rd Amendment of the Constitution and Panchayati Raj Institutions.
2. 74th Amendment of the Constitution and Urban Local Self Govt. (Municipal Corporation, Municipal Council and Nagar Panchayat).
3. TTAADC.

References / Suggested Learning Resources:

1. Fadia, B.L- "Indian Govt. and Politics" Sahitya Bhawan, Agra.
2. D.D.Basu- "An introduction to the Constitution of India" Lexis Nexis publichers.
3. M.V.Pylee- "Constitutional Govt. in India" S.Chand and Company Ltd.
4. S.C.Kashyap(ed)- "Perspectives on the constitution" Shipra Publication.
5. B.K. Sharma- "Introduction to the Constitution of India" Prentice Hall India Private Ltd.
6. Bhattacharya, D.C. and Banerjee, Malay- "Indian Govt. and Politics" Vijaya Publishing House
7. J.C. Johari- "Indian Govt. and Politics" (2 vols)
8. Das Nityananda- "Grassroot Democracy and Panchayati Raj in Tripura" Progressive Publichers

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FOURTH SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Humanities Science - 3	HS 401	Engineering Economics and Accountancy	3	0	0	3	3	100
2.	Humanities Science - 4	HS 402	Universal Human Values-II: Understanding Harmony	2	1	0	3	3	100
3.	Program Core - 6	PC CE 403	Geotechnical Engineering	3	1	0	4	4	100
4.	Program Core - 7	PC CE 404	Solid Mechanics	3	1	0	4	4	100
5.	Program Core - 8	PC CE 405	Fluid Mechanics	3	0	0	3	3	100
6.	Program Core - 9	PC CE 406	Concrete Technology	3	0	0	3	3	100
7.	Program Core - 10	PC CE 407	Geotechnical Engineering Lab.	0	0	2	2	1	100
8.	Program Core - 11	PC CE 408	Solid Mechanics and Fluid Mechanics Lab.	0	0	2	2	1	100
9.	Program Core - 12	PC CE 409	Concrete Technology Lab.	0	0	2	2	1	100
10.	Mandatory Course - 4	MC 410	Essence of Indian Knowledge Tradition	2	0	0	2	0	100
			Total:	19	3	6	28	**23**	**1000**

Engineering Economics and Accountancy

Course Code	HS 401
Course Title	Engineering Economics and Accountancy
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Nil
Course Category	Humanities Science (HS)
Number of classes	38 hours

Course Outcomes:

At the end of the course, the student will be able to

CO Number	CO Description	K-level
CO-1	Understand the importance of engineering economics in business.	K-2
CO-2	Demonstrate the necessary knowledge and skills for running a business organisation.	K-2
CO-3	Understand the financial statement and position of an organisation.	K-2
CO-4	Analyze the accounting information for decision making.	K-4
CO-5	Develop the knowledge & skill on business and management.	K-3

Course Content:

Module 1: Engineering economics (9 hrs)

- Engineering economy and its importance;
- Demand & supply: Wants, satisfaction of wants, demand, supply, elasticity of demand, estimation of demand, supply chain economy;
- Production-Factors of production (land, labor, capital, and entrepreneurship), Laws of return.
- Money – Value of money, quantity theory; inflation and deflection.

Module 2: Business Skills for Engineers (9 hrs)

- Business Structure: Proprietorship, Partnership and Joint Stock Company;
- Basic management for businesses: Basic functions of management,
- Risk Management: Type of risk, Risk management steps
- Entrepreneur and Leadership: Leadership styles, Qualities of a good leader for a business;
- Financing and the business: Objectives and sources of funds;
- Taxation: Basics of Income tax & Goods and Services Tax (GST)

Module 3: Financial Accounting for Business (10 hrs)

- Transactions: Financial event, Features of transactions; Recording of transactions;
- Basic accounting: Ledger, Trail balance, Cash book (double column only);

- Final account: Objectives, Preparation of final accounts (Trading A/C, Profit & Loss A/C and Balance Sheet).

Module 4: Managerial Accounting for Decision-making (10 hrs)

- Cost classifications – Material cost control, labor cost control and overhead cost control (only theory);
- Cost sheet: Objective and preparation of Cost sheet (Basic problem);
- Capital budgeting: Objectives Pay-back period and NPV method for feasibility testing of investment
- Working capital management: Factors and sources of WC
- Ratio analysis: Interpretation for industrial control, Basic ratios- Current Ratio, Debt-equity ratio, proft ratio

References / Suggested Learning Resources:

- Fundamentals of Engineering Economics, 4th Edition, by Chan S. Park, Pearson Publishing;
- Engineering Economics And Financial Accounting Paperback, by Arasu, Scitech publication
- Engineering Economics and Financial Accounting for Anna University Paperback by A. Bagad, Technical Publications;
- Financial Management- An analytical framework , Nayak & Manna, Parul Library;
- Principles of Management, Ghose and Basu,ABS Publishing House;

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Universal Human Values-II: Understanding Harmony

Course Code	HU-402
Course Title	Universal Human Values-II: Understanding Harmony
Number of Credits	3(L: 2, T: 1, P: 0)
Prerequisites	Induction Programme and Universal Human Values -I
Course Category	Humanities Science (HS)
Number of classes	36 hours

Course Outcome: At the end of the course, the student will be able to

CO Number	CO Description	K-level
CO-1	Explain the term self-exploration and its application for self-evaluation and development.	K-2
CO-2	Identify the holistic perception of harmony at level of self, family, society, nature and explain it by various examples.	K-3

CO-3	Illustrate the role of a human being in ensuring harmony in society and nature.	K-2
CO-4	Distinguish between ethical and unethical practices, and start identifying a strategy to actualize a harmonious environment wherever they work.	K-4

Module 1: Course Introduction - Need, Basic Guidelines, Content and Process for Value Education (8 Hrs)

Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration.
Continuous Happiness and Prosperity- A look at basic Human Aspirations.
Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correct priority.
Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario.
Method to fulfill the above human aspirations: understanding and living in harmony at various levels.

Module 2: Understanding Harmony in the Human Being (10 Hrs)

Understanding human being as a co-existence of the sentient 'I' and the material 'Body'.
Understanding the needs of Self ('I') and 'Body' - happiness and physical facility.
Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer).
Understanding the characteristics and activities of 'I' and harmony in 'I'.
Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfillment to ensure mutual happiness; Trust and Respect as the foundational values of relationship.
Understanding the meaning of Trust; Difference between intention and competence
Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals.

Module 3: Understanding Harmony in the Nature and Existence - Whole existence as Coexistence (8 Hrs)

Understanding the harmony in the Nature
Interconnectedness and mutual fulfillment among the four orders of nature- recyclability and self-regulation in nature.
Understanding Existence as Co-existence of mutually interacting units in all-pervasive space.
Holistic perception of harmony at all levels of existence.

Module 4: Implications of the above Holistic Understanding of Harmony on Professional Ethics (10 Hrs)

Natural acceptance of human values. Definitiveness of Ethical Human Conduct.
Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order.

Competence in professional ethics:
a. Ability to utilize the professional competence for augmenting universal human order
b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems,
c. Ability to identify and develop appropriate technologies and management patterns for above production systems.

References / Suggested Learning Resources:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G PBagaria, Excel Books, New Delhi, 2010
2. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of My Experiments with Truth - by Mohandas KaramchandGandhi.
5. Bharat Mein Angreji Raj - PanditSunderlal
6. Rediscovering India - by Dharampal
7. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
8. India Wins Freedom - Maulana Abdul Kalam Azad
9. Vivekananda - Romain Rolland (English)
10. Gandhi - Romain Rolland (English)

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Geotechnical Engineering

Course Code	PC CE 403
Course Title	Geotechnical Engineering
Number of Credits	4 (L: 3, T: 1, P: 0)
Prerequisites	Engineering Mechanics
Course Category	Program Core
Number of classes	48 hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	To Classify the soil and determine the Plasticity Characteristics of Soil	K-2 & K-3
CO-2	To assess the permeability of soil, and analyze the seepage characteristics and effective stress.	K-3 & K-4
CO-3	To analyze the consolidation and compaction characteristics, and stresses distribution in soil	K-4
CO-4	To assess the shear strength characteristics of soil along with stability of slopes and illustrate the soil exploration	K-3 & K-4

Course Content:

Module 1: Classification and Plasticity Characteristics of Soil (12 hours)

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.

Classification of Soils-Introduction of soil classification: particle size classification, textural classification, unified soil classification system, Indian standard soil classification system.

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. Use of consistency limits.

Module 2: Permeability, Seepage and Effective Stress Analysis (12 hours)

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.

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.

Module 3: Compaction, Consolidation and Stresses distribution in soil (12 hours)

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.

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.

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.

Module 4: Shear Strength, Stability of Slopes and Soil Exploration (12 hours)

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.

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.

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.

References / Suggested Learning Resources:

1. Soil Mechanics by Craig R.F., Chapman & Hall
2. Soil mechanics and Foundations by B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, Laxmi publications (p) Ltd.
3. Soil Mechanics and Foundation Engineering by K.R. Arora, Standard Publishers Distributors
4. Fundamentals of Soil Engineering by Taylor, John Wiley & Sons
5. An Introduction to Geotechnical Engineering, by Holtz R.D. and Kovacs, W.D., Prentice Hall, NJ
6. Principles of Geotechnical Engineering, by Braja M. Das, Cengage Learning
7. Principles of Foundation Engineering, by Braja M. Das, Cengage Learning
8. Essentials of Soil Mechanics and Foundations: Basic Geotechnics by David F. McCarthy
9. Soil Mechanics in Engineering Practice by Karl Terzaghi, Ralph B. Peck, and Gholamreza Mesri.
10. Soil Mechanics and Foundation Engineering (Geotechnical Engineering Series) by V.N.S. Murthy.

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Solid Mechanics

Course Code	PC CE 404
Course Title	Solid Mechanics
Number of Credits	4 (L: 3, T: 1, P: 0)
Prerequisites	Engineering Mechanics
Course Category	Professional core courses (PCC)
Number of classes	48 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Describe the concepts and principles, understand the theory of elasticity including strain/displacement and Hooke's law relationships; and perform calculations, relative to the strength and stability of structures and mechanical components	K-2
CO-2	Draw SFD and BMD of Determinate Structures	K-4

CO-3	Calculate the deflection at any point on a beam subjected to a combination of loads; solve for stresses and deflections of beams under unsymmetrical loading	K-3
CO-4	Solve torsion problems in bars	K-3

Module 1: Simple Stresses and Strains (12 hours)

Concept of stress and strain, St. Venant's principle, stress and strain diagram, Elasticity and plasticity – Types of stresses and strains, Hooke's law – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio and volumetric strain – Elastic moduli and the relationship between them – Bars of varying section – composite bars – Temperature stresses. Strain Energy – Resilience – Gradual, sudden, impact and shock loadings – simple applications.
Compound Stresses and Strains- Two-dimensional system, stress at a point on a plane, principal stresses and principal planes, Mohr circle of stress, ellipse of stress and their applications. Two dimensional stress-strain system, principal strains and principal axis of strain, circle of strain and ellipse of strain. Relationship between elastic constants.

Module 2: Bending Moment and Shear Forces Diagrams (12 hours)

Bending moment (BM) and shear force (SF) diagrams.BM and SF diagrams for cantilevers simply supported and fixed beams with or without overhangs. Calculation of maximum BM and SF and the point of contra flexure under concentrated loads,uniformly distributed loads over the whole span or part of span, combination of concentrated loads (two or three) and uniformly distributed loads, uniformly varying loads, application of moments.

Module 3: Bending Stress and Shear Stress in Beams (12 hours)

Flexural Stresses-Theory of simple bending – Assumptions – Derivation of bending equation: M/I = f/y = E/R - Neutral axis – Determination of bending stresses – Section modulus of rectangular and circular sections (Solid and Hollow), I,T, Angle and Channel sections – Design of simple beam sections.

Shear Stresses- Derivation of formula – Shear stress distribution across various beam sections like rectangular, circular, triangular, I, T angle sections.

Module 4: Slope, Deflection and Torsion (12 hours)

Slope and deflection- Relationship between moment, slope and deflection, Moment area method, Macaulay's method. Use of these methods to calculate slope and deflection for determinantbeams.

Torsion- Derivation of torsion equation and its assumptions. Applications of the equation of the hollow and solid circular shafts, torsional rigidity, Combined torsion and bending of circular shafts, principal stress and maximum shear stresses under combined loading of bending and torsion. Analysis of close-coiled-helical springs.

References / Suggested Learning Resources:

1. Timoshenko, S. and Young, D. H., "Elements of Strength of Materials", DVNC, New York, USA.

2. Kazmi, S. M. A., "Solid Mechanics" TMH, Delhi, India.
3. Hibbeler, R. C. Mechanics of Materials. 6th ed. East Rutherford, NJ: Pearson Prentice Hall, 2004
4. 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
5. Laboratory Manual of Testing Materials - William Kendrick Hall
6. Mechanics of Materials - Ferdinand P. Beer, E. Russel Jhonston Jr., John T. DEwolf – TMH 2002.
7. Strength of Materials by R. Subramanian, Oxford University Press, New Delhi.

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Fluid Mechanics

Course Code	PC CE 405
Course Title	Fluid Mechanics
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Nil
Course Category	Program Core (PC)
Number of classes	36 hours

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

CO Number	CO Description	K-level
CO-1	Understand definitions of the basic terms used in fluid mechanics.	K2
CO-2	Understand the broad principles of fluid statics, kinematics and dynamics.	K2
CO-3	Understand classifications of fluid flow.	K2
CO-4	Apply the continuity, momentum and energy principles.	K3
CO-5	Apply dimensional analysis.	K3

Course Content:

Module 1: Introduction to Fluid Mechanics (9 hours)

Basic Concepts and Definitions – Distinction between a fluid and a solid; Density, Specific weight, Specific gravity, Kinematic and dynamic viscosity; variation of viscosity with temperature, Newton law of viscosity; vapour pressure, boiling point, cavitation; surface tension, capillarity, Bulk modulus of elasticity, compressibility.

Module 2: Fluid Statics (9 hours)

Fluid Pressure: Pressure at a point, Pascal's law, pressure variation with temperature, density and altitude. Piezometer, U-Tube Manometer, Single Column Manometer, U-Tube Differential Manometer,

Micromanometers. pressure gauges, Hydrostatic pressure and force: horizontal, vertical and inclined surfaces. Buoyancy and stability of floating bodies.

Module 3: Fluid Kinematics (9 hours)

Classification of fluid flow : steady and unsteady flow; uniform and non-uniform flow; laminar and turbulent flow; rotational and irrotational flow; compressible and incompressible flow; ideal and real fluid flow; continuity equation; velocity and acceleration; one, two and three dimensional flows; Stream line, path line, streak line and stream tube; stream function, velocity potential function, three-dimensional continuity equations in Cartesian coordinates.

Module 4: Fluid Dynamics (9 hours)

Surface and body forces; Equations of motion - Euler's equation; Bernoulli's equation – derivation; Energy Principle; Practical applications of Bernoulli's equation : venturimeter, orifice meter and pitot tube; Momentum principle; Forces exerted by fluid flow on pipe bend; Vortex Flow – Free and Forced; Reynolds Number, Froude Number, Mach Number, Weber Number and Euler Number. Flow through different notches and weirs, Time of emptying a reservoir with rectangular and triangular notches.

References / Suggested Learning Resources:

1. Modi, P. N.and Seth, S.M., Hydraulics and Fluid Mechanics, Standard book house, Delhi.
2. S.S. Rattan, Fluid Mechanics & Hydraulic Machines, Khanna Book Publishing Co., New Delhi.
3. Ramamrutham, and Narayan, R., Hydraulics, Fluid Mechanics and Fluid Machines, Dhanpat Rai Publishing Company, New Delhi.
4. Khurmi R S, Hydraulics, Fluid Mechanics, Hydraulic machines, S. Chand Publishers
5. Rajput, R K, Fluid Mechanics, S Chand, New Delhi.
6. Ojha, C S P, Berndtsson, R, and Chandramoulli P. N., Fluid Mechanics and Machinery, Oxford University Press, New Delhi.

