Course Structure and Syllabus

(As per NEP - 2020)

5 Years Integrated Dual Degree Program

(B. Tech. in Civil Engineering and M. Tech. in Water Resources Engineering/Transportation Engineering

Effective from Session 2022-2023

DEPARTMENT OF CIVIL ENGINEERING
SCHOOL OF ENGINEERING AND TECHNOLOGY
CENTRAL UNIVERSITY OF JHARKHAND,
RANCHI 835 222, JHARKHAND

Vision of the University

To develop enlightened citizenship of a knowledge society for peace and prosperity of individuals, nation and the world, through promotion of innovation, creative endeavors and scholarly inquiry.

Mission

To serve as a beacon of change, through multi-disciplinary learning for creation of knowledge community by building a strong character and nurturing a value-based transparent work ethics, promoting creative and critical thinking for holistic development and self-sustenance for the people of India. The University seeks to achieve this objective by cultivating an environment of excellence in teaching, research and innovation in pure and applied areas of learning.

Objectives

1. To disseminate advance knowledge by providing instructional and research facilities in such branches of learning as it may deem fit.
2. To make special provisions for integrated courses in humanities, social sciences, science and technology in its educational program.
3. To take appropriate measures for promoting innovations in teaching-learning process and inter-disciplinary studies and research.
4. To educate and train manpower for the development of the country.
5. To establish linkages with industries for the promotion of science and technology and
6. To pay special attention to the improvement of the social and economic conditions and welfare of the people, their intellectual, academic and cultural development.

Vision of the Department

To serve the Nation and the world through excellence in education and advanced research in all the streams of Civil Engineering

Mission of the Department

- To serve by producing excellent engineers, innovators, entrepreneurs and academicians for the growth of the industry and the society.
- To develop sense of competitiveness, self-confidence, sincerity, punctuality and ethical values among students.
- To undertake innovative collaborative projects with industries, government agencies and other organizations to cater the needs of society and solve real field problems.
- To develop research and teaching potential to the fullest extent.
- To remain a role model in the field of Civil Engineering.

Program Educational Objectives (PEOs)

- To equip our students with high quality education, knowledge, innovation and computational skills in the area of Civil Engineering.
- To empower students to analyses realistic problems, to design civil structures as per IS codes which are economically feasible and to cope up with recent technological innovations.
- To develop professional ethics, communication skills, leadership quality, and team work capability in the students of the Civil Engineering Department for their successful career at international and national level.

Course Code Definitions

L	Lecture
T	Tutorial
P	Practical
C	Credit
TCH	Total contact hours per week/semester
HSC/HSS	Humanities & Social Science Courses
BSC	Basic Science Courses
ESC	Engineering Science Courses
PCC	Program Core Courses
PEC	Professional Elective Courses
OEC	Open Elective Courses
AU	Audit Courses
LC	Lab Courses
Proj	Project/ Summer Internship/ Seminar
MSC/MSH	Minor Specialization Course

Course codes:

Professional Core courses	01
Minor specialization	02
Basic Science courses	03
Humanities and Social Sciences	04
Seminar and internship in industry	05
Engineering Science Courses including workshop, drawing, basics of electrical/computer etc	07
Professional Elective Courses	08
Open Electives	09
Audit (Mandatory Courses)	10

Proposed Course Code Preparation style:

Position from Left →	First, Second & Third	Fourth & Fifth	Sixth	Seventh & Eights
Code →	DDD	MJ/MN/	1	XX
Concerned →	Department code	Subjects Category (Major/Minor/AEC……	Programme year / Intensity level of Course	Programme Code (for odd semester: 01, 03,05…… and for even semester: 02, 04, 06……..)

Definition of Credit

1	1 Hr. Lecture (L) per week	1 Credit
2	1 Hr. Tutorial (T) per week	1 Credit
3	2 Hours Practical (P) per week	1 Credit

Structure of Integrated UG-PG Program

S. No.	Category	Breakup of Credits	CE Credit
1.	Humanities & Social Science Courses	12-15	7
2.	Basic Science Courses	23-29	22
3.	Engineering Sciences including Workshop, Drawing, Basics of Electrical/Mechanical/Computer etc.	17-27	12
4.	Program Core Courses (Branch specific)	58-64	62
5.	Professional Elective Courses (Branch specific)	9-18	26
6.	Open Elective Courses (Cross Discipline Subjects) – Electives from other technical and /or emerging subjects	9-15	12
7.	Project work, Seminar and Internship in Industry or elsewhere	16-20	48
8.	Mandatory Audit Courses [Environmental Sciences, Induction Program, Indian Constitution, Essence of Indian Traditional Knowledge]	0 (non-credit)	0
9.	Laboratory courses		16
Total credit for acquiring B. Tech. degree		160-163	170-172
10.	Minor Specialization Course	18-20	20
Total credit for acquiring B. Tech. (Hons.) degree		178-183	190-192
Total credit for acquiring Integrated M. Tech. degree		200-210	210-212
Total credit for acquiring Integrated M. Tech. degree with B. Tech. (Hons.)		218-223	230-232

Multiple Entry- Multiple Exit

Academic Level	Entry Qualifications at various levels	Exiting Qualifications at various levels
Final year Diploma/ 1st year UG Degree	• Class 12 • 12+ Industrial Training Certificate (Engg.) • Class 12+ QPs & NOCs	UG Certificate (Engg.)
2nd year UG Degree	UG Certificate (Engg.)	UG Diploma (Engg.)
3rd year UG Degree	UG Diploma (Engg.)	B. Voc (Engg.)
Final year UG Degree	B. Voc (Engg.)	B.E./B. Tech.
1st Year PG (Engg.)	B.E./B. Tech.	M.Voc (Engg.)
2nd year PG (Engg.)	M.Voc. (Engg.)	M. Tech

Important: Under Graduate Degree Courses (Honors) in Emerging / Multidisciplinary Areas of Engineering shall be allowed as specialization from the same department. The minimum additional Credits for such Courses shall be in the range of 18-20 (including credit transferred from the SWAYAM platform) and the same shall be mentioned in the degree as specialization in that particular area. For example, doing extra 20 credits for Water Resources

Engineering in Civil Engineering shall earn B.Tech. (Hons.) Civil Engineering with specialization in Water Resources Engineering. The twenty credits of courses shall be allowed to take during the total program period i.e. up to eight semesters. The Department may offer suitable additional electives based on the expertise available or in online mode from SWAYAM.

Bridge courses for students opting 'Exit Option' at different level

After First Year

The following courses are available (2 for each) of 3 credits each need to be earned by the students to qualify for Undergraduate Certificate (Engineering) equivalent to National Apprenticeship Certificate in the area of Draughtsman (Civil) and Surveyor.

- Total Station – Application, Components Parts, Accessories Used, Characteristics and Data reading,
- Theodolite, identification & understanding of parts intro.
- BIS Code of Practice for Architectural & building drawings,
- Treatments for buildings,
- Floors & Floorings,
- Bricks and Stone Masonry works and Plumbing works

After Second Year

The candidate should pass any two suitable skill-based courses of Diploma Level to qualify for 'Undergraduate Diploma (Engineering)' which is equivalent to Diploma (Civil Engineering).

- Building Materials,
- Concrete Technology
- Public Health Engineering
- Estimating, Costing and Entrepreneurship

After Third Year

The candidate should pass any two suitable skill-based courses of Degree Level to qualify for B. Voc (Engineering)

Structural Drawings,

- Structural Drawings
- Elements of Highway Engineering,
- Geometric Design of Transportation Facility,
- Design of Hydraulic Structures,
- Water Resources Planning and Management.

Each student is required to undergo summer internship after 4^{th} and 6^{th} semester. The department shall only facilitate.

Note: In the beginning of 7th semester, students can opt for Masters in Water Resources Engineering or Transportation Engineering. Criteria for master discipline shall be CGPA up to 6th semester.

First Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1.	BSC	Physics	3	1	0	4	PHY03101
2.	BSC	Mathematics-I	3	1	0	4	MAT03101
3.	ESC	Basics Electrical Engineering	3	1	0	4	EEN07101
4.	ESC	Engineering Graphics & Design	1	0	2	2	EEN07103
5.	HSS	Communicative English	2	0	2	3	ENG04101
6.	LC	Basics Electrical Engineering Lab	0	0	2	1	EEN07105
7.	LC	Physics lab	0	0	2	1	PHY03103
8.	HSS	Design Thinking	0	0	2	1	HSS04101
			Total Credits			20	

Second Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1.	BSC	Chemistry	3	0	0	3	CHM03102
2.	BSC	Mathematics-II	3	1	0	4	MAT03102
3.	BSC	Biology for Engineers	3	0	0	3	MME07102
4.	ESC	Programming for Problem Solving	3	0	0	3	CSE07102
5.	ESC	Workshop Manufacturing Practices	1	0	4	3	EEN07102
6.	HSS	Universal Human Values	2	1	0	3	HSS04102
7.	LC	Chemistry Lab	0	0	2	1	CHM03104
8.	LC	Programming for Problem Solving Lab	0	0	2	1	CSE07104
9.	AU	NSS/NCC	2	0	0	0	NSS10102
			Total Credits			21	

Total credits after 1st year = 41

Third Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1	ESC	Engineering Mechanics	3	0	0	3	DCE07201
2	PCC	Surveying and Geomatics	2	1	2	4	DCE01201
3	PCC	Fluid Mechanics	2	1	0	3	DCE01203
4	PCC	Civil Engineering Materials	2	1	0	3	DCE01205
5	BSC	Mathematics III	3	1	0	4	
6	LC	Civil Engineering Materials Lab	0	0	2	1	DCE01207
7	LC	Engineering Mechanics Lab	0	0	2	1	DCE07203
8	LC	Fluid Mechanics Lab	0	0	2	1	DCE01209
9	AU	Disaster Management	2	0	0	0	DGI10201
			Total Credits			20	

Fourth Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1	PCC	Mechanics of Materials and Solids	2	1	0	3	DCE01202
3	PCC	Design of RCC Structures-I	3	1	0	4	DCE01204
4	PCC	Building Construction	2	1	0	3	DCE01206
5	PCC	Structural Analysis I	2	1	0	3	DCE01208
6	PCC	Civil Engineering Drawing	1	0	2	2	DCE01210
7	PCC	Transportation Engineering I	3	1	0	4	DCE01212
8	OEC	Project Management Techniques	3	0	0	3	DCE09202
9	LC	Mechanics of Materials and Solids Lab	0	0	2	1	DCE01214
10	AU	Environmental Sciences	2	0	0	0	
11	MSH 1						
	MSH 2						
			Total Credits			23	

Total credits after 2nd year = 84

Fifth Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1.	OEC	Remote Sensing and GIS in Engineering	2	1	0	3	DCE09301
2.	ESC	Engineering Economics	2	1	0	3	DCE07301
3.	PCC	Steel Structures Design	3	1	0	4	DCE01301
4.	PCC	Engineering Hydrology	3	1	0	4	DCE01303
5.	PCC	Transportation Engineering II	3	0	0	3	DCE01305
	PCC	Structural Analysis II	2	1	0	3	DCE01307
6.	LC	Transportation Engineering Lab	0	0	2	1	DCE01309
7.	MSH 3						
8.	MSH 4						
			Total Credits			22	

Sixth Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1.	PCC	Civil Engineering Estimating and Costing	2	1	0	3	DCE01302
2.	PCC	Design of RCC Structures-II	3	1	0	4	DCE01304
3.	PCC	Geotechnical Engineering	2	1	0	3	DCE01306
4.	PCC	Systems Analysis	2	1	0	3	DCE01308
5.	PCC	Environmental Engineering	2	1	0	3	DCE01310
6.	OEC	Watershed Management	3	0	0	3	DCE09302
7.	LC	Geotechnical Engineering Lab	0	0	2	1	DCE01312
8.	LC	Concrete Lab	0	0	2	1	DCE01314
9.	LC	Environmental Engineering Lab	0	0	2	1	DCE01316
10.	PROJ	Seminar & Technical Report Writing	0	0	2	1	DCE05302
11.	MSH 5						
12.	MSH 6						
			Total Credits			23	