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Concrete Technology

Course Code	PC-CE 406
Course Title	Concrete Technology
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Building Materials
Course Category	Professional core courses (PCC)
Number of classes	36 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Examine the properties of ingredients of concrete.	K-4

CO-2	Illustrate the properties of fresh and hardened concrete.	K-2
CO-3	Designed the mix proportion of concrete.	K-6
CO-4	Apply the results of Non-Destructive testing of concrete.	K-3

Course contents:-

Module 1: Properties of Concrete (9 hours)

Properties of Ingredients-Properties of coarse and fine aggregates and their influence on concrete, types of cement and their use, physical properties of 33 Grade, 43 Grade, 53 Grade ordinary Portland cement, Portland pozzolana cement, rapid hardening Portland cement, hydrophobic cement, low heat Portland cement and sulphate resisting Portland cement as per relevant I.S. codes. Stone types and properties, preservative treatments, stone aggregates. Grades of concrete- Concrete for ordinary work, light weight concrete, high density concrete, workability, durability and strength requirements, effect of w/c ratio, acceptability criteria, laboratory testing of fresh and hardened concrete.

Module 2: Concrete Mix Design (9 hours)

Mix design for compressive strength by I.S. methods, road note method and British method, mix design for flexural strength. High performance concrete-Constituents of high grade concrete, various tests and application of high performance concrete.

Module 3: Admixtures and Ready Mix Concrete (9 hours)

Admixtures-Plasticizers, retarders, accelerators and other admixtures, test on admixtures, chemistry and compatibility with concrete. Ready mix concrete: requirements of ready mix concrete, transit mixer details, mix design of RMC.

Module 4: Concrete for Repairs and Rehabilitation of Structures (9 hours)

Concrete for repairs and rehabilitation of structures-Polymer concrete, fiber reinforced concrete, polymer impregnated concrete, polymer modified cement concrete and Ferro cement, different tests. Non-Destructive testing of concrete-hammer test, ultrasonic pulse velocity test, load test, carbonation test, half-cell potentiometer, corrosion of steel, core test and relevant provision of I.S. codes.

References / Suggested Learning Resources:

1. Plain & reinforced concrete, Vol. I, O.P. Jain & Jaikrishna,
2. Concrete technology, theory and practice, M.S. Shetty.
3. Properties of concrete, Neville, El, Society & Pub.
4. Relevant I.S. codes.
5. Special Publication of ACI on Polymer concrete and FRC.
6. Proceedings of International Conferences on Polymer Concrete and FRC.

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Geotechnical Engineering Lab.

Course Code	PC CE 407
Course Title	Geotechnical Engineering Lab.
Number of Credits	1 (L:0, T: 0, P: 2)
Prerequisites	Engineering Mechanics
Course Category	Program Core
Number of classes	26 hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	Determine the basic properties of soil like field density, moisture content, specific gravity, grain size analysis along with field identification of soil.	K-3
CO-2	Determine the permeability of soil using Constant-head and variable head test method	K-3
CO-3	Determine the consistency limits of soil	K-3
CO-4	Assess the compaction and consolidation characteristics of soil	K-3
CO-5	Compute the shear strength characteristics of soil by using different laboratory test	K-3

Course Content:

List of Experiments (*Minimum 6 or more experiments are to be performed. Use of virtual laboratory to perform few experiments may be explored, if available****):***

1. Determination of Field Density of soil using Core Cutter method.
2. Determination of Field Density of soil using Sand replacement method.
3. Determination of Natural moisture content using Oven Drying method.
4. Field identification of Fine-Grained soils.
5. Determination of Specific gravity of Soils.
6. Grain size distribution by Sieve Analysis.
7. Grain size distribution by Hydrometer Analysis.
8. Determination of Consistency limits by Liquid limit
9. Determination of Consistency limits by Plastic limit
10. Determination of Consistency limits by Shrinkage limit.
11. Permeability test using Constant-head test method.
12. Permeability test using Falling-head method.
13. Compaction test: Standard Proctor test.
14. Compaction test: Modified Proctor test.
15. Determination of Relative density.
16. Determination of consolidation characteristics of soil by Oedometer Test.
17. Determination of shear strength parameter by Triaxial Test (UU)
18. Determination of shear strength by laboratory Vane shear test
19. Determination of shear strength parameter Direct Shear Test
20. Unconfined Compression Strength Test**.**

References / Suggested Learning Resources:

1. Soil mechanics and Foundations by B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, Laxmi publications (p) Ltd.
2. Soil Mechanics and Foundation Engineering by K.R. Arora, Standard Publishers Distributors
3. Fundamentals of Soil Engineering by Taylor, John Wiley & Sons
4. Principles of Geotechnical Engineering, by Braja M. Das, Cengage Learning
5. Principles of Foundation Engineering, by Braja M. Das, Cengage Learning
6. Soil Mechanics in Engineering Practice by Karl Terzaghi, Ralph B. Peck, and Gholamreza Mesri.
7. Soil Mechanics and Foundation Engineering (Geotechnical Engineering Series) by V.N.S. Murthy.

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Solid Mechanics and Fluid Mechanics Lab.

Course Code	PC CE 408
Course Title	Solid Mechanics and Fluid Mechanics Lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Professional core courses (PCC)
Number of classes	20 hours

Course Outcome:

CO No	CO Description	K-level
CO-1	Determine compressive strength of concrete	K-2
CO-2	Investigate Hook's law that is the proportional relation between force and stretching in elastic deformation	K-3
CO-3	Compare Tension test, Impact test, Shear test, Bend test steel bar	K-4
CO-4	Percieve the broad principles of fluid statics, Kinematics and dynamics.	K-5
CO-5	Characterize laminar and turbulent flows	K-4
CO-6	Determine flow and flow properties.	K-4

Solid Mechanics

List of Experiments (*Minimum 3 or more experiments are to be performed. Use of virtual laboratory to perform few experiments may be explored, if available****):***

1. Tension test
2. Bending tests on simply supported beam and Cantilever beam.
3. Compression test on concrete
4. Impact test
5. Shear test
6. Investigation of Hook's law that is the proportional relation between force and stretching in elastic deformation,
7. Measurement of deflections in statically determinate beam,
8. Measurement of strain in a bar
9. Bend test steel bar;

10. Yield/tensile strength of steel bar;

Fluid Mechanics

List of Experiments (*Minimum 3 or more experiments are to be performed. Use of virtual laboratory to perform few experiments may be explored, if available****):***

1. To find critical Reynold's number for a pipe flow.
2. To verify Bernoulli's theorem.
3. To determine metacentric height of a floating body.
4. To determine the coefficient of discharge of venturimeter.
5. To determine the coefficient of discharge, contraction and velocity of an orifice.
6. To determine the coefficient of discharge of venturimeter.
7. To determine the coefficient of impact for vanes.
8. To determine the friction factor for the pipes (major losses).
9. To determine the minor losses due to sudden enlargement , sudden contraction and bends.
10. To determine the coefficient of discharge of Notch (V and rectangular types).
11. To measure viscosity of fluid.

References / Suggested Learning Resources:

1. Timoshenko, S. and Young, D. H., "Elements of Strength of Materials", DVNC, NewYork, USA.
2. Kazmi, S. M. A., "Solid Mechanics" TMH, Delhi, India.
3. Laboratory Manual of Testing Materials - William Kendrick Hall
4. Mechanics of Materials - Ferdinand P. Beer, E. Russel Jhonston Jr., John T. DEwolf –TMH 2002.
5. Strength of Materials by R. Subramanian, Oxford University Press, New Delhi.
6. Applied Fluid Mechanics Lab Manual.2019 , Habib Ahmari, Shah Md. Imran Kabir , Ginny Bowers.
7. Theory and Applications of Fluid Mechanics, K Subramaniya. Tata Mc Graw Hill.
8. Lab Manual.

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Concrete Technology Lab.

Course Code	PC CE 409
Course Title	Concrete Technology Lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Professional core courses (PCC)
Number of classes	24 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Evaluate the properties of concrete in plastic and hardened state	K-6
CO-2	Estimate the quantity of admixture and other additives in concrete	K-6
CO-3	Designed the mix proportion of concrete.	K-6
CO-4	Apply the results of Non-Destructive testing of concrete.	K-3

List of Experiments (*Minimum 6 or more experiments are to be performed. Use of virtual laboratory to perform few experiments may be explored, if available****):***

(a) Effect of w/c ratio on workability (slump cone, compaction factor, V-B test, flow table)
(b) Effect of w/c ratio on strength of concrete,
(c) Mix design in laboratory
(d) Non-destructive testing of concrete – some applications (hammer, ultrasonic)
(e) Compressive, Flexural and tensile strength of Mortar.
(f) Study of admixtures & their effect on workability and strength of concrete.
(g) Modulus of rupture of concrete.
(h) Initial drying shrinkage, moisture movement, and coefficient of expansion of concrete.
(i) Stress strain curve of concrete.
(j) Tests on fiber-reinforced concrete.
(k) Flexure test on beam (central point load and two point load) (plotting of load deflection curve and finding value of E).

References / Suggested Learning Resources:

1. Plain & reinforced concrete, Vol. I, O.P. Jain &Jaikrishna,
2. Concrete technology, theory and practice, M.S. Shetty.
3. Properties of concrete, Neville, El, Society & Pub.
4. Relevant I.S. codes.
5. Special Publication of ACI on Polymer concrete and FRC.
6. Proceedings of International Conferences on Polymer Concrete and FRC.

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Essence of Indian Knowledge Tradition

Course Code	MC-410
Course Title	Essence of Indian Knowledge Tradition
Number of Credits	0 (L: 2, T: 0, P: 0)
Prerequisites	Nil
Course Category	Mandatory Course (MC)
Number of classes	26 hours

Course Outcome:

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

CO Number	CO Description	K-level
CO-1	Outline Vedic literature, Puranic Literature and other ancient knowledge tradition of India.	K-2
CO-2	Explain about scientific heritage of ancient India along with comprehending its relevance and application in various modern scientific disciplines.	K-2

CO-3	Demonstrate Indian Philosophical systems with a conscious emphasis on their relevance and application in modern scientific enquiry.	K-2
CO-4	Illustrate Indian Linguistic tradition along with its branches.	K-2
CO-5	Critically analyse the worth of Indian intellectual heritage, traditional practices and Indian lifestyle from scientific lenses.	K-4

Course Content:

Module 1: Introduction to Vedic Literature, Dharmaśāstra and Purāṇas (08 hrs)

- General structure of Vedic Literature,
- Different theories on the age of the Vedas,
- Educational system in the Vedic times
- Subject-matter of Ṛgveda-samhitā, *Sāmaveda -Saṁhitā, Yajurveda-Saṁhitā, Atharvaveda-Saṁhitā, Brāhmaṇa* and *Āraṇyaka* literature, Upaveda
- Vedāṅga Literature
- History of Dharmaśāstra
- Basic concepts of *Purāna*s

Module 2: Indian Knowledge System, Yoga and Health care (06 hrs)

- Origin and Development of Indian Knowledge System
- Concept of Dharma in Indian knowledge tradition
- General ideas about Yoga,
- Origin and Development of Pātañjala Yoga
- Origin and Development of Āyurveda and its relevance

Module 3: Introduction to Indian Philosophy (06 hrs)

- General introduction to Indian Philosophical systems, i.e. Orthodox and Heterodox
- Concept of *Puruṣārtha*s in Indian Philosophy
- General introduction of Upaniṣadic literature
- Indian Philosophy and Modern Science
- Principles in different philosophical systems
- Relevance of Indian Philosophy in Modern time

Module 4: Indian Linguistic and Artistic Tradition (06 hrs)

- Origin and Definition of Language
- Branches and aspects of Science of language
- Vedic and Classical Sanskrit
- Indo-European family of Language
- Role of Sanskrit in comparative Philology
- Sanskrit Phonology and Phonetic laws
- History of Sanskrit Grammar
- Introduction to Śikṣā literature
- Origin and Development of Artistic tradition

References / Suggested Learning Resources:

1) Capra, Fritjof. *The Tao of Phisics*. New York: Harpercollins, 2007.
2) Capra, Fritjof. *The Web of Life*. London: Harpar Collins Publishers, 1996.
3) Chaitanya, Krishna. *Arts of India*, Abhinav Publications, 1987.
4) Chatterjee, S.C & Datta, D.M. *An Introduction to Indian Philosophy*, Calcutta: University of Calcutta, 1984.
5) Cowell, E.B and Gough. A.E (Ed.), *Sarvadarśanasaṅgraha*. Sadguru Publications, 2008.
6) Dasgupta, Surendranath & De, Sushil Kumar. *A History of Sanskrit Literature.* Delhi: Motilal Banarsidass, 2017.
7) Dasgupta, Surendranath. *A History of Indian Philosophy*. Delhi: Motilal Banarsidass, 1991.
8) GN Jha (Eng. Trans.), Ed. RN Jha, *Yoga-darshanam with Vyasa Bhashya*, Vidyanidhi Prakashan, Delhi 2016.
9) Gonda, Jan. *A History of Vedic Literature*. Delhi: Monohar Publishers and Distributors, 2020.
10) Jha, R.N. *Science and Consciousness Psychotherapy and Yoga Practices*. Delhi: Vidyanidhi Prakashan, 2016.
11) Jha, V.N. Language, *Thought and Reality*.
12) Kane. P.V. *History of Dharmasastra*, Poona: Bhandarkar Oriental Research Institute, 1930.
13) Knowledge traditions and practices of India, CBSE Publications.
14) Max Muller. *Ancient Sanskrit Literature*, London: Spottiswoode and Co., 1859.
15) Nagaswamy, R. *Foundations of Indian Art*, Tamil Arts Academy, 2002.
16) Pride of India, New Delhi: Samskrita Bharati, 2006.
17) Shastri, Gourinath. *A History of Vedic Literature*, Kolkata: Sanskrit Pustak Bhandar, 2006.
18) Sinha, Jadunath. *Indian Philosophy*. Delhi: Motilal Banarsidass,1938.
19) Subrahmanialyer, K.S. *Vakyapadia of Bhrarthrihari*. Pune: Deccan College, 1965.
20) V. Sivaramakrishnan (Ed.), *Cultural Heritage of India-course material*. Mumbai: Bharatiya Vidya Bhavan, 5th Edition, 2014.
21) Wujastiyk, Dominik. *The Roots of Ayurveda*. India: Penguin India, 2000.

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FIFTH SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Humanities Science -5	HS 501	Professional Practice, Law and Ethics	2	0	0	2	2	100
2.	Program Core-13	PC CE 502	Structural Engineering	3	0	0	3	3	100
3.	Program Core-14	PC CE 503	Design of Structures-I	3	0	0	3	3	100
4.	Program Core-15	PC CE 504	Hydrology and Water Resources Engineering	3	0	0	3	3	100
5.	Program Core-16	PC CE 505	Transportation Engineering-I	3	0	0	3	3	100
6.	Program Core-17	PC CE 506	Environmental Engineering	3	0	0	3	3	100
7.	Program Core-18	PC CE 507	Structural Engineering Lab.	0	0	2	2	1	100
8.	Program Core-19	PC CE 508	Hydrology and Water Resources Engineering Lab.	0	0	2	2	1	100
9.	Program Core-20	PC CE 509	Environmental Engineering Lab.	0	0	4	4	2	100
10.	Summer Internship-1	SI CE 510	Industry Internship – I	0	0	0	0	1	100
			Total :	17	0	8	25	**22**	**1000**

Professional Practice, Law and Ethics

Course Code	HS 501
Course Title	Professional Practice, Law & Ethics
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Nil
Course Category	Humanities Science (HS)
Number of classes	26 hours

Course Outcome:- After completion of the course, students will be able to:

CO Number	CO Description	K Level
CO 1	Develop ideas of the professionalism, values and ethics in a profession	K-3
CO 2	Develop a good insight into contracts and contracts management in engineering, arbitration and dispute resolution mechanisms	K-3
CO 3	Interpret laws governing engagement of labour in construction related works and other related areas	K-2
CO 4	Demonstrate an understanding of Intellectual Property Rights and Patents	K-2

Module 1: Professionalism, Values and Ethics in Profession (6 hrs)

Professionalism: Professional characteristics, professional education, professional development in Industry.
Values and Ethics in Profession- Value system- goodness, means and ends; Ethics-ethical premises, expectation, conflicts and practices; Moral and ego, Ethics and morality
Right, virtue ethics and justice, utility and justice, privacy, challenges to privacy, privacy on the Internet.

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 and Arbitration (10 hrs)

Indian Contract Act, 1972 and amendments covering General principles of contracting; Valid & Voidable Contracts; Prime and Subcontracts Tenders, Request For Proposals, Bids & Proposals; Bid Evaluation; Cost escalation; Delays, Suspensions & Terminations; Time extensions & Force Majeure; Delay Analysis; Liquidated damages & Penalties; Insurance & Taxation.

Arbitration, Conciliation and ADR (Alternative Dispute Resolution) system: Arbitration – meaning, scope and types – distinction between laws of 1940 and 1996; 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.

Module 3: Engagement of Labour & other construction-related Laws (5 hrs)

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 4: Law relating to Intellectual property (5 hrs)

Introduction – meaning of intellectual property, main forms of IP, Copyright, Trademarks, Patents and Designs, Secrets; 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. Process of obtaining patent – application, examination, opposition and sealing of patents. Duration of patents – law and policy considerations, Infringement and related remedies;

References / Suggested Learning Resources:

1. B.S. Patil, Legal Aspects of Building and Engineering Contracts, 1974.
2. The National Building Code, BIS, 2017
3. Meena Rao (2006), Fundamental concepts in Law of Contract, 3rd Edn. Professional Offset

1 . Neelima Chandiramani (2000), The Law of Contract: An Outline, 2nd Edn. Avinash Publications Mumbai

5. Avtarsingh (2002), Law of Contract, Eastern Book Co. 7. Dutt (1994), Indian Contract Act, Eastern Law House

6. T. Ramappa (2010), Intellectual Property Rights Law in India, Asia Law House 9. Bare text (2005), Right to Information Act

7. O.P. Malhotra, Law of Industrial Disputes, N.M. Tripathi Publishers
8. Ethics in Engineering- M.W. Martin& R. Schinzinger, McGraw-Hill
9. Engineering Ethics, National Institute for Engineering Ethics, USA.

11. Ethics & Mgmt and Ethos , Ghosh, VIKASH
12. Business Ethics; Concept and Cases, Velasqez, Pearson

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Structural Engineering

Course Code	PC-CE 502
Course Title	Structural Engineering
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Nil
Course Category	Professional core courses (PCC)
Number of classes	36 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Apply knowledge of structural mechanics in addressing design problems of structural engineering	K-3
CO-2	Predict problems dealing with analysis and design criteria of structures	K-3
CO-3	Model Structural Elements for design purpose	K-4
CO-4	Categorize analysis and design process of structures	K-3

Module 1: Introduction (9 hrs)

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 principles of process of design.

Module 2: Planning and Design Process (9 hrs)

Materials, Loads, and Design Safety; Behaviour and Properties of Concrete and Steel; Wind and Earthquake Loads.

Module 3: Materials and Structural Design Criteria (9 hrs)

Introduction to the analysis and design of structural systems. Analyses of determinate and indeterminate trusses, beams, and frames, and designphilosophies for structural engineering. Laboratory experiments dealing with the analysis of determinate and indeterminate structures;

Module 4: Design of Structural Elements (9 hrs)

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 for Flexure; 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

References / Suggested Learning Resources:

1. Schodek.D.L., Betchthold.M., *Structures.* 7th edition. Pearson,2014.
2. Schueller.W., *Building Support Structures- Analysis and Design using SAP2000 Software*. 2nd edition. Computers and Structures, Inc.,2008.

3.Galambos, T.V., Lin, F.J., Johnston, B.G., *Basic Steel Design with LRFD*, Prentice Hall, 1996
4.Segui, W. T., *LRFD Steel Design*, 2nd Ed., PWS Publishing, Boston.
5.Salmon, C.G. and Johnson, J.E., *Steel Structures: Design and Behavior*, 3rd Edition, Harper & Row, Publishers, New York, 1990.
6.MacGregor, J. G., *Reinforced Concrete: Mechanics and Design*, 3rd Edition, Prentice Hall,New Jersey, 1997.
7.Nawy, E. G., *Reinforced Concrete: A Fundamental Approach*, 5th Edition, Prentice Hall, NewJersey.
8.Wang C-K. and Salmon, C. G., *Reinforced Concrete Design*, 6th Edition, Addison Wesley,New York.
9.Nawy, E. G. *Prestressed Concrete: A Fundamental Approach*, Prentice Hall, NJ, (2003).
10. Related Codes of Practice of BIS
11. Smith, J. C., *Structural Analysis*, Harpor and Row, Publishers, New York.
12. W. McGuire, R. H. Gallagher and R. D. Ziemian. "Matrix Structural Analysis", 2nd Edition,John Wiley and Sons, 2000.
13. NBC, *National Building Code*, BIS (2017).
14. ASCE, *Minimum Design Loads for Buildings and Other Structures, ASCE 7-02*, AmericanSociety of Civil Engineers, Virginia, 2002.

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Design of Structures-I

Course Code	PC CE 503
Course Title	Design of Structures-I
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	--
Course Category	Professional core courses (PCC)
Number of classes	36 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Differentiate the basic difference between working stress, limit state & ultimate load method.	K-4
CO-2	Design the various types of beams with behavior of shear and deflections.	K-5
CO-3	Design the various components of buildings like slabs, columns, footings and stairs.	K-5
CO-4	Design isolated column foundation under axial load resting directly on bearing soil.	K-5

Module 1: Introduction to RCC and Design of Rectangular Beam in Flexure (9 hrs)

Introduction- Properties of concrete and reinforcing steel, characteristic strengths, stress-strain curves, I.S.

specifications. Design philosophies- Working stress, ultimate strength and limit state method of design. Flexure of beams by working stress and limit state methods- singly and doubly reinforced rectangular beam.

Module 2: Design of RCC Beam for Shear, Bond, Deflection and Cracking (9 hrs)

Behavior of beams in shear and bond, design for shear, anchorage, splicing of reinforcement and detailing of reinforcements. Design of flanged beam and cantilever beam. Limit state of deflection and cracking, calculation of deflections.

Module 3: **Design of RCC Slab, Lintel and Staircases (9 hrs)**

Design of one way and two-way slabs; circular slabs, yield line theory for slabs, lintel and stair cases.

Module 4: Design of RCC Column, Column Foundation and Prestressed Concrete (9 hrs)

Design of Short and Long columns, eccentrically loaded columns.

Design of isolated column foundation under axial load resting directly on bearing soil, for uniform thickness of the footing slab, with solution. Introduction to prestressed concrete-problems.

References / Suggested Learning Resources:

1. Limit state Design of Reinforced Concrete, P.C Vargheese, P.H.I. Publisher.
2. Limit State Design of R.C.C Structures, A.K. Jain, Nemchand Brothers.
3. Design of Reinforced Concrete Structures, N.Krishnaraju, CBS Publishers.
4. Reinforced Concrete Design, C.K.Wang & C.G. Salman, Harpur International Edition.
5. Reinforced Concrete Design, Mallik and Gupta, Oxford and IBH Publications.

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Hydrology and Water Resources Engineering

Course Code	PC CE 504
Course Title	Hydrology and Water Resources Engineering
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Nil
Course Category	Professional core (PC)
Number of classes	36 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Understand the various components of hydrologic cycle that affect the movement of water in the earth.	K-2
CO-2	Analyze and represent hydrological data.	K-4
CO-3	Measure precipitation and estimate abstractions from precipitation.	K-6

CO-4	Compute yield from a catchment and develop rainfall-runoff model.	K-6
CO-5	Formulate and solve hydrologic flood routing model.	K-6
CO-6	Understand the concept of ground water, Channel flow theories and apply in design of irrigation channels.	K-2

Course contents:-

Module 1: Introduction to Hydrology (9 hours)

Hydrology - definition & scope, Hydrologic cycle and its components, Hydrologic data variability, Hydrologic data analysis.

Precipitation- Formation and types, Forms, Measurement, Estimating missing precipitation data, Average precipitation over area, Depth-area-duration analysis, Abstractions from precipitation, Evapotranspiration and its measurement, Infiltration and its measurement, Interception process.

Module 2: Runoff and Hydrograph (9 hours)

Runoff components, Drainage basin characteristics, Factor effecting runoff, Hydrograph and its components, Base flow separation, Unit hydrograph– concept, derivation, limitations and use, S-hydrograph, Synthetic unit hydrograph, Instantaneous unit hydrograph. .

Module 3: Floods (9 hours)

Definition, Flood estimation, Rational method and unit hydrograph method, Flood routing: reservoir routing and channel routing, Flood frequency analysis.

Module 4: Ground Water Hydrology and Irrigation (9 hours)

Ground water hydrology
Occurrence of ground water, Aquifers, Movement of ground water, Darcy's law, Porosity, specific yield and specific retention, Yield from wells for confined and unconfined aquifers, Yield of an open well.

Irrigation- Water requirement of crops, duty and delta, soil- water relationships, root zone soil water, irrigation requirement and types of irrigation. Water distribution system, canal system, design of irrigation channels – Kennedy's theory and Lacey's theory of regime channels.

References / Suggested Learning Resources:

1. V. T. Chow, D. R. Maidment and L. W. Mays, "Applied Hydrology", McGraw Hill, 1st Edition, 1988.
2. K. Subramanya, "Engineering hydrology", McGraw Hill, 2nd Edition, 1994.
3. S K Jain, P K Agarwal and V P Singh, "Springer Hydrology and Water resources of India", 1st edition, 2007
4. V. P. Singh, "Elementary Hydrology", Englewood Cliffs, NJ : Prentice Hall, 1stEdition, 1992.

5. D. K. Tood and L. W. Mays, "Ground Water Hydrology", Wiley India Pvt. Ltd, 3rdEdition, 2004.
6. T Davie, Taylor and Francis, Fundamentals of Hydrology 2nd edition, 2008

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Transportation Engineering-I

Course Code	PC CE 505
Course Title	Transportation Engineering-I
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Nil
Course Category	Professional core (PC)
Number of classes	36 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Build up surveys involved in planning and highway alignment and design the geometric elements of highway.	K-3 & K-6
CO-2	Examine and characterize the various pavement materials.	K-4
CO-3	Design flexible and rigid pavements as per IRC.	K-6
CO-4	Identify the various problem related to traffic studies with traffic control systems.	K-3

Course Contents:-

Module- 1: Highway development and planning (10 hours)

Classification of roads, road development in India, current road projects in India; highway alignment and project preparation, geometric design of highways with cross section elements; sight distance, design of horizontal alignment; design of vertical alignment; design of intersections, problems

Module- 2: Pavement Materials (8 hours)

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.

Module- 3: **Pavement Design (10 hours)**

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; pavement failures; highway drainage.

Module- 4: Traffic Engineering & Control (10 hours)

Traffic engineering & control- Traffic Characteristics, traffic engineering studies, traffic flow and capacity, introduction to shockwaves and delay studies, traffic regulation and control; design of road intersections; design of parking facilities; highway lighting; problems; traffic signs and marking:

References / Suggested learning Resources:-

1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017
2. L R Kadiyali, N B Lal, Principles and practice of highway engineering, Khanna Publications, 2005
3. Principles of Transportation Engineering, Partha Chakraborty, PHI Learning, 1st edition
4. Principles of Highway Engineering and Traffic Analysis, 4th Edition, Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski, John Wiley

Reference Books:

1. Morlok, E.R., An Introduction to Transportation Engineering and Planning, McGraw Hill, NY, 1970
2. Hay W.W., Introduction to transportation Engineering, John Wiley & Sons, NY, 1988.
3. Papacostas C.S., Fundamentals of transportation Engineering, Prentice Hall of India, 1987.
4. Srinivasa Kumar, R, Textbook of Highway Engineering, Universities Press, 2011.

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Environmental Engineering

Course Code	PC CE 506
Course Title	Environmental Engineering
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Environmental Science
Course Category	Professional core (PC)
Number of classes	36 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Explain air pollution, noise pollution, solid waste management.	K-5
CO-2	Elaborate water demand and water quality, design water treatment plant and explain the distribution of treated water.	K-5, K-6
CO-3	Explain the characteristics of sewage and sewerage system	K-5
CO-4	Design the sewage treatment plant and explain the disposal of waste water.	K-5, K-6

Course Contents:-

Module 1: Air Pollution, Municipal Solid Waste and Noise Pollution (9 hours)

Air Pollution: Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits.

Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid wastes management (reuse/ recycle energy recovery, treatment and disposal).
Noise Pollution: Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution. Water Demand: Design flows, design Hours, and design population, factors affecting water consumption, water demand, and design capacities for various water supply components.

Module 2: Quantity of Water and Distribution of Water (9 hours)

Quality of Water: The hydrological cycle and water quality, physical, chemical and biological water quality, water quality parameters, water quality requirements, Indian standards. Treatment of Water: Historical overview of water treatment, water treatment process, water treatment process (Theory and Application): Aeration, solid separation, settling operations, coagulation, softening, filtration, disinfections, other treatment process: dissolved solid removal, treatment design, preparation of hydraulic profiles.
Distribution of Water: Methods of distribution of water, distribution reservoirs, distribution systems, distribution system components, capacity and pressure requirements, design of distribution system, hydraulic analysis of distribution systems, Storage capacity of distribution reservoir, pumping required for water supply systems.

Module 3: Water and Waste Water (9 hours)

General Terms: Sewerage, domestic Sewage, Sewage treatment, Disposal, Scope, role of an Environmental Engineer. Historical overview Sewage Characteristics Quality parameters: BOD, COD, TOC, Solids, DO, Nitrogen, Phosphorus, Standards of disposal into natural water courses and on land, Indian standards.
Collection of Sewage System of sewerage: Separate, combined and partially separate, components of sewerage systems, systems of layout, Quantity of sanitary sewage and variations, quantity of storm water, rational method, shapes of sewer, circular and egg shaped, Hydraulic design of sewers: diameter, self-cleansing velocity and slopes, Construction and testing of sewer lines, Sewer materials, joints and appurtenances, sewage pumping and pumping stations, Maintenance of Sewerage system.

Module 4: Sewage Treatment and Waste Water Disposal (9 hours)

Sewage Treatment Various units: Their purposes sequence and efficiencies, Preliminary treatment: Screening and grit removal units oil and grease removal, Primary treatment, Secondary Treatment: activated sludge process, trickling filter, Sludge digestion and drying beds. Stabilization pond, Septic tank, soakage systems, Imhoff tank, Recent trends in sewage treatment, advanced wastewater treatment: nutrient removal, solids removal.
Wastewater Disposal and Reuse Disposal of sewage by dilution, self-purification of streams, sewage disposal by irrigation & sewage farming, wastewater reuse. Plumbing for Drainage of Buildings Various systems of plumbing- one pipe, two pipe, single stack, traps, Layout of house drainage.