Total credits after 3rd year = 129

Seventh Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1.	PCC	Foundation Engineering	**2**	**1**	**0**	**3**	DCE01401
2.	PCC	Open Channel and Fluvial Hydraulics	**2**	**1**	**0**	**3**	DCE01403
3.	PEC	**Elective – I**	**2**	**1**	**0**	**3**	
		Pavement Materials	2	1	0	3	DCE08401
		Intelligent transportation System	2	1	0	3	DCE08403
		Groundwater Hydrology	2	1	0	3	DCE08405
		Urban Water Management	2	1	0	3	DCE08407
4.	PEC	**Elective – II**	**2**	**1**	**0**	**3**	
		Design of Hydraulic Structures	2	1	0	3	DCE08409
		Pavement Geotechnics	2	1	0	3	DCE08411
		Freight Transport and Logistics	2	1	0	3	DCE08413
		Hydrologic Systems Modelling	3	0	0	3	DCE08415
5.	PEC	**Elective – III**	**2**	**1**	**0**	**3**	
		Water and Wastewater Engineering	2	1	0	3	DCE08417
		Traffic Engineering	2	1	0	3	DCE08419
		Geometric Design of Transportation Facility	2	1	0	3	DCE08421
		Land & Water Engineering and Management	2	1	0	3	DCE08423
7.	PROJ	Engineering Project I	0	0	10	**5**	DCE05401
8.	PROJ	45 days Summer Internship	0	0	0	1	DCE05403
9.	LC	Traffic Engineering Lab	0	0	2	1	DCE08425
10.	LC	Open Channel and Fluvial Hydraulics Lab	0	0	2	1	DCE01405
11.	MSH 7						
12.	MSH 8						
			Total Credits			22/23	

Eighth Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1.	PEC	**Elective – V**	**2**	**1**	**0**	**3**	
		Irrigation and Drainage Engineering	2	1	0	3	DCE08402
		Ground Improvement Techniques	2	1	0	3	DCE08404
		Advanced Soil and Water Conservation Engineering	2	1	0	3	DCE08406
		Airport System Planning & Design	2	1	0	3	DCE08408
2.	PEC	**Elective – VI**	**2**	**1**	**0**	**3**	
		Water resources Planning and Management	2	1	0	3	DCE08410
		Intersection Design and Analysis	2	1	0	3	DCE08412
		Stochastic Hydrology	2	1	0	3	DCE08414
		Mass Transit Systems					DCE08416
4.	PEC	**Elective - VII**	**2**	**1**	**0**	**3**	
		Flood Forecasting and Flood Hazard Management	2	1	0	3	DCE08418
		Modeling, Analysis and Simulation	2	1	0	3	DCE08420
		Transportation Economics	3	0	0	3	DCE08422
		Pavement Analysis and Design	2	1	0	3	DCE08424
5.	PROJ	Engineering Project II	0	0	20	10	DCE05402
6.	LC	Irrigation and Drainage Engineering lab	0	0	2	1	DCE08426
7.	MSH 9						
8.	MSH 10						
			Total Credits			19/20	

Total credits after 4th year = 170-172 with B. Tech in Civil Engineering

Ninth Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1.	PEC	**Elective – IX**	**2**	**1**	**0**	**3**	
		Environmental Impact Assessment	2	1	0	3	DCE08501
		Railways and Waterways	2	1	0	3	DCE08503
		Hydropower Engineering	2	1	0	3	DCE08505
		Sediment Transportation	2	1	0	3	DCE08507
		Road safety	3	0	0	3	DCE08509
2.	PEC	**Elective – X**	**2**	**1**	**0**	**3**	
		Reinforced Soil Structures	2	1	0	3	DCE08511
		Water Policy and Auditing	2	1	0	3	DCE08513
		Integrated River Basin Planning and Management	2	1	0	3	DCE08515
		GIS application is Transportation Engineering	3	0	0	3	DCE08517
3.	PCC	Research Methodology and IPR	2	0	0	2	DCE01501
4.	PROJ	Dissertation I	0	0	24	12	DCE05501
			Total Credits			20	

Tenth Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1.	PROJ	Dissertation II	0	0	40	20	DCE05502
			Total Credits			20	

Total credits after 5th year = 210-212 with a separate degree of B. Tech in Civil Engineering and 5 years Integrated M.Tech in Water Resources Engineering/Transportation Engineering.

Exit: Students desirous of taking exit with specified degree after first, second, third and fourth year with Undergraduate Certificate, Undergraduate Diploma, B.Voc and B.Tech in Civil Engineering, respectively shall be required to submit their request to Dean (Academic) through Head and Dean (SET) at one semester prior of exit. For example, student willing to take exit after 4th year, must inform at the end of 7th semester as per academic calendar.

List of Minor Specialization Course

MSH 1	Subsurface Investigation and Instrumentation	3	1	0	4	DCE02202
MSH 2	Finite Element Methods	3	1	0	4	DCE02204
MSH 3	Hill Road	3	1	0	4	DCE02301
MSH 4	Climate Change Impact on Water Resources	3	1	0	4	DCE02303
MSH 5	Evaluation and Strengthening of Pavement	3	1	0	4	DCE02302
MSH 6	Geomatics in Water Resources Planning and Management	3	1	0	4	DCE02304
MSH 7	Highway Construction Practice	3	1	0	4	DCE02401
MSH 8	Statistics for Engineers	3	1	0	4	DCE02403
MSH 9	Solute Transport Modeling	3	1	0	4	DCE02402
MSH 10	Road Safety	3	1	0	4	DCE02404

Syllabus

First Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
9.	BSC	Physics	3	1	0	4	PHY03101
10.	BSC	Mathematics-I	3	1	0	4	MAT03101
11.	ESC	Basics Electrical Engineering	3	1	0	4	EEN07101
12.	ESC	Engineering Graphics & Design	1	0	2	2	EEN07103
13.	HSS	Communicative English	2	0	2	3	ENG04101
14.	LC	Basics Electrical Engineering Lab	0	0	2	1	EEN07105
15.	LC	Physics lab	0	0	2	1	PHY03103
16.	HSS	Design Thinking	0	0	2	1	HSS04101
			Total Credits			20	

Course Code	**:**	**PHY03101**
Course Title	**:**	**Physics**
Number of Credits	**:**	**4 (L:3, T:1, P:0)**
Course Category	**:**	**Basic Science Course**

Course Objective: The objective of this course is to familiarize the students with basic laws of motion, rigid body dynamics, mechanical properties of matter, oscillations and waves, and relativity. It aims to equip the students to deal with basic problems that they would be seeing in the real world. The course shall enhance the fundamental knowledge in Physics and its applications relevant to various streams of Engineering and Technology.

Course Content:

Unit	Content	Hours
I	Review of Vector Calculus: Vector algebra addition, Subtraction, components of vectors, scalar and vector multiplications, triple products, three orthogonal coordinate systems (rectangular, cylindrical and spherical). Vector calculus differentiation, partial differentiation, Integration, vector operator del, gradient, divergence and curl, Integral theorems of vectors. Conversion of vector from one coordinate system to another.	**15**
II	Static Electric Field: Coulomb's law, Electric field intensity, Electrical field due to charges. Line, surface, Volume charge distributions. Gauss law and its applications. Absolute electric potential, Potential difference, calculation of potential differences for different configurations. Electric dipole, electrostatic	**10**

	energy and energy density.	
III	Static Magnetic Field: Biot-savert Law, Ampere Law, Magnetic Flux and Magnetic flux density, Scalar and Vector magnetic potentials, steady magnetic fields produced by current carrying conductors.	**10**
IV	Rigid Body Motion: Rigid body, Moment of inertia, Rigid body kinematics, Rigid body kinetics, Motion of gyroscope.	**5**
V	Mechanical Properties of Matter: Modulus of rigidity, Poisson's ratio, relation connecting different elastic-constants, Viscosity, Ponselle's equation of liquid flow through a narrow tube.	**10**
VI	Oscillations and Waves: Simple harmonic oscillation, damped harmonic oscillation and forced oscillation, Q factor and resonance. Differential equation of one dimensional wave and its solution, reflection and transmission of waves.	**10**

Recommended Books/References

1. Resanick and Halliday, Physics Part-I, Vol I, Edition 5, Wiley, 2007.
2. D.S. Mathur, Mechanics, S. Chand Publishing, 2000.
3. H.C. Verma, Concepts in Physics 1, Vol. I, Bharati Bhavan, 2020.
4. R.K. Shukla and Anchal Srivastava, Mechanics, New Age International Publishers, 2006
5. D. Kleppner and R. Kolenkow, An Introduction to Mechanics, McGraw Hill, 2017.
6. C. Kettel, W. D. Knight, M.A. Ruderman and A.C. Helmholz, Mechanics (Berkeley Physics Course), McGraw Hill Education, 2017.
7. Ian G. Main, Vibrations and waves in physics, Cambridge University Press, 1993.
8. H.J. Pain, The physics of vibrations and waves, John Wiley & Sons Ltd, 2005.

Course Outcomes: After successful completion of this course, students will demonstrate the ability

- To understand the basic laws of mechanics.
- To use and apply the Moment of inertia, rigid body kinematics, Rigid body kinetics.
- To understand mechanical concepts of matter like Viscosity and Ponselle's equation.
- To explain Simple harmonic oscillation, damped harmonic oscillation and forced oscillation.
- To understand the theory of relativity.

Course Code	**:**	**MAT03101**
Course Title	**:**	**Mathematics-I**
Number of Credits	**:**	**4 (L:3, T:1, P:0)**
Course Category	**:**	**Basic Science Course**

Course Objective: The goal of this course is to achieve conceptual understanding and to retain the best traditions of traditional calculus. The syllabus is designed to provide the basic tools of calculus mainly for the purpose of modeling the engineering problems mathematically and obtaining solutions. This is a foundation course which mainly deals with topics such as single variable and multivariable calculus and plays an important role in the understanding of science, engineering, economics and computer science, among other disciplines.

Course Content:

Unit	Content	Hours
I	Calculus: Evolutes and involutes; Evaluation of definite and improper integrals; Beta and Gamma functions and their properties; Applications of definite integrals to evaluate surface areas and volumes of revolutions. Rolle's Theorem, Mean value theorems, Taylor's and Maclaurin theorems with remainders; indeterminate forms and L'Hospital's rule; Maxima and minima.	**15**
II	Sequences and Series: Convergence of sequence and series, tests for convergence; Power series, Taylor's series, series for exponential, trigonometric and logarithm functions; Fourier series: Half range sine and cosine series, Parseval's theorem.	**15**
III	Multivariable Calculus (Differentiation): Limit, continuity and partial derivatives, directional derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points; Method of Lagrange multipliers; Gradient, curl and divergence.	**15**
IV	Matrices: Inverse and rank of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Diagonalization of matrices; Cayley-Hamilton Theorem, and Orthogonal transformation.	**15**

Recommended Books/References

1. R. Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.
2. R. Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.
3. E. Kreyszig, Advanced Engineering Mathematics, 10^{th} Edition, John Wiley & Sons, 2006.
4. T. Veerarajan, Engineering Mathematics for first year, Tata McGraw-Hill, New

Delhi, 2008.
5. W. E. Boyce and R.C. Di Prima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
6. N. P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
7. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Course Outcomes: The students will learn:

- To apply differential and integral calculus to notions of curvature and to improper integrals. Apart from some other applications they will have a basic understanding of Beta and Gamma functions.
- To explain the fallouts of Rolle's Theorem that is fundamental to application of analysis to Engineering problems.
- To discuss the tool of power series and Fourier series for learning advanced Engineering Mathematics.
- To deal with functions of several variables that is essential in most branches of engineering.
- To use the essential tool of matrices and linear algebra in a comprehensive manner.