References / Suggested learning Resources:-

1. Environmental Engineering Peavy, H.S.,Rowe,D.R and Tchobanoglous McGraw Hill Book Company,1985.
2. Water and waste water Engineering fair,G.M.,Geyer,J.C and Okun,D.S fair,G.M.,Geyer,J.Cand Okun,D.S

3. Water supply and Pollution Control Viessman,Jr.andHammer,M.J Harper Collins College publishers,1985.
4 Water supply, Waste Disposal A.K.ChatterjeeKhanna Publishers and Environmental Pollution Engineering.
5.Water supply and sanitary S.C.Rangawala, Engineering K.S.RangawalaCharotar publishing P.S.Rangawala housing
6. Water supply and sanitryG.S.Birdie& J.S. Birdie DhanpatRai Engineering publishing
Company, New Delhi.
7. Environmental Engineering Peavy H.S., McGraw Hill Book Row D.R. and Company, 1985 Tchobanoglous G
8. Environmental Engineering (Vol. I) Water Supply Engineering ,S K Garg, Khanna Publishers
9. Sewage Disposal and Air Pollution Engineering S.K.Garg, Khanna Publishers, Pollution Control Engineering 1979. Environmental Engineering Vol.II.

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Structural Engineering Lab.

Course Code	PC CE 507
Course Title	Structural Engineering Lab.
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Professional core (PC)
Number of classes	20 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Review the physical behavior of cement and concrete	K-2
CO-2	Predict the behavior arches and frame structures	K-3
CO-3	Compute the bond strength between steel bar and concrete	K-3
CO-4	Analyze the behavior of RCC structures,	K-4

Course Contents:-

List of Experiments (*Minimum 6 or more experiments are to be performed. Use of virtual laboratory to perform few experiments may be explored, if available****):***

1. Water content for standard consistency of cement.
2. Initial and final setting times of cement
3. Soundness of Cement by Le-Chatalier's Apparatus &Autoclave test method.
4. Compressive strength & tensile strength of cement.
5. Water absorption, compressive strength of Bricks.
6. Behaviour of pre-stressed concrete beams in flexure.
7. Ultimate strength and deflection of R.C.C. slab.

8. Behaviour of under reinforced and over reinforced R.C. beams in flexure.
9. Behaviour of R.C. beams, with and without shear reinforcement in shear.
10. Bond strength between steel bar and concrete (a) in a beam specimen and (b) by pull-out test.
11. Two and Three hinged arch.
12. Verification of Muller-Breslau principle-Arch / continuous beam / frame models.
13. Fineness of cement by sieving & air permeability method.
14. Tensile and bend test of M.S and HYSD bar.

References / Suggested learning Resources:-

1. Basic Structural Analysis, Reddy, C. S., Tata McGraw Hill.
2. Elementary Structural Analysis, Norris and Wilbur, Tata McGraw Hill.
3. Theory & Analysis of Structures, Jain, O. P.and Jain B. K, Nem Chand &Vol.I & II Bros .
4. Theory of Structures, Vol. II Jain, O.P. &Arya A. S em Chand &Bors.,
5. Indeterminate Structural Analysis Wang, C. K, McGraw Hill Book Company
6. Matrix Analysis of framed Structures, Weaver, W. & Gere, J. M., CBS Publishers & Distributors, Delhi.
7. Structural Dynamics, Mario Paz, CBS publishers and Distributors
8. Dynamics of Structurs, A. K. Chopra

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Hydrology and Water Resources Engineering Lab.

Course Code	PC CE 507
Course Title	Hydrology and Water Resources Engineering Laboratory
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Program core (PC)
Number of classes	24 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Measure precipitation by different methods.	K-5
CO-2	Estimate abstractions from precipitation.	K-6
CO-3	Analyse rainfall data.	K-6
CO-4	Determine the velocity of water in a canal and calculate discharge.	K-5
CO-5	Demonstrate the concept of ground water storage, and its movement.	K-2

List of Experiments (*Minimum 6 or more experiments are to be performed. Use of virtual laboratory to perform few experiments may be explored, if available****):***

(a) Rainfall measurement using rain gauge.
(b) Rainfall measurement by Theisen polygon method.
(c) Measurement of infiltration using double ring infiltrometer.
(d) Evaporation measurement using evaporimeter.
(e) Analysis of rainfall data.
(f) Determination of velocity of water in a canal by current meter and calculation of approximate discharge of the canal.
(g) Determination of hydraulic conductivity.
(h) Steady flow into a well in unconfined aquifer.
(i) Steady flow into a well in confined aquifer.
(j) Abstractions from a single well in an unconfined aquifer.
(k) Applications of Remote sensing and GIS in Water Resources Engineering.
(l) Study on Weather Station.

References / Suggested learning Resources:-

1. V. T. Chow, D. R. Maidment and L. W. Mays, "Applied Hydrology", McGraw Hill, 1st Edition, 1988.
2. K. Subramanya, "Engineering hydrology", McGraw Hill, 2nd Edition, 1994.
3. V. P. Singh, "Elementary Hydrology", Englewood Cliffs, NJ : Prentice Hall, 1st Edition, 1992.
4. D. K. Tood and L. W. Mays, "Ground Water Hydrology", Wiley India Pvt. Ltd, 3rd Edition, 2004.
5. David R. Maidment, "Handbook of Hydrology", McGraw Hill, Ist Edition 1993

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Environmental Engineering Lab.

Course Code	PC CE 507
Course Title	Environmental Engineering Lab.
Number of Credits	2 (L: 0, T: 0, P: 4)
Prerequisites	Nil
Course Category	Program core (PC)
Number of classes	40 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Analyze sound samples, solid waste and air sample.	K-4
CO-2	Measure Physical parameters of water	K-5
CO-3	Measure Chemical parameters of water	K-5
CO-4	Measure Physical and chemical parameters of waste water	K-5

List of Experiments (*Minimum 10 or more experiments are to be performed. Use of virtual laboratory to perform few experiments may be explored, if available****):***

1. Collection and analysis of sound samples.

2. Classification of Solid wastes.
3. Air volume sampling.
4. Determination of turbidity, colour and conductivity.
5. Determination of pH, alkalinity and acidity.
6. Determination of hardness and chlorides.
7. Determination of residual chlorine and chlorine demand.
8. Determination of Dissolved Oxygen.
9. Determination of Most Probable Number (MPN) of Coliforms.
10. Determination of B.O.D of sewage
11. Determination of C.O.D of domestic and industrial sewage.
12. Determination of kjeldal nitrogen
13. Determination of volatile, mixed, filterable and dissolved solids.
14. Determination of optimum dose of coagulants.
15. Determination iron and two heavy metals.
16. Determination of SO2 in the ambient air.
17. Measurement of particulate matter in air.

References / Suggested learning Resources:-

1. Environmental Engineering Peavy, H.S.,Rowe,D.R and Tchobanoglous McGraw Hill BookCompany,1985.
2. Water and waste water Engineering fair,G.M.,Geyer,J.C and Okun,D.S fair,G.M.,Geyer,J.C and Okun,D.S
3. Water supply and Pollution Control Viessman,Jr.andHammer,M.J Harper Collins College publishers,1985.
4 Water supply, Waste Disposal A.K.ChatterjeeKhanna Publishers and Environmental Pollution Engineering.
5. Water supply and sanitary S.C.Rangawala, Engineering K.S.RangawalaCharotar publishing P.S.Rangawala housing
6. Water supply and sanitryG.S.Birdie& J.S. Birdie DhanpatRai Engineering publishing Company, New Delhi.
7. Environmental Engineering Peavy H.S., McGraw Hill Book Row D.R. and Company, 1985 Tchobanoglous G
8. Sewage Disposal and Air S.K.Garg, Khanna Publishers, Pollution Control Engineering 1979.Environmental Engineering Vol.I

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Industry Internship – I

Course Code	SI CE 503
Course Title	Industry Internship – I
Number of Credits	1 (L: 0, T: 0, P: 0)
Prerequisites	Nil
Course Category	Summer Internship (SI)
Number of classes	-

Course Outcome:-

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

CO Number	CO Description	K-level
CO-1	Solve real life challenges in the workplace by analysing work environment and conditions, and selecting appropriate skill sets acquired from the course of study	K-3
CO-2	Develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organisational setting	K-3
CO-3	Demonstrate the skill to communicate and collaborate effectively and appropriately with different professionals in the work environment through written and oral means	K-2
CO-4	Show professional ethics by displaying positive disposition during internship.	K-2
CO-5	Decide career options by considering opportunities in company, sector, industry, professional, educational advancement and entrepreneurship;	K-5

Course Content:-

The industry internship aims to provide the student with:

1. A practice-oriented and 'hands-on' working experience in the real world or industry, and to enhance the student's learning experience.

2. An opportunity to develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organisational setting.

3. An opportunity to further develop and enhance operational, customer service and other life-long knowledge and skills in a real world work environment.

4. Pre-employment training opportunities and an opportunity for the company or organisation to assess the performance of the student and to offer the student an employment opportunity after his/her graduation, if it deems fit.

Each student shall

1) Identify an internship program of relevance in his/her branch of engineering to undergo during summer break between 4th and 5th semester,

2) Get approval of the concerned HOD,
3) Undergo the industry internship program for minimum 4 weeks duration
4) Prepare their own report
5) Present in the class among fellow students and faculty members / deliver viva voce.
6) Submit the report and participation/course completion certificate.

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SIXTH SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Total Marks
1.	Program Core-21	PC CE 601	Design of Structures-II	3	0	0	3	3	100
2.	Program Core-22	PC CE 602	Civil Engineering Estimation and Costing	3	0	0	3	3	100
3.	Program Core-23	PC CE 603	Foundation Engineering	3	0	0	3	3	100
4.	Program Core-24	PC CE 604	Transportation Engineering-II	3	0	0	3	3	100
5.	Program Core-25	PC CE 605	Foundation Engineering Lab.	0	0	2	2	1	100
6.	Program Core-26	PC CE 606	Transportation Engineering Lab.	0	0	2	2	1	100
7.	Program Core-27	PC CE 607	CAD in Civil Engineering	0	0	2	2	1	100
8.	Program Elective-1 (any one)	PE CE 608/1	Hydraulic Engineering	3	0	0	3	3	100
		PE CE 608/2	Construction Engineering and Management	3	0	0			
		PE CE 608/3	Prestressed Concrete	3	0	0			
9.	Project - 1	PR CE 609	Mini Project	0	0	6	6	3	100
			Total :	15	0	12	27	**21**	**900**

Design of Structures-II

Course Code	PE CE 601
Course Title	Design of Structures-II
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Nil
Course Category	Professional Core (PC)
Number of classes	36 hours

Course Outcome:- After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Design riveted and welded steel connections.	K-5
CO-2	Design steel tension and compression members.	K-5
CO-3	Design steel beams and plate girders.	K-5
CO-4	Design foundation used in steel structures and steel industrial roofs.	K-5

Course Contents:-

Module 1: Riveted and Welded Connections (9 hours)

Properties of structural steel, I.S. Rolled Sections, I.S. Specifications. Factor of safety, permissible and working stresses, elastic method, plastic method, introduction to limit states of design. Riveted, bolted and welded connections, strength & efficiency and design of joints.

Module 2: Tension and Compression Members (9 hours)

Tension Members- Design of tension members. Compression members-Strut and column, built-up column, column with lacings and batten, Column splices.

Module 3: Steel Beams (9 hours)

Beams-Stability of flange and web, build-up sections, plate girders including stiffeners, connections, web crippling, web buckling. Design of web splice. Beam-column connection- Stability considerations, Interaction formulae. Welded Plate Girder.

Module 4: Steel Column, Column Bases and Roof Truss (9 hours)

Columns and Bases- Design of columns under axial loads using single or multiple rolled steel sections, columns subjected to axial load and bending, design of slab base, gusseted base and grillage footing. Roofing systems and simple design of industrial roofs.

References / Suggested learning Resources:-

1. Limit State Design of Steel Structures IS:800-2007, V.L.Shah and Veena Gore, Structures Publications, 2010.
2. Design of Steel Structures, S.S.Bhavikatti , I.K. International Publishing House Limited, 2010.

3. Design of Steel Structures, Ramchandra, Standard book House (Vol –I, II). 4.Design of Steel Structures, L.S.Negi, Tata McGraw Hill.
5.Design of steel structures, A.S Arya & J.L.Azmani, Nemchand&Brothers.
6. Design of Steel Structures, N. Subramanian, Oxford University Press, 2010
7. Relevant IS Codes

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Civil Engineering Estimation and Costing

Course Code	PE CE 602
Course Title	Civil Engineering Estimation and Costing
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Basic Units
Course Category	Professional Core (PC)
Number of classes	36 hours

Course Outcome:- After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Explain types of estimate and duties of estimator and also calculate the quantity with cost in detail of various Civil Engineering works.	K-2, K-5
CO-2	Detecting the rates for various items of Civil work.	K-5
CO-3	Implementing different specification of construction items.	K-3
CO-4	Focusing on tender and tender documents for execution of works and also the valuation of the property.	K-4

Course Contents:-

Module 1: Estimate of Buildings **9 Hours**

Estimates-Various types, their relative importances. Factors to be considered complete set of Estimate. Approximate estimates- importance, purpose, different methods. Methods of preparation of estimates for projects such as: R.C.C. Building and Load bearing Building.

Module 2: Measurement of Various Items **9 Hours**

Use of 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, Earthwork Calculations. Material survey-Thumb rules for computation of materials requirement for different materials for buildings, percentage breakup of the cost, cost sensitive index, market survey of basic materials. Estimate of Road, Culvert and Irrigation.

Module 3: Specifications and Rate Analysis **9 Hours**

Specifications-Types, requirements and importance, detailed specifications for the buildings, roads, minor bridges and industrial structures. Rate analysis-Purpose, importance and necessity of the same, factors affecting, task work, daily output from different equipment.

Estimate of water supply and sewerage: miscellaneous works like Manhole, water storage tank, septic tanks; trusses of steel.

Module 4: Tender and Contracts **9 Hours**

Tender- Preparation of tender documents, importance of inviting tenders, contract types, relative merits, prequalification. general and special conditions, termination of contracts, extra work and items, penalty and liquidated charges, Settlement of disputes, R.A. Bill & Final Bill, Payment of advance, insurance, claims, price variation, etc. Introduction to acts pertaining to-Minimum wages, Workman's compensation, Contracts, Arbitration, Easement rights, Valuation.

Team Work Assignments to include:

1. To find out the approximate estimate of a single-storied building by approximate method.
2. Detailed estimate of the following with the required material survey for the same.
    a. ground plus two storied building (RCC)
    b. bridge with minimum 2 spans
    c. road work
    d. cross drainage work
    e. load bearing structure
3. Assignments on rate analysis, specifications and simple estimates.
4. Bar bending schedule.

References / Suggested learning Resources:-

1. M Chakravarty, Estimating, Costing Specifications & Valuation.
2. Joy P K, Handbook of Construction Management, Macmillan.
3. B.S. Patil , Building & Engineering Contracts.
4. Relevant Indian Standard Specifications.
5. World Bank Approved Contract Documents.
6. FIDIC Contract Conditions.
7. Acts Related to Minimum Wages, Workman‟s Compensation, Contract, and Arbitration.

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Foundation Engineering

Course Code	PC CE 603
Course Title	Foundation Engineering
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Geotechnical Engineering
Course Category	Program Core
Number of classes	38 hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	To compute the exploration and determine the bearing capacity and settlement of soil.	K-3
CO-2	To practice the ground improvement and analyze and design the substructures.	K-3 & K-4 & K-5
CO-3	To analyze the lateral earth pressure and retaining structure.	K-4
CO-4	To assess the fundamentals of pile foundations and underground conduits including cuts.	K-6

Course Content:

Module 1: Exploration, Bearing Capacity and Settlement (11 hours)

Introduction- Foundations: their importance and purpose, types of foundations- selection criteria.

Exploration, Sampling and In Situ soil measurements- Data required, methods of exploration, planning of exploration program, Number and depth of boring, the standard penetration test (SPT), SPT correlations, Cone penetration test (CPT), bore log preparation.

Bearing Capacity of Shallow Foundations- Introduction, Definitions of ultimate, net ultimate, net safe, gross safe bearing capacity, net safe settlement pressure, net allowable bearing pressure, modes of failure in soil. Bearing capacity theories: Terzaghi's approach (1943), Meyerhof's (1963) general bearing capacity, Vesic (1973), IS code of practice for computing bearing capacity, Effect of water table on bearing capacity, bearing capacity equations for square and circular footings, performance of footings in different soils, ultimate bearing capacity in case of local shear failure, ultimate bearing capacity of footings based on the SPT(N) and CPT values. Field Plate load test and estimation of allowable bearing pressure by plate load test,

Settlement of foundation- Types of settlement under load, determination of immediate settlement of cohesive and cohesionless soil, consolidation settlement of cohesive soil.

Module 2: Ground Improvement and Foundation Design (8 hours)

Improvement site soils for foundation use- different approaches to soil properties modification, mechanical compaction: determination of zero air voids line, effect of compaction on engineering behaviour, field compaction and control; compaction for deeper layers of soil: vibroflotation, dropping of heavy weight,

blasting; preloading: sand drain and wick drains; sand compaction pile and stone columns; stabilization by use of admixtures.

Analysis of factors considered in foundation design- footing depth and spacing, displaced soil effects, erosion problems for structures adjacent to flowing water, corrosion protection, water table fluctuation, volume change related consideration, environmental consideration.

R.C.C. design of isolated and combined footings.

Module 3: Lateral Earth Pressures and Retaining Structure (10 hours)

Lateral Earth Pressures - Introduction: applications of earth pressure theories, different types of lateral earth pressure, Rankine's Earth Pressure Theory, active earth pressure and passive earth pressure for horizontal and inclined backfill including the direction of failure Planes for cohesion-less and cohesive soils. Coulomb's Wedge Theory: Coulomb's active pressure in cohesion-less soils, expression for active pressure, Coulomb's passive earth pressure. Culmann's graphical solutions for active soils, Wedge Method, passive pressure by friction circle method for cohesion-less and cohesive soils.

Earth Retaining Structures- types of retaining walls, Rigid and flexible retaining structures, stability analysis of retaining walls, cantilever retaining Walls, construction details, drainage and wall joints, Stability of the gravity and cantilever retaining wall.

Module 4: Pile Foundation and Underground Conduits (9 hours)

Axially Loaded Pile Foundations- Introduction to pile foundations, necessity of pile foundation, classification of piles, construction methods of bored piles, concrete bored piles, driven cast in-situ piles. Pile capacity based on static analysis, piles in sand, piles in clay, dynamic methods and their limitations, in-situ penetration tests and pile load test as per IS 2911 specifications, negative skin friction, Pile groups, ultimate capacity of pile groups.

Underground Conduits- Classes of underground conduits, load on a ditch conduit, settlement ratio, ditch condition and projection condition, imperfect ditch conduit.

Open Cuts-Difference in open cuts and retaining walls, apparent pressure diagrams, average apparent pressure diagrams for sand and stiff clay, estimation of loads on struts.

Sheet pile- types and materials used for sheet pile, pressure distribution in sheet pile, cantilever Sheet pile in granular and cohesive soil.

References / Suggested Learning Resources:

1. Soil Mechanics and Foundation Engineering (Geotechnical Engineering Series) by V.N.S. Murthy, CBS Publishers and distributor Pvt. Ltd.
2. Foundation analysis and design by J.E. Bowles , McGraw-Hill Companies.
3. Soil mechanics and Foundations by B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, Laxmi publications (p) Ltd.
4. Soil Mechanics and Foundation Engineering by K.R. Arora, Standard Publishers Distributors..
5. Soil Mechanics in Engineering Practice by K. Terzaghi& R.B. Peck Wiley 3rd Ed.
6. Design Aids in Soil Mechanics and Foundation Engineering by S.R. Kaniraj, TMH New Delhi, 2004

7. Foundation Design Manual by N.V. Nayak, Dhanpat Rai Publications, New Delhi
8. Relevant Indian Standard Specifications and Codes.
9. A. Singh, Modern Geotechnical Engineering, 3rd Ed., CBS Publishers, New Delhi, 1999.
10. B.M. Das, Principles of Foundation Engineering, 5th Ed., Thomson Asia, Singapore, 2003.
11. N. Som, Theory and Practice of Foundation Design, Prentice Hall, New Delhi, 2003.

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Transportation Engineering-II

Course Code	PE CE 604
Course Title	Transportation Engineering-II
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Nil
Course Category	Professional Core (PC)
Number of classes	38 hours

Course Outcome:- After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Explain and develop the basic knowledge of different components of railway track	K-2 & K-3
CO-2	Develop a clear idea on various layouts of track junctions, station and yards with operations of signaling and interlocking.	K-3
CO-3	Develop as well as can apply the various alternative steps involved in airport planning and design of runways, taxiways.	K-3
CO-4	Identify the various classifications of ports and harbour with navigational facilities.	K-3

Course Contents:-

Module- 1: Different components of Railway Track (10 hours)

Railway track gauge, alignment of railway lines, engineering surveys and construction of new lines, tracks and track stresses; rails, sleepers; ballast; subgrade and formation, track fittings and fastenings, creep of rails, geometric design of track, curves and super-elevation.

Module- 2: Track junctions with signalling and interlocking (8 hours)

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.

Module- 3: **Airport planning and design (10 hours)**

Aircraft characteristics; Aircraft performance characteristics: airport planning and air travel demand forecasting: airport site selection; geometric design of the airfield: determination of runway capacity, taxiway, exit taxiway and gate Capacity - terminal area and airport layout, airport drainage, airport marking and lighting, air traffic control.

Module- 4: Ports and Harbour (10 hours)

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, turning basin, harbour entrances, type of docks, its location and number, Docks and Repair Facilities: breakwaters, berthing structures - jetties, fenders, piers, wharves, dolphins, trestle, moles, Harbour docks, use of wet docks, repair docks, lift docks, dry docks, keel and bilge blocking, floating docks, slipways, lock gates, Navigational Aids, light houses, beacon lights, floating navigational aids, light ships, buoys, Port facilities: Port development, port planning, port building facilities, transit sheds, warehouses, cargo handling facilities, container handling terminal facilities, shipping terminals, inland port facilities.

References / Suggested learning Resources:-

1. Saxena S.C. and Arora S. P., A Course of Railway Engineering, DhanpatRai, New Delhi
2. Khanna and Arora, Airport Planning & Design, Nemchand Bros, Roorkee
3. Agarwal, M. M. (1991). Indian Railway Track, Sachdeva Press, New Delhi
4. Bindra S.P., Docks & Harbor Engineering, DhanpatRai, New Delhi
5. R Shrinivasan, Harbor Dock and Tunnel Engineering 6. Rao G.V., Airport Engineering, Tata McGraw Hill.
6. Horonjeff&Mcklerey, Planning & Design of Airport.
7. Quinn A D, Design and Construction of Ports and Marine Structures.

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Foundation Engineering Lab.

Course Code	PC CE 605
Course Title	Foundation Engineering Lab
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Geotechnical Engineering
Course Category	Program Core
Number of classes	24 hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	To collect the disturb and undisturbed soil sample for laboratory experiments	K-2

CO-2	To determine bearing capacity, relative density of soil by using in-situ test.	K-3
CO-3	To assess the settlement and bearing capacity of shallow and deep footing by loading test.	K-3
CO-4	To calculate the bearing capacity of soil in the laboratory by Model footing test	K-4
CO-5	To assess the swelling characteristics of soil	K-3

Course Content:

List of Experiments (*Minimum 6 or more experiments are to be performed. Use of virtual laboratory to perform few experiments may be explored, if available****):***

1. Disturb and undisturbed sampling of soil by using standard sampler
2. Determination of soil characteristics like ultimate bearing capacity, relative density of soil by using Standard Penetration Test (SPT)
3. Determination of bearing capacity of soils with the help of Static Cone Penetration Test (SCPT)
4. Asses the bearing capacity of soil corresponding to a given settlement by plate load test.
5. Measure of settlement of pile under working load by using pile load test
6. Predict the bearing capacity of footing in the laboratory by Model footing test.
7. Evaluation of in-place shear strength of saturated clay of soft consistency by field vane shear test
8. Asses the differential free swelling of soil.

References / Suggested Learning Resources:

1. Soil Mechanics and Foundation Engineering (Geotechnical Engineering Series) by V.N.S. Murthy, CBS Publishers and distributor Pvt. Ltd.
2. Soil mechanics and Foundations by B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, Laxmi publications (p) Ltd.
3. Soil Mechanics and Foundation Engineering by K.R. Arora, Standard Publishers Distributors..
4. Soil Mechanics in Engineering Practice by K. Terzaghi& R.B. Peck Wiley 3rd Ed.
5. Design Aids in Soil Mechanics and Foundation Engineering by S.R. Kaniraj, TMH New Delhi, 2004
6. Foundation Design Manual by N.V. Nayak, Dhanpat Rai Publications, New Delhi
7. Relevant Indian Standard Specifications and Codes.
8. A. Singh, Modern Geotechnical Engineering, 3rd Ed., CBS Publishers, New Delhi, 1999.
9. N. Som, Theory and Practice of Foundation Design, Prentice Hall, New Delhi, 2003.

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Transportation Engineering Lab.

Course Code	PC CE 606
Course Title	Transportation Engineering Lab.
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Program Core (PC)
Number of classes	20 hours

Course Outcome: After completion of this course the students will be able to:

CO Number	CO Description	K-level
CO-1	Explain and develop the various characteristics of road aggregates.	K-2
CO-2	Determine the CBR value for road construction.	K-5
CO-3	Infer the suitability of road aggregates for the construction of road.	K-2
CO-4	Determine and characterize the pavement materials (Bitumen)	K-5
CO-5	Develop quality control tests on pavements and pavement materials.	K-3

Course Content:

List of Experiments (*Minimum 6 or more experiments are to be performed. Use of virtual laboratory to perform few experiments may be explored, if available****):***

1. Determination of Water absorption and Specific gravity of road aggregates.
2. Determination of Impact Test of aggregates.
3. Los Angel's abrasion and Devel's abrasion test.
4. Determination of Crushing Strength of Aggregates.
5. Determination of Flakiness and Elongation Indices of aggregates, Angularity number.
6. Determination of CBR value (Lab) and CBR value (Field).
7. Determination of penetration test of bitumen.
8. Determination of viscosity of bitumen.
9. Determination of Specific Gravity and Softening point of bitumen.
10. Determination of Ductility of bitumen.
11. Determination of Water content of bitumen.
12. Determination of Loss on Heating of bitumen.
13. Marshal Test.

References / Suggested Learning Resources:

1. Concrete Technology, M.S.Shetty, S.Chand &Comp. Ltd.
2. Method of Test for aggregate IS: 2386 (Part I,II,III,IV) 1963. Bureau of Indian Standards for concrete.
3. Determination of Specific Gravity of bitumen. IS: 1202-1978(I)Bureau of Indian Standars.
4. Determination of Viscosity of bitumen. IS: 1206-1978(I)Bureau of Indian Standards.
5. Determination of Flash Point of bitumen. IS: 1209-1978, Bureau of Indian Standards.

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CAD in Civil Engineering

Course Code	PC CE 607
Course Title	CAD in Civil Engineering
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Program core (PC)
Number of classes	24 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Develop graphical skills for communicating concepts, ideas and designs of engineering products graphically/visually as well as understand another person's designs.	K-3
CO-2	Create, analyse, Produce and interpret 2D & 3D drawings.	K-6
CO-3	Examine a design critically and also develop drawings for conventional structures using 2D and 3D Computer Aided Design and drafting softwares.	K-4
CO-4	Understand the need for software tools in analysis and design in Civil Engineering systems	K-4

List of Experiments (*Minimum 6 or more experiments are to be performed. Use of virtual laboratory to perform few experiments may be explored, if available****):***

1. Introduction and getting started with computer aided drafting software.
2. Practice exercises on CAD commands.
3. Page set up in a layout and Plotting in CAD.
4. Drawing of Plans of single storey/ multi-storeyed residential buildings using software.
5. Developing sections and elevations for single storey/ multi-storeyed public buildings using software.
6. Layout and section of water supply and drainage connections to a building.
7. Symbols for electrical installations, water supply and sanitary fixtures.
8. Perspective view of one and two storey buildings.
9. Reinforcement drawings for typical slabs and beams, columns and spread footings.
10. Introduction to 3D modelling using software.
11. Developing a 3D modelling of a building.
12. Design and analysis of RCC buildings using ETABS, SAP, STAAD Pro Softwares etc.

References / Suggested Learning Resources:

1. Subhash C sharma & Gurucharan Singh(2005), "Civil Engineering Drawing," Standard Plublishers.
2. Sikka, V.B (2013), A course in civil Engineering Drawing, S.K. Kataria & Sons,
3. CAD software theory and User Mannuals.
4. Sham Tickoo Swapna D (2009), "2009, "AUTOCAD for Engineers and Designers", Pearson Education,
5. Balagopal and Prabhu (1987), "Building Drawing and detailing", Spades publishing KDR building , Calicut,
6. Autocad 2019 user manual.
7. Software Manuals.

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Hydraulic Engineering

Course Code	PE CE 608/1
Course Title	Hydraulic Engineering.
Number of Credits	3 (L: 3, T: 0, P: 0)

Prerequisites	Fluid Mechanics
Course Category	Program Elective (PE)
Number of classes	38 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Distinguish open channel flow, pipe flow and analyse critical flow.	K-4
CO-2	Develop understanding of uniform flow and Design the most economical channel section.	K-6
CO-3	Compute gradually varied flow.	K-6
CO-4	Formulate and solve rapidly varied flow problems.	K-6

Course contents:-

Module 1: Open Channel Flow (9 hours)

Introduction to open channel flow, difference between Open channel flow and pipe flow, classification of open channel flows, velocity and pressure distributions, energy and momentum coefficients in open channel flow and their needs.

Critical Flow- Conservation of mass, conservation of momentum and conservation of energy, specific energy and specific force concepts, introduction to critical flow and computation, various methods for critical depth estimation.

Module 2: Uniform Flow (9 hours)

Introduction to uniform flow, flow resistance formulas, roughness coefficient, computation of uniform flow using different methods, hydraulically most efficient channel sections, most economical channel design.

Module 3: Gradually Varied Flow (10 hours)

Introduction to gradually varied flow, governing equation of gradually varied flow, classification and characteristics of water-surface profiles, sketching of water-surface profiles, computation of gradually varied flow: direct-step method and standard step method, numerical methods for calculation of gradually varied flow.

Module 4: Rapidly Varied Flow (10 hours)

Introduction to rapidly varied flow, hydraulic jump, classification and practical application of hydraulic jump, ratio of sequent depths, height and length of jump, energy loss and jump location.
Energy dissipations and other uses, surge as a moving hydraulic jump. Positive and negative surges.

References / Suggested Learning Resources:

1. M. H. Chaudhry, “Open Channel Flow”, Prentice Hall, 2nd Edition, 2008
2. K.G., RangaRaju, “Flow Through Open Channels”, Tata McGraw Hill, 2nd Edition 1993.
3. K Subramanya, Flow in open channels, McGraw Hill, 3rd edition, 2009
4. F. M. Henderson, “Open Channel Flow”, Tata McGraw Hill, 1st Edition, 1992.

5. V.T. Chow, “Open Channel Hydraulics”, Tata McGraw Hill, 3rdEdition, 2009.
6. M M Das, Open channel flow, PHI, 3rd edition, 2011.