Course Code	**:**	**EEN07101**
Course Title	**:**	**Basic Electrical Engineering**
Number of Credits	**:**	**4 (L: 3, T:1, P:0)**
Course Category	**:**	**Engineering Sciences Course**

Course Objective: The objective of this Course is to provide the students with an introductory and broad treatment of the field of Electrical Engineering. Course Content:

Unit	Content	Hours
I	D. C. Circuits covering, Ohm's Law and Kirchhoff's Laws; Analysis of series, parallel and series-parallel circuits excited by independent voltage sources; Power and energy; Electromagnetism covering, Faradays Laws, Lenz's Law, Fleming's Rules, Statically and dynamically induced EMF; Concepts of self-inductance, mutual inductance and coefficient of coupling; Energy stored in magnetic fields.	10
II	Single Phase A.C. Circuits covering, Generation of sinusoidal voltage-definition of average value, root mean square value, form factor and peak factor of sinusoidal voltage and current and phasor representation of alternating quantities; Analysis with phasor diagrams of R, L, C, RL, RC and RLC circuits; Real power, reactive power, apparent power and power factor, series, parallel and series- parallel circuits; Three Phase A.C. Circuits	15

	covering, Necessity and Advantages of three phase systems, Generation of three phase power, definition of Phase sequence, balanced supply and balanced load; Relationship between line and phase values of balanced star and delta connections; Power in balanced three phase circuits, measurement of power by two wattmeter method.	
III	Transformers covering, Principle of operation and construction of single phase transformers (core and shell types). EMF equation, losses, efficiency and voltage regulation; Synchronous Generators covering, Principle of operation; Types and constructional features; EMF equation	10
IV	DC Machines covering, Working principle of DC machine as a generator and a motor; Types and constructional features; EMF equation of generator, relation between EMF induced and terminal voltage enumerating the brush drop and drop due to armature reaction; DC motor working principle; Back EMF and its significance, torque equation; Types of D.C. motors, characteristics and applications; Necessity of a starter for DC motor	10
V	Three Phase Induction Motors covering; Concept of rotating magnetic field; Principle of operation, types and constructional features; Slip and its significance; Applications of squirrel cage and slip ring motors; Necessity of a starter, star-delta starter.	10
VI	Sources of Electrical Power covering, Introduction to Wind, Solar, Fuel cell, Tidal, Geo-thermal, Hydroelectric, Thermal-steam, diesel, gas, nuclear power plants; Concept of cogeneration, and distributed generation	5

Recommended Books/References

1. I. J. Nagrath and D. P. Kothari, Basic Electrical Engineering, Tata McGraw Hill, 2001.
2. Hayt and Kimberly, Engineering Circuit Analysis, Tata McGraw Hill.
3. R. Sahdev, Basic Electrical Engineering, Khanna Book Publishing Company, 2019.
4. D.C. Kulshreshtha, Basic Electrical Engineering, Tata McGraw Hill, 2009.
5. R. Prasad, Fundamentals of Electrical Engineering, Prentice Hall, India, 2009.

Course Outcomes: The students will be able to:

- Learn strong basics of Electrical Engineering and practical implementation of Electrical fundamentals.
- Learn different applications of commonly used electrical machinery.

Course Code	**:**	**EEN07103**
Course Title	**:**	**Engineering Graphics & Design**
Number of Credits	**:**	**2 (L:1,T:0, P:2)**
Course Category	**:**	**Engineering Science Course**

Course Objective: The objective of this Course is to provide the basic knowledge about Engineering Drawing. Detailed concepts are given in projections, technical drawing, dimensioning and specifications, so useful for a student in preparing for an engineering career.

Course Content:

Unit	Content	Hours
I	Introduction to Engineering Drawing: Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales	**5**
II	Orthographic Projections: Principles of Orthographic Projections-Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes	**5**
III	Projections of Regular Solids: Covering those inclined to both the Planes-Auxiliary Views; Draw simple annotation, dimensioning and scale. Floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc.	**5**
IV	Sections and Sectional Views of Right Angular Solids: Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone; Draw the sectional orthographic views of geometrical solids, objects from industry and dwellings (foundation to slab only).	**10**
V	Isometric Projections: Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions	**5**
VI	Overview of Computer Graphics: Listing the computer technologies that impact on graphical communication, Demonstrating knowledge of the theory of CAD software [such as: The Menu System, Toolbars (Standard, Object Properties, Draw, Modify and Dimension), Drawing Area (Background, Crosshairs, Coordinate System), Dialog boxes and windows, Shortcut menus (Button Bars), The Command Line (where applicable), The Status Bar, Different methods of zoom as used in CAD, Select and erase objects.;	**5**

	Isometric Views of lines, Planes, Simple and compound Solids.	
VII	Customisation & CAD Drawing: Consisting of set up of the drawing page and the printer, including scale settings, Setting up of units and drawing limits; ISO and ANSI standards for coordinate dimensioning and tolerancing; Orthographic constraints, Snap to objects manually and automatically; Producing drawings by using various coordinate input entry methods to draw straight lines, Applying various ways of drawing circles;	**10**
VIII	Annotations, layering & other functions: Covering applying dimensions to objects, applying annotations to drawings; Setting up and use of Layers, layers to create drawings, Create, edit and use customized layers; Changing line lengths through modifying existing lines (extend/lengthen); Printing documents to paper using the print command; orthographic projection techniques; Drawing sectional views of composite right regular geometric solids and project the true shape of the sectioned surface; Drawing annotation, Computer-aided design (CAD) software modeling of parts and assemblies. Parametric and non-parametric solid, surface, and wireframe models. Part editing and two-dimensional documentation of models. Planar projection theory, including sketching of perspective, isometric, multiview, auxiliary, and section views. Spatial visualization exercises. Dimensioning guidelines, tolerancing techniques; dimensioning and scale multi views of dwelling	**10**
IX	Demonstration of a simple team design project that illustrates: Geometry and topology of engineered components: creation of engineering models and their presentation in standard 2D blueprint form and as 3D wire-frame and shaded solids; meshed topologies for engineering analysis and tool-path generation for component manufacture; geometric dimensioning and tolerancing; Use of solid-modeling software for creating associative models at the component and assembly levels; floor plans that include: windows, doors, and fixtures such as WC, bath, sink, shower, etc. Applying colour coding according to building drawing practice; Drawing sectional elevation showing foundation to ceiling; Introduction to Building Information Modelling (BIM).	**5**

Recommended Books/References

1. N. D. Bhatt, V. M. Panchal, P. R. Ingle, Engineering Drawing, Charotar Publishing House, 2014.
2. P. Jain, Engineering Graphics and Design, Khanna Book Publishing Company, 2019.
3. M.B. Shah and B. C. Rana, Engineering Drawing and Computer Graphics, Pearson Education, 2008.
4. B. Agrawal, C. M. Agrawal, Engineering Graphics, TMH Publication, 2012.
5. K.L. Narayana and P. Kannaiah, Text book on Engineering Drawing, Scitech, 2008. Publishers.

Course Outcomes: The students will learn:

- Introduction to engineering design and its place in society.
- Exposure to the visual aspects of engineering design.

- Exposure to engineering graphics standards.
- Exposure to solid modelling.

Course Code	**:**	**ENG04101**
Course Title	**:**	**Communicative English**
Number of Credits	**:**	**3 (L:2,T:0, P:2)**
Course Category	**:**	**HSS**

Course Objective: The objective of this Course is to Help the students develop an overall knowledge and understanding of English Grammar and Phonetics and communicate ideas and information effectively. The students will be familiarized with the basics of communication and thus develop their ability to use English for performing some of the most vital communicative functions in academic, social and professional situations. The student will follow the writing conventions correctly without making any serious lapses in grammar or word choices.

Course Content:

Unit	Content	Hours
I	Vocabulary Building: The concept of Word Formation, Root words from foreign languages and their use in English, Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonyms, antonyms, and standard abbreviations.	**5**
II	Basic Writing Skills: Sentence Structures, Use of phrases and clauses in sentences, Importance of proper punctuation, Creating coherence, Organizing principles of paragraphs in documents, Techniques for writing precisely.	**5**
III	Identifying Common Errors in Writing: Subject-verb agreement, Noun-pronoun agreement, Misplaced modifiers, Articles, Prepositions, Redundancies, Clichés.	**5**
IV	Nature and Style of sensible Writing: Describing, Defining, Classifying, Providing examples or evidence, Writing introduction and conclusion, Writing Practices: Comprehension, Précis Writing, Essay Writing, Letter Writing, Resume, CV, Picture reading and Caption Writing Suggested Reading	**10**
V	Oral Communication: Listening Comprehension, Pronunciation, Intonation, Stress and Rhythm, Common Everyday Situations: Conversations and Dialogues, Communication at Workplace, Interviews Formal Presentations. Communication: Definition, Process, Types-Verbal, Non-Verbal, Effective Communication, Communication Network in an organization, barriers of communication	**5**

Recommended Books/References

1. E. Suresh Kumar and P. Sreehari, Fluency in English – Part II, Communicative English, OUP, 2006.

2. P.C. Wren, H. Martin, N.D.V Prasada Rao, High School English Grammar & Composition. New Delhi: S. Chand,1973.
3. L. Alexander, Longman English grammar practice. New York: Longman,1999.
4. R. Murphy, English grammar in use. Cambridge: Cambridge University Press, 2012.

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

- Identify deviant use of English both in written and spoken forms
- Recognize the errors of usage and correct them
- Recognize their own ability to improve their own competence in using the language
- Understand and appreciate English spoken by people from different regions
- Use language for speaking with confidence in an intelligible and acceptable manner

Course Code	**:**	**EEN07105**
Course Title	**:**	**Basics Electrical Engineering Lab**
Number of Credits	**:**	**1 (L:0,T:0, P:2)**
Course Category	**:**	**Basic Science Course**

Course Objective: The objective of this lab. is to provide hands-on training on the basic Electrical Engineering.

Course Content:

Exp No.	Title
1.	Verification of KCL&KVL.
2.	Study of AC R-L-C Series circuit.
3.	Study of AC R-L-C parallel circuit.
4.	Verification of Thevenin's theorem
5.	Verification of Superposition theorem
6.	Verification of Maximum Power Transfer theorem
7.	To Measure the power and the power factor of a single phase load by 3-Voltmeter Method.
8.	To Measure the power and the power factor of a single phase load by 3-Ammter Method.
9.	Study of resonance in electrical circuit.
10.	Transformer testing.

Recommended Books/References

1. Johnetta Keizer, Basic Electrical LAB Experiment Guide, 2021.
2. M.Siva Ramkumar, A.Amudha, M.S Krishnan, G.Emayavaramban, Basic electrical engineering laboratory : Fundamental of Electrical, Notion Press; 1st edition, 2019.
3. Nagrath I.J. and D. P. Kothari, Basic Electrical Engineering, Tata McGraw Hill, 2001.
4. Hayt and Kimberly, Engineering Circuit Analysis, Tata McGraw Hill.
5. Ritu Sahdev, Basic Electrical Engineering, Khanna Book Publishing Company, 2019.

6. D.C. Kulshreshtha, Basic Electrical Engineering, Tata McGraw Hill, 2009.
7. Rajendra Prasad, Fundamentals of Electrical Engineering, Prentice Hall, India, 2009.

Course Outcomes:

- Students will learn on the practical implementation of Electrical fundamentals.
- Students will visualize the concept of circuit laws and network theorems.
- Students will acquire skills in electrical measuring devices.
- Students will learn different applications of electrical machinery.

Course Code	**:**	**PHY03103**
Course Title	**:**	**Physics Lab**
Number of Credits	**:**	**1 (L:0,T:0, P:2)**
Course Category	**:**	**Basic Science Course**

Course Objective: To give students a foundational understanding of rigid body dynamics through basic experiments. To teach principles of motion, forces, and moments applied to solid objects. Develop skills in analyzing and predicting motion behaviors. Apply theoretical concepts to practical scenarios, fostering a strong grasp of mechanical systems and their behaviors.