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Construction Engineering and Management

Course Code	PE CE 608/2
Course Title	Construction Engineering and Management
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Nil
Course Category	Professional Elective courses (PE)
Number of classes	38 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Describe how structures are built and projects are developed on the field.	K-1
CO-2	Explain about modern construction practices.	K-2
CO-3	Describe how different construction machineries are work	K-2
CO-4	Develop plan, control and monitor construction projects with respect to time and cost.	K-5

Course Contents:-

Module 1:- **Construction Project Planning (10 hours)**

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, calculation of probability of completion.

Module 2: Construction Methods (9 hours)

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;

Module 3: Construction Equipments (9 hours)

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 4: Planning, Organizing Construction Site and Resources (10 hours)

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.

References / Suggested Learning Resources:

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

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Prestressed Concrete

Course Code	PE CE 608/3
Course Title	Prestressed Concrete
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Design of Structures-I
Course Category	Professional Elective courses (PE)
Number of classes	36 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Explain the basic concept and general principles of pre-stressed concrete sections.	K-2
CO-2	Select the relevant precast concrete element for a given type of construction.	K-3, K-5
CO-3	Use relevant components for prefabricated structures.	K-3
CO-4	Design of simply supported pre-tensioned and post tensioned slabs and beams.	K-6

Course Contents:

Module 1: Introduction to Pre-stressed Concrete 9 Hours

Basic concept and general principles, materials used and their properties, methods and techniques of pre-stressing, pre-stressing systems, loss of pre-stress. Analysis of pre-stressed concrete sections: loading stages and computation of section properties, critical sections under working load for pre-tensioned and post-tensioned members, load balancing method of analysis of pre-stressed concrete beams.

Module 2: Precast Concrete Elements **9 Hours**

Precast concrete elements- Advantages and disadvantages, Non-structural Precast elements - Paver blocks, Fencing Poles, Transmission Poles, Manhole Covers, Hollow and Solid Blocks, kerb stones as per relevant BIS specifications. Structural Precast elements – tunnel linings, Canal lining, Box culvert, bridge panels, foundation, sheet piles, testing of Precast components as per BIS standards.

Module 3: Precast Structural Buildings **9 Hours**

Precast Structural Building components such as slab panels, beams, columns, footings, walls, lintels and chajjas, staircase elements, Prefabricated building using precast load bearing and non-load bearing wall panels, floor systems - Material characteristics, Plans & Standard specifications. Design for shear: calculation of principle tension under working load, permissible principle tension, shear strength calculation under limit state of collapse for both sections cracked and un-cracked in flexure.

Module 4: Design of Pre-Stressed Concrete Beams **9 Hours**

design of simply supported pre-tensioned and post tensioned slabs and beams, cable Profile in simply supported rectangular beam section – concentric, eccentric straight and parabolic, effect of cable profile on maximum stresses at mid span and at support, determination of maximum stresses at mid spans with linear (concentric and eccentric) cable profiles only.

References / Suggested Learning Resources:

1. Plain and Reinforced Concrete Vol. I, Jain & Jaikrishna, Nemchand.
2. Design of Reinforced Concrete Structures, Dayaratnam P, Oxford & IBH.
3. Reinforced Concrete Structures, Sayal&Goel, Wheeler.
4. Design of Pre-stressed Concrete Structures, T. Y. Lin & N. H. Burns
5. Pre-stressed Concrete, R. H. Evans & E.W. Bennet.
6. Pre-stressed Concrete, N. Krishna Raju.
7. Modern Pre-stressed Concrete, James Libby.

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Mini Project

Course Code	PR CE 609
Course Title	Mini Project
Number of Credits	3 (L: 0, T: 0, P: 6)
Prerequisites	Nil
Course Category	Project (PR)
Number of classes	70 hours

Course Outcome:- After completion of the course, students will be able to:

CO Number	CO Description	K-level

CO-1	Demonstrate a through and systematic understanding of project contents	K-2
CO-2	Identify the methodologies and professional way of documentation and communication	K-3
CO-3	Illustrate the key stages in development of the project	K-2
CO-4	Develop the skill of working in a Team	K-3
CO-5	Apply the idea of mini project for developing systematic work plan in major project	K-3

Course Content:-

The mini project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

1) Perform detailed study about various components of a project.
2) Study about methodologies and professional way of documentation and communication related to project work.
3) Develop idea about problem formulation.
4) Knowledge of how to organize, scope, plan, do and act within a project thesis.
5) Familiarity with specific tools (i.e. hardware equipment and software) relevant to the project selected.
6) Demonstrate the implementation of a mini project work.

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SEVENTH SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Program Elective-2 (any one)	PE CE 701/1	Design of Hydraulic Structures	3	0	0	3	3	100
		PE CE 701/2	Bridge Engineering	3	0	0			
		PE CE 701/3	Geotechnical Design	3	0	0			
2.	Program Elective-3 (any one)	PE CE 702/1	Rural Water Supply and Sanitation Systems	2	0	0	2	2	100
		PE CE 702/2	Traffic Engineering and Management	2	0	0			
		PE CE 702/3	Building Construction Practice	2	0	0			
3.	Open Elective-1	OE 703	See in Annexure-I	3	0	0	3	3	100
4.	Open Elective-2	OE 704	See in Annexure-II	2	0	0	2	2	100
5.	Project - 2	PR CE 705	Project Work Intermediate	0	0	12	12	6	200
6.	Summer Internship-2	SI CE-706	Internship – II	0	0	0	0	1	100
7.	Seminar - 1	SE CE 707	Seminar on Contemporary Engineering Topics - I	0	0	2	2	1	100
			Total :	10	0	14	24	**18**	**800**

Design of Hydraulic Structures

Course Code	PE-CE 701/1
Course Title	Design of Hydraulic Structures
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Hydrology and Water Resources Engineering
Course Category	Program Elective (PE)
Number of classes	38 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Analyse and design of Earthen dams.	K-4
CO-2	Analyse and design of Gravity dams.	K-5
CO-3	Design Ogee spillways, canal falls and cross drainage structures	K-6
CO-5	Understand the hydroelectric power development.	K-2

Module 1: **Embankment Dams** **(9 hours)**

Investigation Survey, Selection of dam Site, Selection of type of dam, Classification of dams. Earth and Rockfill Dam- Causes of failures and remedial measure, selection of earth dam, design considerations, Phreatic lines, Seepage loss through earth dams, Stability analysis, Control of seepage through earth dams, rockfill dams.

Module 2: **Gravity Dams** **(9 hours)**

Gravity Dams: Forces acting on gravity dam; modes of failures; load combination for design, elementary profile, practical profile, low and high gravity dam, stability analysis, Galleries in dam.

Module 3: **Spillways, Canal Fall and Diversion Head Works** **(10 hours)**

Spillways and energy dissipation systems: Types of spillways, Design of Ogee spillway, Design of stilling basins. Canal regulators, Types of canal falls, Design of Sarda type fall, Design of straight glacis fall, Diversion head works: Layout of a diversion head work, Types and components of Diversion headworks.

Module 4: **Cross Drainage works and Hydroelectric Power Development** **(10 hours)**

Types of cross drainage works, Design of canal fluming, Design of aqueduct/ syphon aqueduct.
Introduction to Hydroelectric power development, components of hydroelectric schemes development, selection of turbines.

References / Suggested Learning Resources:

1. Modi P.M, Irrigation Water Resources and Hydropower Engineering, Standard Publishing Company, New Delhi, 2000.
2. Arora K.L. Irrigation Water Resources Engineering, Standard Book Publishing Co., Delhi, 1996.
3. Asawa G.L., Irrigation and Engineering, New Age Publishing Co., Delhi, 1996.

4. Murthy C.S.N., Water Resources Engineering – Principles and Practice, New Age Publishing Company, Delhi, 2002.
5. Hydraulic Structures by Varshney.

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Bridge Engineering

Course Code	PE CE 701/2
Course Title	Bridge Engineering
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Nil
Course Category	Program Elective (PE)
Number of classes	38 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Select alignment, survey, plan and selection the different types of bridge.	K-3, K-5
CO-2	Design, analysis and maintain the various types of bridge.	K-6
CO-3	Plan and design of substructure and superstructure of bridge.	K-6
CO-5	Design the steel bridges.	K-3, K-6

Course Contents:

Module 1: Introduction and Deck Slab of Bridge 9 Hours

Definition, types of bridges, components of bridges. Bridge site investigations, Hydraulic design, Loading standard, temporary bridges- movable bridges, economic spans, aesthetics, selection of suitable type of bridge, Design loads and their distribution-IRC loads, railway loading, analysis of deck slab and IRC loads, load distribution among longitudinal beams of a bridge.

Module 2: Design of Superstructure of Bridge 10 Hours

Design of balanced cantilever concrete bridge, introduction to design of RC arch bridge, pre-stressed concrete and box Girder Bridge. Design of lattice girder railway bridge.

Module 3: Design of Substructure of Bridge 10 Hours

Different types of foundations, their choice and method of construction, design of well foundation, design of piers and abutments, various types of bearings and their design.

Module 4: Design of Steel Bridge 9 Hours

Different types of steel bridges with design. Large – span bridges. Bearings, joints and hand rails. Construction methods and maintenance-Erection of bridge superstructures, cantilever construction.

References / Suggested Learning Resources:

1. Victor D J, essentials of Bridge Engineering, Oxford & IBH
2. Raju N K, Design of Bridges, Oxford & IBH
3. Ponnuswamy S, Bridge Engineering, Tata McGraw Hill
4. Raina V K, Concrete Bridge Practice, Tata McGraw Hill

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Geotechnical Design

Course Code	PE CE 701/3
Course Title	Geotechnical Design
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Foundation Engineering
Course Category	Program Elective
Number of classes	38 hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	To compute the subsurface investigation	K-3
CO-2	To analyze and design shallow foundations	K-4 & K-5
CO-3	To analyze and design of pile foundation and retaining structure	K-4 & K-5
CO-4	To analyze and design marine substructure, foundation in expensive soil and foundation of transmission line tower.	K-4 & K-5

Course Content:

Module 1: Subsurface investigation (09 hours)

Introduction- Substructure: Definition and purpose, Role of foundation engineer, general requirements of substructure.

Subsurface site evaluation: Introduction, open pits with sampling, methods of bring- auger boring, wash boring, percussion boring, rotary boring, amount of boring: depth of boreholes, spacing and number of boreholes; location of water table, soil sampling, sampling tools, types of samplers, standard penetration test (SPT), dynamic cone penetration test (DCPT), Static cone penetration test (SCPT), plate load test, field vane shear test, field permeability test; *geophysical methods*: Seismic Method, electrical resistivity method; planning of exploration program.

Module 2: Design of shallow foundation (09 hours)

Foundation design- General principles: types of foundation, basic requirements of a foundation, terminology: total overburden pressure, effective overburden pressure, total foundation pressure, net foundation pressure, ultimate bearing capacity, net ultimate bearing capacity, net safe bearing capacity, allowable bearing pressure, computation of load.

Design of shallow foundation- introduction: location and depth of foundation; bearing capacity of footings: modes of shear failure, general bearing capacity equation; footing on layered soils, settlement of footings, types of mat foundation, allowable bearing pressure for raft foundation, mat settlement, the coefficient of subgrade reaction, design of mat foundation by rigid and elastic plate method, uplift capacity of footings; *Structural Design*-Isolated footing, combined footing, foundation with strap beam, raft foundation.

Module 3: design of pile foundation and retaining wall (10 hours)

Design of pile foundation- ultimate bearing capacity of bord and cast-in-situ piles in cohesive soil, bearing capacity of pile from dynamic analysis, pile load test, coyle and reese (1966) method of estimating load settlement behavior of pile, negative skin friction, vertical pile subjected to lateral load, lateral load capacity of single pile, uplift capacity of piles, pile group- spacing of piles, efficiency of a pile group, bearing capacity of a pile group, settlement of pile group, negative skin friction in a pile group, uplift capacity of a pile group, ultimate lateral load resistance of pile group, lateral pile load test, proportioning and design of pile foundation,

Rigid retaining wall- types of retaining wall, concept under which Rankine and Coulomb formulas are applicable to retaining walls under active state, proportioning of retaining wall, stability of retaining wall, structural design of retaining wall.

Module 4: design of Marine substructure, foundation in expensive soil and foundation of transmission line tower (10 hours)

bridge substructures- elements of a bridge substructure, determination of the maximum depth of scour, depth of foundation, allowable bearing pressure, load to be considered, later stability of well foundation, design of pier cap, design of pier, types of well foundation, design of well cap, design of well steining, design of well curb, design of cutting edge, design of bottom plug, top plug and filling, sinking of wells, tilts and sifts.

Foundation in expensive soil- introduction, mineral structure, identification of expensive soil, swell potential and swelling pressure, expansion index, swell index, traditional Indian practice of foundation on expansive soil, drilled pier foundation, belled piers foundation, replacement of soils and 'CNS' concept, remedial measure for cracked building.

Foundation of transmission line towers- introduction, forces on tower foundation, general design criteria, chose and type of foundation, design of foundation of transmission line towers.

References / Suggested Learning Resources:

1. Analysis and design of substructures, by S. Saran, Oxford and IBH Publishing company Ltd.
2. Foundation analysis and design by J.E. Bowles , McGraw-Hill Companies.
3. B.M. Das, Principles of Foundation Engineering, 5th Ed., Thomson Asia, Singapore, 2003.
4. N. Som, Theory and Practice of Foundation Design, Prentice Hall, New Delhi, 2003.
5. Relevant Indian Standard Specifications and Codes.

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Rural Water Supply and Sanitation

Course Code	PE CE 702/1
Course Title	Rural Water Supply and Sanitation
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Environmental Engineering
Course Category	Program Elective
Number of classes	26 hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	Explain water quality, hygiene and sanitation.	K-2
CO-2	Develop water resources.	K-3
CO-3	Explain community sanitation.	K-2
CO-4	Explain the concept of biogas.	K-2

Course Content:

Module 4: General (7 hours)

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.
Concept and scope of Environmental sanitation in rural areas, magnitude and problems of water supply and sanitation in rural areas in India, National Policy.

Module 4: Water Supply Schemes (7 hours)

Quality aspects: specific impurities ad their significance, Design population, Demand and variations, Planning of water supply schemes in rural areas: individual village and group schemes, Sources of water supply: springs, wells, infiltration wells, radial wells, infiltration galleries and surface water intake, Treatment of water for rural water supply, compact system: multi bottom settler, slow sand filter, diatomaceous earth filter, cloth filter, chlorine diffusion cartridges, pumps, pipe, materials, appurtenances and improvised device for use in rural water supply schemes, Distribution systems for rural water supply, Iron removal plant, Rain water harvesting, Ground water recharging.

Module 4: Disposal of Night soil and wastewater (6 hours)

Various methods of collection and disposal of night soil: Sanitary latrines, community latrines, Privies of a conservancy system of sanitation, septic tanks, soakage system, anaerobic filter, Imhoff tank, Plumbing

system, Compact and simple wastewater treatment units: Stabilization ponds, revolving biological surface, Garbage, ash, rubbish, collection methods, transportation, disposal, Hauled container and stationary container system, Impact on improper disposal of solid wastes on human health and environment.

Module 4: Biogas Plants and Waste Management (6 hours)

Quantity of cow dung, Required capacity and design, Disposal of Solid Wastes, sanitary land fill, Indore process, Bangalore process, Composting, land filling, Incineration, Pyrolysis, Strategies for reducing pollution and improving the environment, Pollution related diseases, Sustainable consumption, Need and challenges for sustainable development, Sources and classification of waste, Impact of waste accumulation, Waste management – need and practice, Participation in waste management.

References / Suggested Learning Resources:

1. Water supply for Rural areas and small communities, Wagner, E.G and Lanoix, J.N.
2. Rural Water Supply and Sanitation, Wright, F.B.,.
3. Excreta Disposal for Rural Areas Wagner and Small Communities E.G., Lanoix, J.N.
4. Water supply and sanitary S.C.Rangawala, Engineering K.S.RangawalaCharotar publishing P.S.Rangawala housing
5. Water supply and sanitryG.S.Birdie& J.S. Birdie DhanpatRai Engineering publishing Company, New Delhi.

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Traffic Engineering and Management

Course Code	PE CE 702/2
Course Title	Traffic Engineering and Management
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Transportation Engineering-I
Course Category	Program Elective (PE)
Number of classes	26 hours

Course Outcome: After completion of this course the students will be able to:

CO Number	CO Description	K-level
CO-1	Explain and apply fundamental relation of traffic flow with its parameters.	K-2 & K-3
CO-2	Design the signalized and unsignalized intersections	K-6
CO-3	Develop a clear idea on traffic operation and management, demand relationships	K-3
CO-4	Elaborate parking study, shockwaves, headway distribution.	K-6

Course Contents:-

Module- 1: Traffic flow theory and traffic studies (6 hours)

Driver behavior, traffic information and control systems, traffic studies- volume, speed and delay studies, elements of traffic flow theory, characteristics of uninterrupted traffic, capacity and LOS of Uninterrupted facilities, Highway capacity: Passenger's car units, level of service, factor affecting capacity and level of service, influence of mixed traffic.

Module- 2: Unsignalized and signalized intersections (6 hours)

Hours Characteristics of interrupted traffic, traffic characteristics at un-signalised intersections, design of signalized intersections, types of traffic signals, advantages, determination of optimal cycle time and signal setting for an intersection with fixed time signals, actuated signal control, signal coordination, Rotary design.

Module- 3: **Traffic operation and management, design hourly volume, demand relationships (7 hours)**

Traffic Operation and Management- Various measures and their scope, relative merits and demerits Traffic congestion, circulation, Planning, control devices, Speed change Lane- Different type of speed change lane, Design of speed change lane, Advantages and Disadvantages of one way lane and reversible lane. Street lighting. 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 & relationships.

Module- 4: Parking studies, gap acceptance, shockwaves, headway distribution (7 hours)

Parking- On street parking, parallel parking and angle parking, Off street parking,Advantages and Disadvantages of on street and off street parking,Accident- Spot map, Collision Map, Condition diagram, Introduction to intelligent transportation systems, Introduction to advanced computational techniques for transportation planning. Shock waves; Queuing theory and applications, Vehicle arrivals, distribution models, gaps and headway distribution models; gap acceptance merging parameters, application of simulation techniques in traffic engineering

References / Suggested learning Resources:-

1. Khanna, S.K., Justo, C.E.G and Veeraragavan, A, 'Highway Engineering', Revised 10th Edition, Nem Chand & Bros, 2017
2. L R Kadiyali, N B Lal, Principles and practice of highway engineering, Khanna Publications, 2005
3. Principles of Transportation Engineering, Partha Chakraborty, PHI Learning, 1st edition
4. Principles of Highway Engineering and Traffic Analysis, 4th Edition, Fred L. Mannering, Scott S. Washburn, Walter P. Kilareski, John Wiley
5. Morlok, E.R., An Introduction to Transportation Engineering and Planning, McGraw Hill, NY, 1970
6. Hay W.W., Introduction to transportation Engineering, John Wiley & Sons, NY, 1988.
7. Papacostas C.S., Fundamentals of transportation Engineering, Prentice Hall of India, 1987.
8. Srinivasa Kumar, R, Textbook of Highway Engineering, Universities Press, 2011.

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Building Construction Practice

Course Code	PE CE 702/3
Course Title	Building Construction Practice
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Materials, Testing and Evaluation
Course Category	Professional elective courses (PEC)
Number of classes	26 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Explain different components and classification of building	I
CO-2	Illustrate sequence of activities of building construction	II
CO-3	Demonstrate different Sub Structure Construction	IV
CO-4	Design Green Buildings	VI

Course contents:-

Module 1: **- Introduction to Building Construction Practice (7 hours)**

Types of buildings, components of a building , details and sequence of activities and construction co-ordination – Site Clearance – Marking – Earthwork - masonry – stone masonry –Brick masonry- Bond in masonry - concrete hollow block masonry – flooring – damp proof courses –cavity walls-partition walls-construction joints – movement and expansion joints.

Module 2: **- Parts of Building Construction (7 hours)**

Building foundations-types – 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 and roof coverings, finishes.

Module 3: **- Sub Structure Construction (6 hours)**

Sub Structure Construction- Techniques of Box jacking – Pipe Jacking –under water construction of diaphragm walls and basement-Tunneling techniques – Piling techniques - well and caisson - sinking cofferdam - cable anchoring and grouting-driving diaphragm walls, sheet piles - shoring for deep cutting - well points –Dewatering.

Module 4: **- Green Buildings (6 hours)**

Importance, Sustainable Site planning: wind/sun path, water management, material use, landscape, topography. Climate responsive architecture: orientation, solar-wind, Building envelope. Arrangement of mechanical and natural ventilation, Sustainable development and it's features, Sanitation. Ratting system: Leadership in energy and environmental design (LEED), green globes, LEED India energy conservation, GRIHA.

References / Suggested learning Resources:-

1. Rangwala, Engineering Materials, Charotar Publishing House Pvt. Ltd.

2. Ashok Kumar Jain, Dr. B.C. Punmia, Arun Kumar Jain, Building Construction, Laxmi Publications Pvt. Ltd.
3. Chudley, R., Greeno (2006), 'Building Construction Handbook' (6th ed.),R. Butterworth- Heinemann
4. S.K.Duggal, Building Materials, 3rd Edition, New Age International Publishers.
5. Sushil Kumar, Building Construction, Standard Publishers Distributors.
6. M.S.Shetty, Concrete Technology: Theory and Practice, S. Chand Publishers.

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Project Work Intermediate

Course Code	PR CE 705
Course Title	Project Work Intermediate
Number of Credits	6 (L: 0, T: 0, P: 12)
Prerequisites	Nil
Course Category	Project (PR)
Number of classes	130 hours

Course Outcome:-

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

CO Number	CO Description	K-level
CO-1	Demonstrate a sound technical knowledge of their selected project topic	K-2
CO-2	Develop the skill of working in a Team	K-3
CO-3	Design engineering solutions to complex problems utilizing a systematic approach	K-6
CO-4	Design the solution of an engineering project involving latest tools and techniques	K-6
CO-5	Develop the skill of effective communication with engineers and the community at large in written an oral forms	K-3
CO-6	Demonstrate the knowledge, skills and attitudes of a professional engineer	K-2

Course Content:-

The project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

1) Develop sound knowledge about the domain of the project work.
2) Perform detailed study about various components of a project.
3) Learn to be an important member of a team for successful execution of a project work.
4) Study about methodologies and professional way of documentation and communication related to project work.
5) Develop idea about problem formulation, finding the solution of a complex engineering problem.

6) Develop project report as per the suggested format to communicate the findings of the project work.
7) Acquire the skill of effective oral communication to the fellow engineers and people in the society at large.
8) Develop knowledge of how to organize, scope, plan, do and act within a project thesis.
9) Familiarity with specific tools (i.e. hardware equipment and software) relevant to the project selected.
10) Demonstrate the implementation of a project work.

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Industry Internship – II

Course Code	SI CE 706
Course Title	Industry Internship – II
Number of Credits	1 (L: 0, T: 0, P: 0)
Prerequisites	Nil
Course Category	Summer Internship (SI)
Number of classes	-

Course Outcome:-

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

CO Number	CO Description	K-level
CO-1	Solve real life challenges in the workplace by analysing work environment and conditions, and selecting appropriate skill sets acquired from the course of study	K-3
CO-2	Develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organisational setting	K-3
CO-3	Demonstrate the skill to communicate and collaborate effectively and appropriately with different professionals in the work environment through written and oral means	K-2
CO-4	Show professional ethics by displaying positive disposition during internship	K-2
CO-5	Decide career options by considering opportunities in company, sector, industry, professional and educational advancement	K-5

Course Content:-

The industry internship aims to provide the student with:

1. A practice-oriented and 'hands-on' working experience in the real world or industry, and to enhance the student's learning experience.

2. An opportunity to develop a right work attitude, self-confidence, interpersonal skills and ability to work as a team in a real organisational setting.

3. An opportunity to further develop and enhance operational, customer service and other life-long knowledge and skills in a real world work environment.

4. Pre-employment training opportunities and an opportunity for the company or organisation to assess the performance of the student and to offer the student an employment opportunity after his/her graduation, if it deems fit.

Each student shall

1) Identify an internship program of relevance in his/her branch of engineering to undergo during summer break between 6th and 7th semester,
2) Get approval of the concerned HOD,
3) Undergo the industry internship program for minimum 4 weeks duration
4) Prepare their own report
5) Present in the class among fellow students and faculty members / deliver viva voce.
6) Submit the report and participation/course completion certificate.

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Seminar on Contemporary Engineering Topics – I

Course Code	SE CE 707
Course Title	Seminar on Contemporary Engineering Topics – I
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Seminar (SE)
Number of classes	24 hours

Course Outcome:-

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

CO Number	CO Description	K-level
CO-1	Identify contemporary topics in respective branch of engineering	K-3
CO-2	Survey literature to understand insight of the selected topic	K-4
CO-3	Develop report writing and presentation making skill	K-3
CO-4	Present the topic so prepared among audience using suitable aid	K-3

Course Content:-

Each student shall

1) Identify a topic of current relevance in his/her branch of engineering,
2) Get approval of the faculty concerned/HOD,
3) Collect sufficient literature on the selected topic, study it thoroughly (literature survey),
4) Prepare their own report and presentation slides and
5) Present in the class among fellow students and faculty members.

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EIGHTH SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Program Elective-4 (any one)	PE CE 801/1	Earthquake Engineering	3	0	0	3	3	100
		PE CE 801/2	Structural Dynamics	3	0	0			
		PE CE 801/3	Pavement Design	3	0	0			
2.	Program Elective-5 (any one)	PE CE 802/1	Remote Sensing and GIS	2	0	0	2	2	100
		PE CE 802/2	Ground Improvement and Ground Engineering	2	0	0			
		PE CE 802/3	Engineering Geology	2	0	0			
3.	Open Elective-3	OE 803	See in Annexure-III	3	0	0	3	3	100
4.	Open Elective-4	OE 804	See in Annexure-IV	2	0	0	2	2	100
5.	Project - 3	PR CE 805	Project Work Final	0	0	12	12	6	200
6.	Seminar - 2	SE CE 806	Seminar on Contemporary Engineering Topics - II	0	0	2	2	1	100
7.	Online Course	SW CE 807	SWAYAM Courses	0	0	0	0	1	100
			Total :	10	0	14	24	**18**	**800**

Earthquake Engineering

Course Code	PE CE 801/1
Course Title	Earthquake Engineering
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Structural Engineering
Course Category	Professional elective courses (PEC)
Number of classes	38 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Illustrate the basic technical terms of earthquake engineering.	K-2
CO-2	Explain seismological background on structures.	K-2
CO-3	Compare static loads and dynamic loads.	K-4
CO-4	Design Earthquake Resistant Structures.	K-5

Course contents:-

Module 1: Dynamic Loads on the Structures **10 Hours**

Definitions of basic problems in dynamics, static versus dynamic loads, different types of dynamic loads, un-damped vibration of SDOF system, natural frequency and Hours of vibration, damping in structure, response to periodic loads, response to general dynamic load, response of structure subject to gravitational motion, use of Fourier series for periodic forces. Direct determination of frequencies and mode shapes, orthogonality principle, approximate methods for determination of frequencies and mode shapes, modal error of forced vibration of MDOF system, modal analysis, applications to multistoried rigid frames subject to lateral dynamic loads.

Module 2: Seismological Background **10 Hours**

Seismicity of a region, earthquake faults and waves, structure of earth, plate tectonics, elastic-rebound theory of earthquake, Richter scale, measurement of ground motion, seismogram. Characterization of ground motion: earthquake response spectra, factors influencing response spectra, design response spectra for elastic systems, peak ground acceleration, response spectrum shapes, deformation, pseudo-velocity, pseudo-acceleration response spectra, peak structural response from the response spectrum, response spectrum characteristics.

Module 3: Deterministic Earthquake Responses **9 Hours**

Types of earthquake excitation, lumped SDOF elastic systems, translational excitation, lumped MDOF elastic systems, translational excitation time history analysis, multistoried buildings with symmetric plans, multistoried buildings with unsymmetric plans, torsional response of symmetric plan building, distributed-parameter elastic systems, translational excitation, combining maximum modal responses using mean square response of a single mode, SRSS and CQCC combination of modal responses.

Module 4: I. S. Code Method of Seismic Analysis **9 Hours**

I. S. code method of seismic analysis: seismic coefficient method and its limitation, response spectrum method, I. S. code provision for seismic analysis of buildings. Review of damages during past earthquakes and remedial measures, seismic design considerations, allowable ductility demand, ductility capacity, reinforcement detailing for members and joints.

References / Suggested learning Resources:-

1. Structural Dynamics-An introduction to Computer Methods, Roy R. Craig.
2. Dynamics of Structures, Anil K. Chopra, Prentice Hall, India.
3. Dynamics of Structures, Cloguh&Penzien, Tata McGraw Hill, New Delhi
4. Structural Dynamics, John M. Biggs, Tata McGraw Hill, New Delhi
5. Fundamentals of Earthquake Engineering, N. M. Newmarks& E. Rosenblueth, Prentice Hall.
6. Earthquake Design Practice for Building, D. Key, Thomas Telford, London, 1988.
7. Earthquake Engineering, R. L. Wiegel, 2nd Edition, Prentice Hall, London, 1989
8. Design of Multistoried Buildings for Earthquake Ground Motions, J. A. Blume, Portland CementAssociation, Chicago, 1961
9. Proceedings on World Conference on Earthquake Engineering, 1956-2000.
10. I. S. codes No. 1893, 4326, 13920. (Latest Editions).

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Structural Dynamics

Course Code	PE CE 801/2
Course Title	Structural Dynamics
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Structural Engineering
Course Category	Professional elective courses (PEC)
Number of classes	38 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Describe basic problems and analysis in structural dynamics	K-2
CO-2	Analyze the assemblages of rigid bodies	K-4
CO-3	Comprehend the random vibrations	K-4
CO-4	Model multi-storey rigid frames subjected to lateral dynamic loads	K-4

Course Contents:-

Module 1: Introduction to Structural Dynamics (10 Hours)

Definition of basic problems in dynamics, static versus dynamic loads, different types of dynamic loads. SDOF systems- Un-damped vibration of SDOF system, natural frequency and period of vibration, damping in structures, viscous damping and coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, logarithmic decrement, forced vibration, response to periodic loading, response to

periodic loading, response to pulsating forces, dynamic load factors, response of structure subjected to general dynamic load, Dulhamel‟s integral, numerical evaluation of dynamics response of SDOF systems, response of structure in frequency domain subjected to general periodic and non-periodic/impulsive forces of short duration, use of complex frequency response function, use of Fourier Series for periodic forces, introduction to vibration isolation, distributed mass system idealized as SDOF system, use of Rayleigh‟s method, response of SDOF system subjected to ground motion.

Module 2: Analysis of Generalized Single Degree of Freedom System (9 Hours)

Generalized properties: Assemblages of Rigid Bodies, Systems with distributed mass and elasticity, expressions for generalized system properties. Structure with distributed mass system- Use of partial differential equation, free vibration analysis of single span beams with various boundary conditions, determination of frequencies of vibration and mode shapes, forced vibration of single span beams subjected to the action of specified dynamic loads.