Course Content:

Exp No.	Title
1.	To determine the value of acceleration due to gravity and radius of gyration using bar pendulum.
2.	To verify the ohm's law and hence determine the unknown resistance of the given material of the wire.
3.	To determine the spring constant of a spring by (a) Static method (b) Dynamic method.
4.	To study the principle of different logic gates in positive logic system.
5.	To determine the moment of inertia of a flywheel.
6.	To determine the value of acceleration due to gravity and radius of gyration using Kater's pendulum.

Recommended Books/References

1. C.L. Arora, Practical of Physics, S. Chand and Company Limited, Edition, 1995.
2. H. Singh and P.S. Hemne, Practical of Physics, S. Chand and Company Limited.
3. P. R. Sasi Kumar, Practical Physics, PHI Learning Pvt. Ltd., 2011.
4. R. K. Shukla, Practical Physics, New Age International, 2007.

Course Outcomes: At the end of the course, students should be able to:

- Understand the concept of radius of gyration and its relation to rotational motion.

- Gain a practical understanding of Ohm's law and its applications in electrical circuits.
- Acquire knowledge of the concept of moment of inertia and learn the experimental procedure to determine the moment of inertia of rotating objects.

Course Code	**:**	**HSS04101**
Course Title	**:**	**Design Thinking**
Number of Credits	**:**	**1 (L:0,T:0, P:2)**
Course Category	**:**	**HSS**

Course Objective: The objective of this Course is to provide the new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products which useful for a student in preparing for an engineering career.

Course Content:

Unit	Content
I	An Insight to Learning; Understanding the Learning Process, Kolb's Learning Styles, Assessing and Interpreting
II	Remembering Memory; Understanding the Memory process, Problems in retention, Memory enhancement techniques
III	Emotions: Experience & Expression: Understanding Emotions: Experience & Expression, Assessing Empathy, Application with Peers
IV	Basics of Design Thinking: Definition of Design Thinking, Need for Design Thinking, Objective of Design Thinking, Concepts & Brainstorming, Stages of Design Thinking Process (explain with examples) – Empathize, Define, Ideate, Prototype, Test
V	Being Ingenious & Fixing Problem: Understanding Creative thinking process, Understanding Problem Solving, Testing Creative Problem Solving
VI	Process of Product Design: Process of Engineering Product Design, Design Thinking Approach, Stages of Product Design, Examples of best product designs and functions, Assignment – Engineering Product Design
VII	Prototyping & Testing; What is Prototype? Why Prototype? Rapid Prototype Development process, Testing, Sample Example, Test Group Marketing
VIII	Celebrating the Difference: Understanding Individual differences & Uniqueness, Group Discussion and Activities to encourage the understanding, acceptance and appreciation of Individual differences
IX	Design Thinking & Customer Centricity: Practical Examples of Customer Challenges, Use of Design Thinking to Enhance Customer Experience, Parameters of Product experience, Alignment of Customer Expectations with Product Design of Tournament – Knock-Out, League/Round Robin & Combination.
X	Feedback, Re-Design & Re-Create: Feedback loop, Focus on User Experience, Address "ergonomic challenges, User focused design, rapid prototyping & testing, final product, Final Presentation – "Solving Practical Engineering Problem through

	Innovative Product Design & Creative Solution".

Recommended Books/References

1. J. Hehn, D. Mendez, W. Brenner, M. Broy, Design Thinking for Software Engineering, springer Link, 2022.
2. I, Cuinas and M. Jose, F Iglesias, Design Thinking for Engineering: A practical guide (Manufacturing), Institution of Engineering and Technology, 2023.

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

- Compare and classify the various learning styles and memory techniques and Apply them in their engineering education
- Analyze emotional experience and Inspect emotional expressions to better understand users while designing innovative products
- Develop new ways of creative thinking and Learn the innovation cycle of Design Thinking process for developing innovative products

Second Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
10.	BSC	Chemistry	3	0	0	3	CHM03102
11.	BSC	Mathematics-II	3	1	0	4	MAT03102
12.	BSC	Biology for Engineers	3	0	0	3	MME07102
13.	ESC	Programming for Problem Solving	3	0	0	3	CSE07102
14.	ESC	Workshop Manufacturing Practices	1	0	4	3	EEN07102
15.	HSS	Universal Human Values	2	1	0	3	HSS04102
16.	LC	Chemistry Lab	0	0	2	1	CHM03104
17.	LC	Programming for Problem Solving Lab	0	0	2	1	CSE07104
18.	AU	NSS/NCC	2	0	0	0	NSS10102
			Total Credits			21	

Course Code	**:**	**CHM03102**
Course Title	**:**	**Chemistry**
Number of Credits	**:**	**3 (L: 3, T: 0, P: 0)**
Course Category	**:**	**Basic Science Course**

Course Objective:

The objective of the Chemistry I is to acquaint the students with the basic phenomenon/concepts of chemistry, the student faces during course of their study in the industry and Engineering field. The student with the knowledge of the basic chemistry, will understand and explain scientifically the various chemistry related problems in the industry/engineering field. The student will able to understand the new developments and breakthroughs efficiently in engineering and technology. The introduction of the latest (R&D oriented) topics will make the engineering student upgraded with the new technologies.

Course Content:

Unit	Content	Hours
I	Atomic and Molecular Structure: Schrodinger equation. Particle in a box solutions and their applications for conjugated molecules and nanoparticles. Forms of the hydrogen atom wave functions and the plots of these functions to explore their spatial variations. Molecular orbitals of diatomic molecules and plots of the multicentre orbitals. Equations for atomic and molecular orbitals. Energy level diagrams of diatomic. Pi-molecular orbitals of butadiene and benzene and aromaticity. Crystal field theory and the energy	**5**

	level diagrams for transition metal ions and their magnetic properties. Band structure of solids and the role of doping on band structures.	
II	Spectroscopic techniques and applications: Principles of spectroscopy and selection rules. Electronic spectroscopy. Fluorescence and its applications in medicine. Vibrational and rotational spectroscopy of diatomic molecules. Applications. Nuclear magnetic resonance and magnetic resonance imaging, surface characterization techniques. Diffraction and scattering.	**5**
III	Intermolecular forces and potential energy surfaces: Ionic, dipolar and van Der Waals interactions. Equations of state of real gases and critical phenomena. Potential energy surfaces of H3, H2F and HCN and trajectories on these surfaces.	**5**
IV	Use of free energy in chemical equilibria: Thermodynamic functions: energy, entropy and free energy. Estimations of entropy and free energies. Free energy and emf. Cell potentials, the Nernst equation and applications. Acid base, oxidation reduction and solubility equilibria. Water chemistry. Corrosion. Use of free energy considerations in metallurgy through Ellingham diagrams.	**5**
V	Periodic properties: Effective nuclear charge, penetration of orbitals, variations of s, p, d and f orbital energies of atoms in the periodic table, electronic configurations, atomic and ionic sizes, ionization energies, electron affinity and electronegativity, polarizability, oxidation states, coordination numbers and geometries, hard soft acids and bases, molecular geometries.	**5**
VI	Stereochemistry: Representations of 3 dimensional structures, structural isomers and stereoisomers, configurations and symmetry and chirality, enantiomers, diastereomers, optical activity, absolute configurations and conformational analysis. Isomerism in transitional metal compounds.	**3**
VII	Organic reactions and synthesis of a drug molecule: Introduction to reactions involving substitution, addition, elimination, oxidation, reduction, cyclization and ring openings. Synthesis of a commonly used drug molecule.	**2**

Recommended Books/References

1. AICTE's Prescribed Textbook: Chemistry – I with Lab Manual, Khanna Book Publishing.
2. Manisha Agrawal, Engineering Chemistry.
3. B. H. Mahan, University chemistry, by
4. M. J. Sienko and R. A. Plane, Chemistry: Principles and Applications
5. C. N. Banwell, Fundamentals of Molecular Spectroscopy
6. B. L. Tembe Kamaluddin and M. S. Krishnan, Engineering Chemistry (NPTEL Web-book), by
7. P. W. Atkins, Physical Chemistry
8. K. P. C. Volhardt and N. E. Schore, Organic Chemistry: Structure and Function 5th Edition http://bcs.whfreeman.com/vollhardtschore5e/default.asp

Course Outcomes: The course will enable the students:

- To analyse microscopic chemistry in terms of atomic and molecular orbitals and intermolecular forces.
- To rationalise bulk properties and processes using thermodynamic considerations.
- To distinguish the ranges of the electromagnetic spectrum used for exciting different molecular energy levels in various spectroscopic techniques
- To rationalise periodic properties such as ionization potential, electronegativity, oxidation states and electronegativity.
- To list major chemical reactions that are used in the synthesis of molecules.

Course Code	**:**	**MAT03102**
Course Title	**:**	**Mathematics- II**
Number of Credits	**:**	**4 (L: 3, T: 1, P: 0)**
Course Category	**:**	**Basic Science Course**

Course Objective: Mathematics fundamental necessary to formulate, solve and analyze engineering problems.

Course Content:

Unit	Content	Hours
I	Matrices: Linear Systems of Equations; Linear Independence; Rank of a Matrix; Determinant, Inverse of a matrix, rank-nullity theorem; System of linear equations; Symmetric, skew-symmetric and orthogonal matrices; Determinants; Eigenvalues and eigenvectors; Orthogonal transformation; Diagonalization of matrices; Cayley-Hamilton Theorem.	**10**
II	First order ordinary differential equations: Exact, linear and Bernoulli's equations. Equations not of first degree: equations solvable for p, equations solvable for y, equations solvable for x and Clairaut's type.	**10**
III	Ordinary differential equations of higher orders: Second order linear differential equations with variable coefficients: Euler-Cauchy equations, solution by variation of parameters; Power series solutions: Legendre's equations and Legendre polynomials, Frobenius method, Bessel's equation and Bessel's functions of the first kind and their properties.	**10**
IV	Complex Variable – Differentiation: Differentiation, Cauchy-Riemann equations, analytic functions, harmonic functions, finding harmonic conjugate; elementary analytic functions (exponential, trigonometric, logarithm) and their properties; Conformal mappings, Mobius transformations and their properties.	**15**

V	Complex Variable – Integration:Contour integrals, Cauchy-Goursat theorem (without proof), Cauchy Integral formula (without proof), Liouville's theorem and Maximum-Modulus theorem (without proof); Taylor's series, zeros of analytic functions, singularities, Laurent's series; Residues, Cauchy Residue theorem (without proof), Evaluation of definite integral involving sine and cosine, Evaluation of certain improper integrals using the Bromwich contour.	**15**

Recommended Books/References

1. AICTE's Prescribed Textbook: Mathematics-II (Calculus, Ordinary Differential Equations and Complex Variable, Khanna Book Publishing Co.
2. R. Garg, Engineering Mathematics, Khanna Book Publishing Company, 2022.
3. R. Garg, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2021.
4. E. Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2006.
5. T. Veerarajan, Engineering Mathematics for first year, Tata McGraw-Hill, New Delhi, 2008.
6. W. E. Boyce and R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, 9th Edn., Wiley India, 2009.
7. D. Poole, Linear Algebra: A Modern Introduction, 2nd Edition, Brooks/Cole, 2005.
8. S. L. Ross, Differential Equations, 3rd Ed., Wiley India, 1984.
9. E. A. Coddington, An Introduction to Ordinary Differential Equations, Prentice Hall India, 1995.
10. E. L. Ince, Ordinary Differential Equations, Dover Publications, 1958.
11. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7th Ed., Mc-Graw Hill, 2004.
12. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
13. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36th Edition, 2010.

Course Outcomes: The students will learn:

- The essential tool of matrices and linear algebra in a comprehensive manner.
- The effective mathematical tools for the solutions of differential equations that model physical processes.
- The tools of differentiation and integration of functions of a complex variable that are used in various techniques dealing engineering problems.

Course Code	**:**	**MME07102**
Course Title	**:**	**Biology for Engineers**
Number of Credits	**:**	**3 (L: 3, T: 0, P: 0)**
Course Category	**:**	**Engineering Science Course**

Course Objectives: The course objective is to establish a bridge to understanding the basics of biological science and various fields of engineering for students in their undergraduate courses.

Course Content:

Unit	Content	Hours
I	Cell Biology: Cell as a unit of life. Prokaryotes and Eukaryotes cells- Structure and functions. Ultrastructure of plant, animal and microbial cells. Cell membranes & structures. Cell Organelles, Types of Cell division: Mitosis and Meiosis. Cell cycle and its regulation, Cancer.	**9**
II	Molecular Biochemistry: Water, Carbohydrates - Sugars-disaccharides, Oligosaccharides, polysaccharides-homo and hetero, amylose, amylopectin, dextran, starch – glycogen, cell wall polysaccharides – cellulose, chitin. Lipids: Fats, Oils, Waxes - Fatty acids. Proteins: Amino acids, - essential and non-essential - dipeptides, fibrous and globulins - primary, secondary, tertiary, quaternary structures, alpha helix and beta pleats – triple helix - Ramachandran plots. Mechanism of enzyme action: enzyme kinetics, regulation of enzyme activity, Cofactor and Coenzyme, Technological application of enzyme. Bioenergetic and Metabolism – Laws of Thermodynamics applied to biological systems, Carbohydrate Metabolism, Lipid Metabolism, Lipid Metabolism, Amino Acid Metabolism, and Nucleic Acid Metabolism.	**9**
III	Human Physiology: Integumentary System, Digestive System, Respiratory System, Circulatory System, Musculoskeletal System, Excretory System, Endocrine System, Nervous Engineering, and Reproductive System. Human Immune System.	**10**
IV	Molecular Biology: Nucleic acids: Nitrogen bases-purines, pyrimidines, nucleosides and nucleotides – oligonucleotides - base paring – DNA, RNA – tRNA, mRNA, rRNA, antisense RNA –single and double-stranded – hypo and hyperchromicity, DNA varieties – A, B, and Z – Okazaki fragment – palindromeconcatenation- polymorphism –DNA Replication, Central Dogma, Genetic code, Gene expression, Translation, Mutation, Immune system.	**10**
V	Application of Biology in Engineering: Biological Engineering Solutions – Biosensor, Bioremediation, Genetic Engineering, Biology vs Technology, Biomimetic Engineering, Alliance between Engineering and Biology – (Mechanical Eng. & Biology, Electronic Eng. & Biology, Electrical Eng. &	**7**

	Biology, Computer Eng. & Biology, Civil Eng. & Biology, Materials Eng. & Biology, Ceramic Eng. & Biology, Mining Eng. & Biology).	

Recommended Books/References

1. Robert K. Murray, Daryl K. Garner, Peter A. Mayes, Victor W. Rodwell, Harper's Biochemistry, 28th edition, Lange Medical Books/ McGraw Hill, New York.
2. David L. Nelson, Michael M. Cox, W. H. Lehninger, Principles of Biochemistry, 5th edition, Freeman Publishers, New York.
3. E.D.P.De Robertis, Cell & Molecular Biology, 8th edition, Lippincott publishers.
4. Alberts, Molecular biology of the cell, 6th edition, Garland Publishing.
5. David Freifelder, Essentials of Molecular biology, Jones & Bartlett Publishers.
6. Lewin Benjamin, Genes, 9th edition,. CBS Publishers and Distributors.
7. J. Cooper and C. Tass, Biosensors: A Practical Approach, Oxford University Press, 2004.
8. C.S. Kumar, Nanomaterials for Biosensors, Wiley – VCH, 2007.
9. Harvey Lodish, David Baltimore, Arnold Berk, Molecular Cell Biology, WH Freeman and Co.
10. Brian, R. Eggins, Chemical Sensors and Biosensors, Wiley New York, Chichester, 2002.
11. G.K. Knoff and A.S. Bassi, Smart Biosensor Technology, CRC Press, 2006.

Course Outcomes: After studying the course, the student will be able to:

- Convey that all forms of life have the same building blocks and yet the manifestations are as diverse as one can imagine
- Classify enzymes and distinguish between different mechanisms of enzyme action.
- Identify DNA as a genetic material in the molecular basis of information transfer.
- Analyse biological processes at the reductionistic level
- Apply thermodynamic principles to biological systems.

Course Code	**:**	**CSE07102**
Course Title	**:**	**Programming for Problem Solving**
Number of Credits	**:**	**3 (L: 3, T: 0, P: 0)**
Course Category	**:**	**Engineering Science Courses**

Course Objectives:

1. To learn the fundamentals of computers.
2. To understand the various steps in program development.
3. To learn the syntax and semantics of C programming language.
4. To learn the usage of structured programming approach in solving problems.
5. To understated and formulate algorithm for programming script
6. To analyze the output based on the given input variables

Course Content:

Unit	Content	Hours
I	Introduction to Programming: Computer system, components of a computer system, computing environments, computer languages, creating and running programs, Algorithms, flowcharts. Introduction to C language: History of C, basic structure of C programs, process of compiling and running a C program, C tokens, keywords, identifiers, constants, strings, special symbols, variables, data types, I/O statements	**10**
II	Operators and expressions: Operators, arithmetic, relational and logical, assignment operators, increment and decrement operators, bitwise and conditional operators, special operators, operator precedence and associativity, evaluation of expressions, type conversions in expressions. Control structures: Decision statements; if and switch statement; Loop control statements: while, for and do while loops, jump statements, break, continue, goto statements.	**10**
III	Arrays: Concepts, One dimensional array, declaration and initialization of one dimensional arrays, two dimensional arrays, initialization and accessing, multi-dimensional arrays, Basic Algorithms: Searching, Basic Sorting Algorithms- Bubble sort, Insertion sort and Selection sort. Functions: User defined and built-in Functions, storage classes, Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference, Recursion, as a different way of solving problems.	**10**
IV	Strings: Arrays of characters, variable length character strings, inputting character strings, character library functions, string handling functions. Pointers: Pointer basics, pointer arithmetic, pointers to pointers, generic pointers, array of pointers, functions returning pointers, Dynamic memory allocation.	**15**

	Structures and unions: Structure definition, initialization, accessing structures, nested structures, arrays of structures, structures and functions, self-referential structures, unions, type def, enumerations. File handling: command line arguments, File modes, basic file operations read, write and append.	

Recommended Books/References

1. B. Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
2. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
3. B. W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hall of India.
4. Byron S. Gottfried, Programming with C, Second edition, Tata McGrawhill, 2007 (Paper back)
5. R.G. Dromey, How to solve it by Computer, Pearson Education, 2008.
6. Y. Kanetkar, Let us C, BPB Publications, 2007.
7. J. R. Hanly and E.B Koffman, Problem Solving and Programm design in C, Pearson Education, 2009.

Course Outcomes: The student will learn:

- To formulate simple algorithms for arithmetic and logical problems.
- To translate the algorithms to programs (in C language).
- To test and execute the programs and correct syntax and logical errors.
- To implement conditional branching, iteration and recursion.
- To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
- To use arrays, pointers and structures to formulate algorithms and programs.

Course Code	**:**	**EEN07102**
Course Title	**:**	**Workshop Manufacturing Practices**
Number of Credits	**:**	**3 (L: 1, T: 0, P: 4)**
Course Category	**:**	**Engineering Science Courses**

Course Objectives:

1. To provide exposure to the students with hands on experience on various basic engineering practices.
2. To have a study and hands-on-exercise on plumbing and carpentry components.
3. To have a practice on gas welding, foundry operations and fitting
4. To have a study on measurement of electrical quantities, energy and resistance to earth.
5. To have a practice on soldering.

Course contents:

Unit	Content
I	Manufacturing Methods- casting, forming, machining, joining, advanced manufacturing methods.
II	CNC machining, Additive manufacturing.
III	Fitting operations & power tools.
IV	Electrical & Electronics.
V	Carpentry
VI	Plastic moulding, glass cutting
VII	Metal casting
VIII	Welding (arc welding & gas welding), brazing

Practicals:

1. Machine shop
2. Fitting shop
3. Carpentry
4. Electrical & Electronics
5. Welding shop (Arc welding + Gas welding)
6. Casting
7. Smithy
8. Plastic moulding & Glass Cutting

Examinations could involve the actual fabrication of simple components, utilizing one or more of the techniques covered above.

Recommended Books/References

1. S.K.H. Choudhury, A.K.H. Choudhury and S.K. Nirjhar Roy, Elements of Workshop Technology, Vol. I and Vol. II, Media promoters and publishers private limited,

Mumbai, 2008, 2010.
2. S. Kalpakjian and S. S. Steven, Manufacturing Engineering and Technology, 4th edition, Pearson Education India Edition, 2002.
3. G. P. Hariharan, A. S. Babu, Manufacturing Technology – I, Pearson Education, 2008.
4. A. Roy, Lindberg, Processes and Materials of Manufacture, 4th edition, Prentice Hall India, 1998.
5. P.N. Rao, Manufacturing Technology, Vol. I and Vol. II, Tata McGraw Hill House, 2017.

Course Outcomes: Upon completion of this course, the students will gain knowledge of the different manufacturing processes which are commonly employed in the industry, to fabricate components using different materials.

Laboratory Outcomes:
Upon completion of this laboratory course, students will be able:

- To fabricate components with their own hands.
- To relate practical knowledge of the dimensional accuracies and dimensional tolerances possible with different manufacturing processes.
- To design small devices of their interest by assembling different components

Course Code	**:**	**HSS04102**
Course Title	**:**	**Universal Human Values-II: Understanding Harmony And Ethical Human Conduct**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**HSS**

Course Objectives: This introductory course input is intended:

1. To help the students appreciate the essential complementarily between 'VALUES' and 'SKILLS' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2. To facilitate the development of a Holistic perspective among students towards life and profession as well as towards happiness and prosperity based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Universal Human Values and movement towards value-based living in a natural way.
3. To highlight plausible implications of such a Holistic understanding in terms of ethical human conduct, trustful and mutually fulfilling human behavior and mutually enriching interaction with Nature.

Course Content:

Unit	Content	Hours

I	Introduction to Value Education: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education); Understanding Value Education; Self-exploration as the Process for Value Education; Continuous Happiness and Prosperity – the Basic Human Aspirations; Happiness and Prosperity – Current Scenario; Method to Fulfill the Basic Human Aspirations Tutorial: Sharing about Oneself; Exploring Human Consciousness; Exploring Natural Acceptance	**9**
II	Harmony in the Human Being: Understanding Human being as the Co-existence of the Self and the Body; Distinguishing between the Needs of the Self and the Body; The Body as an Instrument of the Self; Understanding Harmony in the Self; Harmony of the Self with the Body; Programme to ensure self-regulation and Health Tutorial: Exploring the difference of Needs of Self and Body; Exploring Sources of Imagination in the Self; Exploring Harmony of Self with the Body	**9**
III	Harmony in the Family and Society: Harmony in the Family – the Basic Unit of Human Interaction; 'Trust' – the Foundational Value in Relationship; : 'Respect' – as the Right Evaluation; : Other Feelings, Justice in Human-to-Human Relationship; Understanding Harmony in the Society; Vision for the Universal Human Order. Tutorial: Exploring the Feeling of Trust; Exploring the Feeling of Respect; Exploring Systems to fulfil Human Goal	**9**
IV	Harmony in the Nature/Existence: Understanding Harmony in the Nature; Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature; Realizing Existence as Co-existence at All Levels; The Holistic Perception of Harmony in Existence Tutorial: Exploring the Four Orders of Nature; Exploring Co-existence in Existence	**9**
V	Implications of the Holistic Understanding – a Look at Professional Ethics: Natural Acceptance of Human Values; Definitiveness of (Ethical) Human Conduct; A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order; Holistic Technologies, Production Systems and Management Models- Typical Case Studies; Strategies for Transition towards Value-based Life and Profession; Competence in Professional Ethics; Tutorial: Exploring Ethical Human Conduct; Exploring Humanistic Models in Education; Exploring Steps of Transition towards Universal Human Order	**9**

Recommended Books/References

1. R. R. Gaur, R. Asthana, G. P. Bagaria, The Textbook - A Foundation Course in Human Values and Professional Ethics, 2nd Revised Edition, Excel Books, New

Delhi, 2019.
2. R. R. Gaur, R. Asthana, G. P. Bagaria, The Teacher's Manual- Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, 2nd Revised Edition, Excel Books, New Delhi, 2019.
3. A. Nagaraj, Jeevan Vidya: Ek Parichaya, Jeevan Vidya Prakashan, Amarkantak, 1999.
4. A.N. Tripathi, Human Values, New Age Intl. Publishers, New Delhi, 2004.