Module 3: Analysis of Lumped Mass Multi Degree of Freedom (MDOF) System (10 Hours)

Coupled and uncoupled systems, direct determination of frequencies of vibration and mode shapes, orthogonality principle, vibration of MDOF systems with initial conditions, approximate methods of determination of natural frequencies of vibration and mode shapes-vector iteration methods. Energy methods and use of Lagrange‟s method in writing equations of motions, decoupling of equations of motion, modal equation of motion, concept of modal mass and modal stiffness, forced vibration of MDOF system, modal analysis, application to multi storey rigid frames subjected to lateral dynamic loads.

Module 3: Random Vibrations and Response of Linear SDOF Systems (9 Hours)

-Random processes, stationary and ergodic processes, autocorrelation function, power spectral density function, relationship between power spectral and autocorrelation functions, power spectral density and autocorrelation functions for derivatives of processes, superposition of stationary processes, stationary Gaussian processes, stationary white noise, probability distribution for maxima and extreme values. Stochastic Response of Linear SDOF Systems- Transfer functions, relationship between input and output auto correlation functions, relationship between input and output power spectral density functions, response characteristics for narrowband systems.

References / Suggested learning Resources:-

1. Structural Dynamics-An Introduction to Computer Methods, John Wiley & Sons.
2. Dynamics of Structures, Anil K. Chopra, Prentice Hall, India.
3. Dynamics of Structures, Cloguh & Penzein, Tata McGraw Hill. New Delhi
4. Structural Dynamics, John M. Biggs, Tata McGraw Hill. New Delhi

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Pavement Design

Course Code	PE CE 801/3
Course Title	Pavement Design
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Transportation Engineering-I
Course Category	Professional elective courses (PEC)
Number of classes	38 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Demonstrate flexible and rigid pavements	K-2
CO-2	Design flexible pavement as per IRC	K-6
CO-3	Design rigid pavement as per IRC	K-6
CO-4	Design joints and overlays as per IRC	K-6

Course Contents:-

Module- 1: Introduction (9 hours)

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.

Module- 2: Flexible Pavement Design (10 hours)

Flexible Pavement Design Methods for Highways and Airports: Empirical, AICTE Model Curriculum for Undergraduate degree in Civil Engineering (Engineering & Technology) 145 | Page semi-empirical and theoretical approaches, development, principle, design steps, advantages; design of flexible pavements as per IRC.

Module- 3: **Rigid Pavement Design (10 hours)**

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,

Module- 4: Design of Joints and Overlays (9 hours)

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

References / Suggested learning Resources:-

1. Pavement Analysis and Design, Yang H. Hung, Prentice-Hall 18

2. Design and Performance of Road Pavements, David Croney, McGraw Hill,
3. Guide for Design of Pavement AASHTO
4. Principles of Pavement Design Yoder & Witczak Wiley Publication
5. IRC guidelines for the design of flexible and rigid pavements.

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Remote Sensing and GIS

Course Code	PE CE 802/1
Course Title	Remote Sensing and GIS
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Knowledge of surveying, map reading and basic mathematics.
Course Category	Program elective (PE)
Number of classes	26 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Analyse the energy interactions in the atmosphere and earth surface features	K-4
CO-2	Interpret the images for preparation of thematic maps	K-5
CO-3	Analyze spatial and attribute data for solving spatial problems	K-4
CO-4	Create GIS and cartographic outputs for presentation	K-6
CO-5	Apply Remote sensing and GIS in different engineering contexts	K-3

Course contents:-

Module 1: **- Remote Sensing (8 hours)**

Sources of Energy, active and passive radiation, Electromagnetic spectrum, radiation laws, interaction of energy with atmosphere scattering, absorption, atmospheric windows, interaction of EMR with earth surface features- spectral signatures, stages in remote sensing.

Sensors and Platforms: Characteristics of space platforms and sensors, LANDSAT, SPOT, NOAA and IRS Series.

Module 2: **- Digital Image Processing and GPS (8 hours)**

Photogrammetry; Aerial and Terrestrial; Fundamentals of Satellite Image Interpretation: Types of data products, visual interpretation techniques, Digital image processing, basic concepts of digital image processing techniques.

GPS surveying - principles and methods, DGPS, error in observations and corrections, mapping with GPS.

Module 3: **- GIS (4 hours)**

Fundamental concepts of GIS – Modeling Real World Features- Raster data model, vector data model, Data Formats- Spatial and Non-Spatial data, Data collection and Input, Data conversion, Hardware & software Requirements.

Topology – Editing and Error Rectification, Types of topology, Topological Relationships.

Module 4: **- Analysis in GIS, Applications of GIS and Remote Sensing (6 hours)**

Analysis using raster and vector data — retrieval, reclassification, overlaying, buffering - data output — printers and plotters. Open source software's. GIS and remote sensing applications — urban applications — water resources — urban analysis — watershed management — resources information system — hazard mitigation.

References / Suggested learning Resources:-

1. Floyd F. Sabins, Remote Sensing Principles and Interpretation, W.H. Freeman and Co. 2007.
2. Lillisand T.M and Kiefer R.W, Remote Sensing and Image Interpretation, John Wiley and Sons, 2008.
3. Paul R. Wolf: Elements of Photogrammetry, with Air Photo Interpretation and Remote Sensing, McGraw Hill International Book Company, 2000.
4. C.P. Lo, Albert K. W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice Hall India Pvt. Ltd, New Delhi, 2002.
5. Kang-Tsung Chang, Introduction to Geographic Information Systems, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2008.
6. Peter A. Burrough and Rachael A. McDonnell, Principles of Geographical Information Systems, Oxford University Press, 2005.

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Ground Improvement and Ground Engineering

Course Code	PE CE 802/2
Course Title	Ground Improvement and Ground Engineering
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Geotechnical Engineering
Course Category	Program elective (PE)
Number of classes	26 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Identify basic deficiencies of various soil deposits.	K-3
CO-2	Decide various ways and means of improving the soil.	K-4
CO-3	Categorize the implementing techniques of soil improvement.	K-4
CO-4	Explain the fundamentals of machine foundation	K-2, K-5

Course Contents:

Module 1: Ground Improvement Techniques (7 Hours)

Role of ground improvement and methods. Selection of suitable ground improvement techniques based on various types of soil condition viz. alluvial, laterite and black cotton soils. Ground Improvement Techniques-Sand drains, stone column, diaphragm wall, rock anchors. Heavy damping, compaction of piles. Preloading with sand drains/sand wicks.

Module 2: Machine Foundation, Dewatering and Geosynthetics (6 Hours)

Introduction- Soil dynamics theory of vibration, degrees of freedom, principles of machine foundation design. Dewatering, field pumping test, common dewatering methods. Effects of dewatering. Geosynthetics-Application, types, functions, Properties& designing with geosynthetics.

Module 3: Drainage Techniques, Dynamic Compaction and Consolidation (7 Hours)

Improvement of deep cohesionless soils and cohesive soils, geological properties of reinforced soils. Drainage techniques-Well points-Vaccum and electro osmotic methods. Dynamic compaction and consolidation-Vibroflotation-sand pile compaction-lime piles-installation techniques only-relative merits and their limitations.

Module 4: Reinforced Earth and Geotextiles (6 Hours)

Concept of reinforcement - Types of reinforcement material - Applications of reinforced earth – use of Geotextiles for filtration, drainage and separation in road and other works.Types of grouts - Grouting equipment and machinery - Injection methods - Grout monitoring – Stabilisation with cement, lime and chemicals - Stabilisation of expansive soils.

References / Suggested learning Resources:-

1. Koerner R.M., “Construction and Geotechnical Methods in Foundation Engineering”, McGraw-Hill,1994.
2. Purushothama Raj, P. “Ground Improvement Techniques”, Tata McGraw-Hill Publishing Company,NewDelhi,1995.
3. Moseley M.P., Ground Improvement Blockie Academic and Professional, Chapman and Hall,Glassgow,1993.
4. Jones J.E.P., Earth Reinforcement and Soil Structure, Butterworths, 1995. 2002.
5. Das, B.M., “Principles of Foundation Engineering”, Thomson Books / Cole, 2003.

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Engineering Geology

Course Code	PE CE 802/3
Course Title	Engineering Geology
Number of Credits	4 (L: 2, T: 0, P: 0)
Prerequisites	NIL
Course Category	Program Elective
Number of classes	26 hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	To understand the weathering process, and superficial deposits and its geotechnical importance	K-2
CO-2	To classify the geological formations	K-2
CO-3	To analyze the geological hazards and preventing measures, and ground water with strength behaviour of rock	K-4
CO-4	To apply geological principles for mitigation of natural hazards and select sites for dams and reservoir followed by sub surface investigation.	K-3

Course Content:

Module 1: Physical Geology (06 hours)

Introduction-Branches of geology useful to civil engineering, scope of geological studies in various civil engineering projects. Mineralogy-Mineral, Origin and composition. Physical properties of minerals, basic of optical mineralogy, Rock forming minerals, megascopic identification of common primary & secondary minerals.

Physical Geology- Weathering. Erosion and Denudation. Factors affecting weathering and product of weathering. Superficial deposits and its geotechnical importance: Water fall and Gorges, River meandering, Alluvium, Glacial deposits, Laterite (engineering aspects), Desert Landform, Loess, Residual deposits of Clay with flints, mudflows, Coastal deposits.

Module 2: Petrology (07 hours)

Petrology-Rock forming processes. Specific gravity of rocks. Igneous petrology- Volcanic Phenomenon and different materials ejected by volcanoes. Types of volcanic eruption. Characteristics of different types of magma. Division of rock on the basis of depth of for mation and their characteristics. Chemical and Mineralogical Composition. Texture and its types. Various forms of rocks. Classification of Igneous rocks on the basis of Chemical composition. Detailed study of Acidic Igneous rocks like Granite, Rhyolite or Tuff, Felsite, Pegmatite, Hornfels. Engineering aspect to granite. Basic Igneous rocks Like Gabbro, Dolerite and Basalt. Engineering aspect to Basalt. Sedimentary petrology- mode of formation, Mineralogical Composition. Texture and its types, Structures, Gradation of Clastic rocks. Classification of sedimentary rocks and their characteristics. Detailed study of Conglomerate, Breccia, Sandstone, Mudstone and Shale,

Limestone Metamorphic petrology- Agents and types of metamorphism, metamorphic grades, Mineralogical composition, structures & textures in metamorphic rocks. Important Distinguishing features of rocks as Rock cleavage, Foliation. Detailed study of Gneiss, Schist, Slate with engineering consideration.

Module 3: Geological Hazards and Ground Water with Strength Behavior of Rock (07 hours)

Geological Hazards- Rock Instability and Slope movement: Concept of sliding blocks. Different controlling factors. Instability in vertical rock structures and measures to prevent collapse. Types of landslides. Prevention by surface drainage, slope reinforcement by Rock bolting and Rock anchoring, retaining wall, Slope treatment.

Ground water: Factors controlling water bearing capacity of rock. Pervious & impervious rocks and ground water. Lowering of water table and Subsidence.

Earthquake: Magnitude and intensity of earthquake. Seismic sea waves. Seismic Zone in India.

Module 4: Geology of Dam and Reservoir, Mechanics of Rock (06 in hours)

Geology of dam and reservoir site- Required geological consideration for selecting dam and reservoir site. Failure of Reservoir. Favorable & unfavorable conditions in different types of rocks in presence of various structural features, precautions to be taken to counteract unsuitable conditions, significance of discontinuities on the dam site and treatment giving to such structures.

Rock Mechanics- Sub surface investigations in rocks and engineering characteristics or rocks masses; Structural geology of rocks. Classification of rocks, Field & laboratory tests on rocks, Stress deformation of rocks, Failure theories and strength of rocks, Bearing capacity of rocks.

References / Suggested Learning Resources:

1. Engineering and General Geology, Parbin Singh, 8th Edition (2010), S K Kataria & Sons.
2. Text Book of Engineering Geology, N. Chenna Kesavulu, 2nd Edition (2009), Macmillan Publishers India.
3. Geology for Geotechnical Engineers, J.C.Harvey, Cambridge University Press (1982).
4. Principles of Engineering Geology, K.V.G.K. Gokhale, BS Publications, Hyderabad, 2005
5. Engineering Geology: Principles and Practice, David George Price, Springer, 2009

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Project Work Final

Course Code	PR CE 805
Course Title	Project Work Final
Number of Credits	6 (L: 0, T: 0, P: 12)
Prerequisites	Nil
Course Category	Project (PR)
Number of classes	130 hours

Course Outcome:- After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Demonstrate a sound technical knowledge of their selected project topic	K-2
CO-2	Develop the skill of working in a Team	K-3
CO-3	Design engineering solutions to complex problems utilizing a systematic approach	K-6
CO-4	Design the solution of an engineering project involving latest tools and techniques	K-6
CO-5	Develop the skill of effective communication with engineers and the community at large in written an oral forms	K-3
CO-6	Demonstrate the knowledge, skills and attitudes of a professional engineer	K-2

Course Content:-

The project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

1) Develop sound knowledge about the domain of the project work.
2) Perform detailed study about various components of a project.
3) Learn to be an important member of a team for successful execution of a project work.
4) Study about methodologies and professional way of documentation and communication related to project work.
5) Develop idea about problem formulation, finding the solution of a complex engineering problem.
6) Develop project report as per the suggested format to communicate the findings of the project work.
7) Acquire the skill of effective oral communication to the fellow engineers and people in the society at large.
8) Develop knowledge of how to organize, scope, plan, do and act within a project thesis.
9) Familiarity with specific tools (i.e. hardware equipment and software) relevant to the project selected.
10) Demonstrate the implementation of a project work.

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Seminar on Contemporary Engineering Topics – II

Course Code	SE CE 806
Course Title	Seminar on Contemporary Engineering Topics – II
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Seminar (SE)
Number of classes	24 hours

Course Outcome:- After completion of the course, students will be able to:

CO Number	CO Description	K-level

CO-1	Identify contemporary topics in respective branch of engineering	K-3
CO-2	Survey literature to understand insight of the selected topic	K-4
CO-3	Develop report writing and presentation making skill	K-3
CO-4	Present the topic so prepared among audience using suitable aid	K-3

Course Content:-

Each student shall

1) Identify a topic of current relevance in his/her branch of engineering,
2) Get approval of the faculty concerned/HOD,
3) Collect sufficient literature on the selected topic, study it thoroughly (literature survey),
4) Prepare their own report and presentation slides and
5) Present in the class among fellow students and faculty members.

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SWAYAM Courses

Course Code	SW CE 807
Course Title	SWAYAM Courses
Number of Credits	1 (L: 0, T: 0, P: 0)
Prerequisites	Nil
Course Category	Online Course (SW)
Number of classes	-

Courses Outcome:- After completion of the courses, students will be able to:

CO Number	CO Description	K-level
CO-1	Make use of digital learning platform to enhance knowledge and skill beyond the prescribed curriculum structure	K-3
CO-2	Take part in proctored examination system to prepare oneself for similar future challenges	K-4
CO-3	Utilize the opportunity to learn from best faculty in the country for professional development	K-3
CO-4	Develop the skill of lifelong self-learning and become future ready	K-3

Courses Content:-

SWAYAM (Study Webs of Active-learning for Young Aspiring Minds); India Chapter of Massive Open Online Courses. SWAYAM is an indigenous developed IT platform, initiated by Government of India, which is instrumental for self-actualization providing opportunities for a life-long learning. Learner can choose from hundreds of courses, virtually every course that is taught at the university/college/school level and these

shall be offered by best of the teachers in India and elsewhere. Student having registered a course, having submitting the Assignments as per requirements of the course, shall at the end of each course, be assessed through a proctored examination. A student having successfully completed the course shall get a Certificate.

Each student has to undergo and qualify at least two relevant SWAYAM or equivalent courses (to be certified by concerned HOD) with certification during the entire course of B. Tech. program. The Head of the departments will approve the relevancy of a SWAYAM or equivalent course for respective branch of engineering.

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PROGRAM OUTCOMES (POs) AS PER NATIONAL BOARD OF ACCREDITATION (NBA)

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.