Course Outcomes: By the end of the course, students are expected to become more aware of themselves, and their surroundings (family, society, nature); they would become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.

They would have better critical ability. They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society). It is hoped that they would be able to apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.

Course Code	**:**	**CHM03104**
Course Title	**:**	**Chemistry- I Lab**
Number of Credits	**:**	**1 (L: 0, T: 0, P: 2)**
Course Category	**:**	**Basic Science Course**

Course Objective:

The chemistry laboratory course will consist of experiments illustrating the principles of chemistry relevant to the study of science and engineering.

Exp. No.	Title
1.	Determination of surface tension and viscosity.
2.	Thin layer chromatography.
3.	Ion exchange column for removal of hardness of water.
4.	Determination of chloride content of water.
5.	Colligative properties using freezing point depression.
6.	Determination of the rate constant of a reaction.
7.	Determination of cell constant and conductance of solutions.
8.	Potentiometry - determination of redox potentials and emfs.
9.	Synthesis of a polymer/drug.
10.	Saponification/acid value of an oil.
11.	Chemical analysis of a salt.
12.	Lattice structures and packing of spheres.
13.	Models of potential energy surfaces.
14.	Chemical oscillations- Iodine clock reaction.
15.	Determination of the partition coefficient of a substance between two immiscible liquids.
16.	Adsorption of acetic acid by charcoal.
17.	Use of the capillary viscosimeters to demonstrate of the isoelectric point as the pH of minimum viscosity for gelatin sols and/or coagulation of the white part of egg.

Course Outcomes: The students will learn:

- To estimate rate constants of reactions from concentration of reactants/products as a function of time.
- To measure molecular/system properties such as surface tension, viscosity, conductance of solutions, redox potentials, chloride content of water, etc.
- To synthesize a small drug molecule and analyze a salt sample.

Course Code	**:**	**CSE07104**
Course Title	**:**	**Programming for Problem Solving Lab**
Number of Credits	**:**	**1 (L: 0, T: 0, P: 2)**
Course Category	**:**	**Engineering Science Courses**

Course Objectives:

1. To learn the fundamentals of computers.
2. To understand the various steps in program development.
3. To learn the syntax and semantics of C programming language.
4. To learn the usage of structured programming approach in solving problems.
5. To understated and formulate algorithm for programming script
6. To analyze the output based on the given input variables

Practical No	Title
1	Familiarization with programming environment
2	Simple computational problems using arithmetic expressions
3	Problems involving if-then-else structures
4	Iterative problems e.g., sum of series
5	1D Array manipulation
6	Matrix problems, String operations
7	Simple functions
8	Programming for solving Numerical methods problems
9	Recursive functions
10	Pointers and structures
11	File operations

Recommended Books/References

1. B. Gottfried, Schaum's Outline of Programming with C, McGraw-Hill.
2. E. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill.
3. B. W. Kernighan and D. M. Ritchie, The C Programming Language, Prentice Hall of India.

Course Outcomes: Through following practicals, the student will learn:

- To formulate the algorithms for simple problems.
- To translate given algorithms to a working and correct program.
- To be able to correct syntax errors as reported by the compilers.
- To be able to identify and correct logical errors encountered at run time.
- To be able to write iterative as well as recursive programs.
- To be able to represent data in arrays, strings and structures and manipulate them through a program.

Third Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1	ESC	Engineering Mechanics	3	0	0	3	DCE07201
2	PCC	Surveying and Geomatics	2	1	2	4	DCE01201
3	PCC	Fluid Mechanics	2	1	0	3	DCE01203
4	PCC	Civil Engineering Materials	2	1	0	3	DCE01205
5	BSC	Mathematics III	3	1	0	4	
6	LC	Civil Engineering Materials Lab	0	0	2	1	DCE01207
7	LC	Engineering Mechanics Lab	0	0	2	1	DCE01209
8	LC	Fluid Mechanics Lab	0	0	2	1	DCE01211
9	AU	Disaster Management	2	0	0	0	
			Total Credits			20	

Course Code	**:**	**DCE07201**
Course Title	**:**	**Engineering Mechanics**
Number of Credits	**:**	**3 (L: 3, T: 0, P: 0)**
Course Category	**:**	**Engineering Science Course**

Course Objective: Engineering Mechanics provides the basic concepts and skills that form the foundation for structural and mechanical design. The class is a problem-focused engineering science class that helps engineering students develop the ability to understand and analyse static forces on a variety of structures and engineering applications.

Course Content:

Unit	Content	Hours
I	Force Systems, Basic concepts, Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space, Resultant Moment of Forces and its Applications; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems	10
I	Centroid and Centre of Gravity, 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 the moment of inertia, Moment of inertia of standard sections and composite sections;	10
III	Basic Structural Analysis, Equilibrium in three dimensions; Analysis of simple trusses by method of sections & method of joints, Zero force members, Simple beams and support reactions.	10
IV	Shear forces and bending moment diagrams for statically determinate beams	5
V	Friction: Types of friction, Limiting friction, Laws of Friction, Static & Dynamic Friction; Motion of Bodies, wedge friction, screw jack &	10

	differential screw jack.	

Recommended Books/References

1. J. L. Meriam and L. G. Kraige, Engineering Mechanics, Vol I - Statics, Vol II Dynamics, 6th Ed., John Wiley, 2008
2. I. H. Shames, Engineering Mechanics: Statics and Dynamics, 4th Ed., PHI, 2002.
3. F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, Vol II - Dynamics, 9th Ed., Tata McGraw Hill, 2011
4. R. C. Hibbler, Engineering Mechanics, Vols. I and II, Pearson Press, 2006
5. KL Kumar and Veenu Kumar- Engineering Mechanics, McGraw-Hill, New York,2017
6. J.J. Hughes, K.F. Martin, Basic Engineering Mechanics ISBN: 0333177215, 9780333177211, Macmillan, 1977.
7. Andy Ruina and Rudra Pratap, Introduction to Statics and Dynamics, Oxford University Press, 2011

Course Outcomes:

- To develop the ability to model and analysis of mechanical engineering systems using a vectorial representation of forces and moments.
- To be able to draw the free body diagrams of mechanical components and systems.
- Ability to draw shear force diagram and banding moment for different types of beams taking
- To understand the phenomenon of friction and the ability to solve problems related to the same.
- After completing this course, the students should be able to understand the various effects of force and motion on engineering design structures.

Course Code	**:**	**DCE01201**
Course Title	**:**	**Surveying and Geomatics**
Number of Credits	**:**	**4 (L: 2, T: 1, P: 2)**
Course Category	**:**	**Professional Core Courses**

Course Objective: The course's objectives are to familiarise students with the scope and basic principles of surveying and geomatics. The course also covers advanced surveying techniques that will enable students to get acquainted with solving state-of-the-art problems in the real world.

Course Content:

Unit	Content	Hours
I	Principles of Surveying: Introduction, Principles and classification of surveying; Concept of scales; Survey stations and lines – ranging and bearing; Chain surveying – Concept, Instruments, numerical problems on	**10**

	errors due to incorrect chain; Plane table surveying – Advantages, disadvantages, parts, methods; Elements of simple and compound curves.	
II	Levelling: Principles, Precautions and Difficulties; Differential levelling - Concepts and numerical problems; Contouring. Triangulation and Trilateration: Theodolite survey – Instruments, measurements of horizontal and vertical angles; Triangulation – Network, signals, numerical examples; Baseline measurement – site selection, measuring equipment, numerical problems on baseline corrections; Trigonometric levelling – Axis signal correction.	**15**
III	Advanced Surveying: Principle of Electronic Distance Measurement (EDM); Types of EDM instruments; Distomats; Total Station – Parts, advantages, applications, field procedure and errors; Global Positioning System (GPS) – Concept, applications, segments, location determination, errors; Principle of Differential GPS; Terrestrial laser scanner. Photogrammetric Surveying: Concept; Classification of photogrammetric surveying – terrestrial, aerial and satellite; scale of a vertical photograph; relief displacement and object height determination; Stereoscopic vision – depth perception, parallactic angle, stereoscopes; Object height determination using parallax; Parallax bar; Flight planning – Concept and numerical problems; Photo mosaic; Orthophotography; Stereoscopic plotting instruments.	**15**
IV	Remote Sensing: Energy sources and radiation principles; Concept of Electromagnetic Spectrum; Energy interactions in the atmosphere and earth surface features; Data acquisition and interpretation; Platforms and sensors – Geostationary and sun-synchronous orbits, push-broom and whiskbroom scanning system, characteristics of IRS, Landsat and Sentinel sensors; Visual image interpretation. Digital Image Processing: Concept; Image rectification and restoration; Image enhancement; Image classification; Accuracy assessment and post-classification smoothing.	**15**
V	Applications of Geomatics in Civil Engineering: 3D mapping; Earthquake and landslides; Runoff modelling; Groundwater targeting; Flood risk assessment; Urban planning; Highway and transportation.	**5**

Recommended Books/References

1. N. N. Basak, Surveying and Levelling, Tata McGraw Hill, Noida, India, 2nd Edn., 2017.
2. B. C. Punmia, Ashok K. Jain, Arun K. Jain Surveying – Vol. I, Laxmi Publications (P) Ltd., New Delhi, 17th Edn., 2016.
3. B. C. Punmia, Ashok K. Jain, Arun K. Jain Surveying – Vol. II Laxmi Publications (P) Ltd., New Delhi, 17th Edn., 2023.
4. B. C. Punmia, Ashok K. Jain, Arun K. Jain Surveying – Vol. III, Laxmi Publications

(P) Ltd., New Delhi, 16th Edn., 2022.
5. S. K. Duggal, Surveying – Vol. I & II, Tata McGraw Hill, Noida, India, 5th Edn., 2019.
6. T. P. Kanetkar, S. V. Kulkarni, Surveying & Levelling – Part I, Pune Vidyarthi Griha Prakashan, Pune, 24th Edn., 2010.
7. T. P. Kanetkar, S. V. Kulkarni, Surveying & Levelling – Part II, Pune Vidyarthi Griha Prakashan, Pune, 24th Edn., 2012.
8. T. Lillesand, R. W. Kiefer, J. Chipman, Remote Sensing and Image Interpretation, Wiley India Edition, New Delhi, 7th Edn., 2015.
9. B. Bhatta, Remote Sensing and GIS, Oxford University Press, New Delhi, 3rd Edn., 2020.
10. P. K. Garg, Principles of Geoinformatics, Khanna Publishers, New Delhi, 1st Edn., 2019.

Course Outcomes: After going through this course, the students will be able to:

- Define and state the scope of surveying and geomatics in civil engineering.
- Understand the basic principles of surveying and geomatics engineering.
- Apply the different surveying methods and geomatics to measure the features of interest.
- Analyze the traditional and advanced methods of surveying.
- Evaluate the different techniques of surveying and geomatics in solving real-world problems.
- Design and construct solutions for real-world problems related to surveying and geomatics.

Course Code	**:**	**DCE01203**
Course Title	**:**	**Fluid Mechanics**
Number of Credits	**:**	**3 (L:2, T:1, P:0)**
Course Category	**:**	**Professional Core Courses**

Course Objective: To impart knowledge of the properties of fluids, and application of the integral forms of the three fundamental laws of fluid mechanics to turbulent and laminar flow through pipes and ducts in order to predict relevant pressures, velocities, and forces.

Course Content:

Unit	Content	Hours
I	Introduction: Properties of Fluids, Real and Ideal Fluids, compressibility, Bulk modulus of elasticity, Newtonian and non-Newtonian fluids, Coefficient of thermal expansion, Surface tension, capillarity, concept of viscosity and effect of temperature on viscosity.	**7**
II	Fluid Static: Pascal law, devices based on Pascal law, Hydrostatic Law, Pressure variation in isothermal and adiabatic condition. Manometry and	**7**

	Manometers, Relative equilibrium. Forces of submerged plane inclined and curved surfaces and Buoyancy.	
III	Fluid Kinematics: Kinematics of fluid Motion, Eulerian and Lagrangian description, Type of motion, Concept of control volume and control surface, Streamline, Path line, streak line and stream tube. Continuity equation, One- and Two-dimensional flows, Acceleration of fluid element - normal and tangential accelerations, Linear momentum equation and its application- Forces on pipe bends, vanes, jets and propellers.	**12**
IV	Fluid Rotation: vorticity and angular velocity in terms of velocity field. Irrotational flow, velocity potential and stream function, Flow net and its uses. Free and forced vortex motion, Ideal fluids flow, source and sink, doublet, flow past a stationary and rotating cylinder, Magnus Effects.	**11**
V	Fluid dynamics: Naiver- stock's equation, Euler's equation of motion and streamlines, Bernoulli's equation - isothermal and adiabatic flow and its applications, Venturi meter, orifice meter; mouth pieces, calibration and uses of flow measuring devices. Concept of kinetic energy, and momentum correction factors. Flow over notches and weirs.	**8**

Recommended Books/References

1. F. M., White, Fluid Mechanics, McGraw-Hill, 1999.
2. R. K., Bansal, A Textbook of Fluid Mechanics and Hydraulic Machines, Lakshmi Publications, 9th Edition, 2010.
3. R. L. Daugherty, J. B. Franzini, Fluid Mechanics with Engineering Applications, McGraw-Hill, 2016.
4. R.W. Fox, A.T. McDonald, P.J., Pritchard, Introduction to Fluid Mechanics, Wiley, 2009.
5. S. K. Som and G. Biswas, Introduction to Fluid Mechanics and Fluid Machines, Tata McGraw Hill, 2008.

Course Outcomes: Upon successful completion of the course, the students will be able to:

- Understand the various properties of fluids and their influence on fluid motion and analyze a variety of problems in fluid statics and dynamics.
- Apply appropriate equations and principles to analyze fluid flow problems. Apply Bernoulli’s equation to fluid flow problems and boundary layer theory to determine the lift and drag forces on a submerged body.
- Use different fluid flow measuring devices.

Course Code	**:**	**DCE01205**
Course Title	**:**	**Civil Engineering Materials**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Core Courses**

Course Objective:
To learn the different building materials used in construction of buildings/Roads/structures
Course Content:

Unit	Content	Hours
I	Properties of bricks and stones, forms of bricks, tests on bricks and stones, relevant codes	**09**
II	Cement: compounds & propositions, types of Portland cement, pozolanic cement, high alumina cement and other types, hydration mechanism and hydration products, Setting and hardening, curing, strength of hardened cement, grade of cement, relevant IS codes	**10**
III	Concrete: Ingredients of concrete, Aggregates: properties of coarse & fine aggregates, tests on aggregates, relevant codal provisions; properties of fresh and hardened concrete, strength of concrete, concrete mix design; Special Concrete: Reinforced cement concrete, Polymer concrete, Light weight concrete, Roller compacted concrete, Ready mix concrete, self-compacting concrete, high performance concrete, bacterial concrete.	**14**
IV	Timber: structure of wood, defects in timber, seasoning, preservation; plywood and its manufacturing. Flyash, Paints & varnishes, gypsum, tar, bitumen & asphalt	**12**

Recommended Books/References

1. S. K. Duggal, Building Materials, New Age International Publication, 2008
2. S. C. Rangwala, Engineering Materials, Charotar Book Stall, 2019
3. M. L. Gambhir, Concrete Technology Theory and Practice, Tata Mc Graw Hill, 2013
4. A. M. Neville, Properties of Concrete, Pearson Publicatiion, 2012
5. R. K. Rajput, Engineering Materials, S. Chand Publication, 2008

Course Outcomes: The students will learn:

- The essential elements of civil engineering materials
- To know the properties of every civil engineering materials and its use in construction technology

Course Code	**:**	
Course Title	**:**	**Mathematics III**
Number of Credits	**:**	**3 (L: 3, T: 1, P: 0)**
Course Category	**:**	**Basic Sciences Course**

Course Objective: The main objective of this course is to provide students with the foundations of probabilistic and statistical methods and analysis techniques mostly used in various applications in engineering and science like modelling of processes and predictions based on processes.

Course Content:

Unit	Content	Hour
I	Probability spaces, conditional probability, Bayes' theorem	10
II	Random variables, probability distribution functions, joint distributions, independence, mathematical expectations, Chebyshev's inequality	15
III	Special distributions: binomial, hypereometric, Poisson, exponential, uniform, normal distributions	10
IV	Random sampling, sample mean, sample variance, weak law of large numbers and central limit theorems	10
V	Estimation of parameters, the method of maximum likelihood estimation, confidence intervals, testing of hypotheses, goodness of fit, nonparametric tests, correlation analysis.	15

Recommended Text Books:

1. Papoulis and S.U. Pillai, Probability Random Variables and Stochastic Processes, 4th Ed., McGraw-Hill, 2002.
2. L. Garcia, Probability and Random Processes for Electrical Engineering, 2nd Ed., Addison-Wesley, 1993.
3. Reena Garg and Chandrika Prasad, Advanced Engineering Mathematics, Khanna Book Publishing Company, 2020.

References:

1. P.Z. Peebles, Probability, Random Variables and Random Signal Principles, 4th Ed., Mc-Graw Hill, 2000.
2. H. Stark and J.W. Woods, Probability and Random Processes with Applications to Signal Processing, Prentice Hall, 2002.
3. K. L. Chung and F. AitSahlia, Elementary Probability Theory with Stochastic Processes
4. Introduction to Mathematical Finance, 4th Ed., Springer-Verlag, 2003.
5. Amit Gupta, Manish Sharma, The Practice of Business Statistics, Khanna Book Publishing, 2010.

Course Outcomes:

Students will be able to use appropriate statistical terms to describe data and understand probability space and conditional probability applications.

- Identify the types of data (qualitative, quantitative, discrete, and continuous).

- Identify the types of sampling (random, stratified, systematic, cluster).

Course Code	**:**	**DCE01207**
Course Title	**:**	**Civil Engineering Materials Laboratory**
Number of Credits	**:**	**1 (L: 0, T: 0, P: 2)**
Course Category	**:**	**Lab Course**

Course Objective:

To learn the different tests involved in building materials used in construction of buildings

Course Content:

Experiment No	Title
1	Slump Test of concrete : to test the slump of concrete using Slump cone
2	Air Permeability Test: To test the fineness of cement using Blain air permeability test
3	Water absorption test of Bricks: To test the water absorption of bricks
4	Aggregate Impact test : To know the impact value of aggregates
5	Consistency test of cement: to determine the percentage of water required to prepare the cement paste
6	Soundness of Cement: To know the presence of un combined lime in cement using Le Chatelier apparatus

Recommended Books/References

1. S. K. Duggal, Building Materials, New Age International Publication, 2008
2. S. C. Rangwala, Engineering Materials, Charotar Book Stall, 2019
3. M. L. Gambhir, Concrete Technology Theory and Practice, Tata Mc Graw Hill, 2013
4. A. M. Neville, Properties of Concrete, Pearson Publicatiion, 2012
5. R. K. Rajput, Engineering Materials, S. Chand Publication, 2008

Course Outcomes: The students will learn:

- The various laboratory experiments of civil engineering materials to know the quality of materials used in civil engineering materials.
- To know the properties of every civil engineering material.

Course Code	**:**	**DCE01209**
Course Title	**:**	**Engineering Mechanics Lab**
Number of Credits	**:**	**1 (L: 0, T: 0, P: 2)**
Course Category	**:**	**Lab Course**

Course Objective: The objectives of the Engineering Mechanics Laboratory course are to make students learn the effect of force, moment and coupling on rigid body. Also to compute forces in member of trusses and study the friction effect between two rigid body.

Course Content:

Experiment No	Title
1	Efficiency of a Simple Screw Jack Apparatus
2	Support reactions of a Simply Supported Beam
3	Support reactions of a Cantilever Beam
4	Moment of Inertia of a Fly Wheel
5	Funicular Polygon of Forces
6	Forces in the members of a member Truss Apparatus
7	Determination of Friction coefficient of Flat Belt
8	Forces in Jib and Tie using Jib Crane Apparatus

Recommended Books/References

1. J. L. Meriam and L. G. Kraige, Engineering Mechanics, Vol I - Statics, Vol II - Dynamics, 6th Ed., John Wiley, 2008.
2. I.H. Shames, Engineering Mechanics: Statics and Dynamics, 4th Ed., PHI, 2002.
3. F. P. Beer and E. R. Johnston, Vector Mechanics for Engineers, Vol I - Statics, Vol II - Dynamics, 9th Ed., Tata McGraw Hill, 2011
4. R. C. Hibbler, Engineering Mechanics, Vols. I and II, Pearson Press, 2006
5. KL Kumar and Veenu Kumar- Engineering Mechanics, McGraw-Hill, New York,2017
6. J.J. Hughes, K.F. Martin, Basic Engineering Mechanics ISBN: 0333177215, 9780333177211, Macmillan, 1977.

Course Outcomes: After going through this course, the students will be able to:

- Illustrate the concept of efficieny of a simple screw jack.
- Explain the method of determining deflection of Simply Supported and Cantilever beams.
- Demonstrate the method to determine the Momemt of Inertia of a Fly Wheel.

Course Code	**:**	**DCE01211**
Course Title	**:**	**Fluid Mechanics Lab**
Number of Credits	**:**	**1 (L: 0, T: 0, P: 2)**
Course Category	**:**	**Lab Course**

Course Objective: To impart knowledge through demonstration of the working principle of the theories of fluid mechanics and the use of various instruments for fluid flow measurement.

Course Content:

Experiment No	Title
1	Verification of momentum equation
2	Friction loss in pipes
3	Rainfall-runoff relationship
4	Flow over the sharp-crested weir
5	Flow in pipe networks
6	Bernoulli theorem
7	Fall velocity of objects
8	Point velocity measurement by ADV
9	Reynolds' apparatus
10	Venturi meter and orifice meter
11	Energy loss in bends
12	Ground water flow/ well abstraction
13	Hydrogen bubble flow visualization
14	Hydraulic jump
15	Flow past a cylinder

Recommended Books/References

1. M. K. Khan, Fluid Mechanics and Machinery, Oxford University Press, 2015.
2. P. N. Modi, and S. M. Seth, Hydraulics and Fluid Mechanics, Standard Book House, New Delhi, 2009.
3. S. Singh, Experiments in Fluid Mechanics, PHI Pvt. Ltd., New Delhi, 2012.

Course outcomes: Upon successful completion of the course, the students will be able to:

- Develop an understanding of the properties of fluids and the use of various instruments for fluid flow measurement.
- Understand the working of hydraulic machines under various conditions of working and their characteristics.
- Perform experiments to determine the coefficient of discharge of flow-measuring devices.
- Conduct experiments on hydraulic turbines and pumps to draw characteristics.

- Determine the energy flow pattern through the hydraulic turbines and pumps.

Course Code	**:**	
Course Title	**:**	**Disaster Management**
Number of Credits	**:**	**2 (L: 2, T: 0, P: 0)**
Course Category	**:**	**Audit Course**

Course Objective: To provide basic conceptual understanding of Natural and manmade disasters and its remedial measures with planning of disaster preparedness.

Course Contents:

Unit	Contents	Hours
I	Introduction to Disasters and Natural Hazards: Types of Hazards, Earth as a system, Seismic zonation of India, Case Study of Cyclone, Earthquakes, Landslides, Floods and Tsunami, Disaster prediction and warning, Surviving Natural Disaster, Myths and perception about Natural Disaster, Natural Disaster preparedness, mitigation and Emergency response.	**06**
II	Plate Tectonics and related Hazards: Earthquake and their causes, mitigation, Active faults and related hazards in India, Ground effects and evaluation of earthquake hazards, Liquefaction and related geological features.	**06**
III	Volcanic Eruption and related Hazards: Types of volcanoes, causes and mitigation plans.	**06**
IV	Landslides, Hurricanes, Cyclones, Typhoons and Storms: Causes of landslides and mudslides, Classification, zonation, Protection, Land subsidence, Control and stabilization of landslides. Classification of Hurricanes, Cyclones, Typhoons and Storms, Mitigation, preparedness, storm surge, case study of the recent tropical cyclones, Hailstorms, Tornadoes, dust and sand storms, case study.	**06**
IV	Floods, Droughts and Diseases: Streams and river hydrology, types of floods, Nature and extent of floods Hazard, flood hazard zoning, flood control and protection. Types of Droughts Effect and measurement of drought, predicting drought depending on weather patterns, case study depending on widespread famine and decimation of crops. Causes of diseases, Epidemic, Pandemic, case study of historic plagues, Case study of twentieth century virus outbreak, twenty first century virus outbreak, Mitigation and preparedness	**06**

Recommended Books/References

1. D.P. Coppola, Introduction to International Disaster Management, Elsevier Science (B/H), London, 2007
2. M. C. Gupta, Manual on natural disaster management in India, NIDM, New Delhi
3. World Disasters Report, International Federation of Red Cross and Red Crescent, Switzerland, 2009
4. S.L. Goyal, Encyclopedia of disaster management, Vol I, II and IIIL Disaster management policy and administration, Deep & Deep, New Delhi, 2006
5. ational Disaster Management Policy, 2009, GoI

Course Outcome: After learning the course, the student will be able to understand the natural and manmade disasters, disaster preparedness and measures taken to mitigate them.

Fourth Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1	PCC	Mechanics of Materials and Solids	2	1	0	3	DCE01202
3	PCC	Design of RCC Structures-I	3	1	0	4	DCE01204
4	PCC	Building Construction	2	1	0	3	DCE01206
5	PCC	Structural Analysis I	2	1	0	3	DCE01208
6	PCC	Civil Engineering Drawing	1	0	2	2	DCE01210
7	PCC	Transportation Engineering I	3	1	0	4	DCE01212
8	OEC	Project Management Techniques	3	0	0	3	DCE09202
9	LC	Mechanics of Materials and Solids Lab	0	0	2	1	DCE01214
10	AU	Environmental Sciences	2	0	0	0	
11	MSH 1						
	MSH 2						
			Total Credits			23	

Course Code	**:**	**DCE01202**
Course Title	**:**	**Mechanics of Materials and Solids**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Core Course**

Course Objective: The objectives of the Mechanics of Materials and Solid course (often referred to as Solid Mechanics or Mechanics of Solids) are to make students understand the behavior of materials and structures under different actions to ensure safety, functionality, and durability.

Course Content:

Unit	Content	Hours
I	Load, Stress, Principle of St. Venant, Stress concentration, Principle of Superposition, Strain, Hooke's law, Modulus of Elasticity, Stress-Strain, fatigue, reversal of stresses, endurance limit. Working Stress, Factor of safety, Strain energy in tension and compression, Resilience, Impact loads. Analysis of Axially Loaded Members - Composite bars in tension and compression - temperature stresses in composite rods, statically	**10**

	indeterminate problems. Shear stress, Complimentary shear stress, Shear strain, Modulus of rigidity, Poisson's ratio, Bulk Modulus, Relationship between elastic constants.	
II	Analysis of Biaxial Stress - Plane stress, Principal stress, Principal plane, Mohr's Circle for Biaxial Stress. Analysis of Strain: Two- and three-dimensional state of strain, Strain displacement relations, Mohr's circle for strain, Principal strains and principal axes of strain measurements, Calculation of principal stresses from principal strains. Shear Force and Bending Moment - Shear force and bending moment. Types of load and Types of support. Support reactions, Relationship between bending moment and shear force, Point of inflection. Shear Force and Bending Moment diagram.	**15**
III	Simple Bending of Beams - Theory of simple bending of initially straight beams, Bending stresses, Shear stresses in bending, Distribution of normal and shear stress, beams of two materials, Composite beams. Deflection of Beams: Differential equation of the elastic line, Slope, and deflection of beams by integration method and Macaulay's method.	**15**
IV	Torsion - Torsion in solid and hollow circular shafts, Twisting moment, Strain energy in shear and torsion, Strength of solid and hollow circular shafts. Stresses due to combined bending and torsion, Strength of shafts in combined bending and twisting. Members under axial and shear stresses.	**5**

Recommended Books/References

1. B. C. Punmia, Ashok K. Jain, Arun K. Jain, Mechanics of Materials, Laxmi Publications (P) Ltd., New Delhi, Revised 4th Edn., 2010.
2. R. K. Bansal, A Textbook of Strength of Materials, Laxmi Publications (P) Ltd., New Delhi, Reprint, 2006.
3. S.P. Timoshenko, D.H. Young, Elements of Strength of Materials, East West Press Pvt. Ltd., New Delhi, 5th Edn., 2003.
4. R. Subramanian, Strength of Materials, Oxford University Press, New Delhi , 2nd Edn. (Reprint), 2010.
5. R. C. Hibbeler, Mechanics of Materials, Pearson, New Delhi, Revised 10th Edn. (Reprint), 2016.

Course Outcomes: After going through this course, the students will be able to:

- Analyze and solve problems related to members subjected to axial load.
- Analyze and solve problems related to members subjected to bi-axial & tri-axial stresses.
- Analyze and solve problems related to shear force and bending moment.
- Calculate bending stress and shear stress, and determine slope, and deflection of a beam.
- Analyze hollow and solid shafts subjected to torsion.
- Apply the concept of buckling of columns and develop knowledge regarding

applying closed coil helical springs.

Course Code	**:**	**DCE01204**
Course Title	**:**	**Design of RCC Structures-I**
Number of Credits	**:**	**4 (L:3, T:1, P:0)**
Course Category	**:**	**Professional Core Course**

Course Objective: The objective of this course is to provide the students with the knowledge of the behavior of reinforced concrete structural elements in flexure, shear, compression and torsion; and enable them to design essential elements such as beams, columns, slabs staircases and footings under various loads.

Course Content:

Unit	Content	Hours
I	Study of the strength, behavior, and design of indeterminate reinforced concrete structures, Load and stresses, load combinations, Working stress and limit state approach.	**15**
II	Analysis and design of sections in bending – working stress and limit state method, Rectangular and T-sections, Beams with reinforcement in compression, One-way slab.	**15**
III	Design for shear and bond, Mechanism of shear and bond failure, Design of shear using limit state concept, Development length of bars; Design of sections in torsion. Design of two-way slabs; Design of flat slab – direct method; Circular slab; Slab type staircase, Placement of reinforcement in slabs; Voided slab	**15**
IV	Design of compression members, Short column, Columns with uni-axial and bi-axial bending; Long columns, use of design charts. Design of foundation; Wall footing, Isolated and combined footing for columns.	**15**

Recommended Books/References

1. S.U. Pillai, D. Menon – Reinforced Concrete Design, Tata McGraw Hill Publishing Co., 2005.
2. B. C. Punmia, A.K. Jain, RCC Designs, Laxmi Publications Ltd., 2015.
3. P.C. Varghese, Limit State Design of Reinforced Concrete, Prentice Hall of India Pvt Ltd, 2008.
4. Relevant IS codes (I.S 456, I.S 875, SP 34) A. H. Design of Concrete Structures. 13th edition. McGraw Hill,

Course Outcomes: The students will be able to:

- Apply the fundamental concepts of limit state method
- Use IS code of practice for the design of concrete elements
- Understand the structural behavior of reinforced concrete elements in bending, shear, compression and torsion.

- Design beams, slab, stairs and columns and draw the reinforcement details.

Course Code	**:**	**DCE01206**
Course Title	**:**	**Building Construction**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Core Course**

Course Objective:

To learn the techniques of building construction using different methods

Course Content:

Unit	Content	Hours
I	Foundation - functions of foundations, essential requirements of a good foundation, Types of Foundations: shallow foundations, deep foundations.	**10**
II	Masonry - Stone masonry and brick masonry- English bond, single & double Flemish bond, different terms used in masonry; Composite masonry; panel walls, load bearing walls, compound walls, cavity walls, partition walls.	**12**
III	Floors and Roofs -Flooring: general considerations, different types of floorings. Flat-Floor and Flat- Roof construction: different types of upper floors. Sloped roofs: types of sloped roofs. Stairs and escalators: requirements of a good stair, location and types.	**13**
IV	Building Finishes - Plastering, pointing, painting and polishing, white /colour washing, plastic paints. Formwork - Shuttering and scaffolding. Damp proofing and water proofing: treatment to floors, walls and basement. Miscellaneous topics - Fire protection, thermal and sound insulation of buildings.	**10**

Recommended Books/References

1. B.C. Punmia, Ashok Kumar Jain and Arun Kumar Jain, Building Construction by Laxmi Publications (P) Ltd, New Delhi, 2005
2. P.C. Varghese, Building Construction by Prentice Hall of India Pvt.Ltd, New Delhi, 2015
3. Guicharan Singh, Building Construction & Material by Rajsons Publication Pvt. Ltd, New Delhi, 2019
4. Sushi Kumar, Building Construction by Standard Publishers Distributors, New Delhi, 2001

Course Outcomes: The students will learn:

- The essential techniques used in the construction of buildings
- The effective measures to add strength and durability of buildings.

Course Code	**:**	**DCE01208**
Course Title	**:**	**Structural Analysis I**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Core Courses**

Course Objective: To impart the principles of elastic structural analysis and the behaviour of determinate and indeterminate structures.

Course Content:

Unit	Content	Hours
I	Basics of Structural Analysis: Concept of static and kinematic indeterminacy, Determination of degree of indeterminacy for different structures. Betti's law, Clark Maxwell's theorem of reciprocal deflection Analysis of Determinate Structures: Portal Frames, Three hinged arches, Cables	**10**
II	Deflection of Determinate Structures: Energy methods. Theorem of minimum potential energy, the law of conservation of energy, the principle of virtual work, the first and second theorems of Castigilano, the Unit Load method for beams, the Deflection of trusses, and Simple Portal Frames. Displacement-geometric methods: Moment area method, Conjugate beam method.	**15**
III	Analysis of Statically Indeterminate Beams: Theorem of three moments, Energy methods, Force method (Method of consistent deformation) [For analysis of propped cantilever, fixed beams, and continuous beams for simple loading cases], Analysis of two hinged arches.	**15**
IV	Influence Line Diagram: Statically determinate beams and trusses under a series of concentrated and uniformly distributed rolling loads, criteria for maximum and absolute maximum moments, and shear.	**5**

Recommended Books/References

1. S. Ramamrutham, Theory of Structures, Dhanpat Rai Publications, New Delhi, 11th Edn., 2014.
2. B. C. Punmia, Ashok K. Jain, Arun K. Jain, Theory of Structures, Laxmi Publications (P) Ltd., New Delhi, Revised 12th Edn., 2004.
3. V. N. Vazirani, M. M. Ratwani, S. K. Duggal, Analysis of Structures Vol-II, Khanna Publishers, New Delhi, 16th Edn. (Reprint), 2016.
4. R.C. Hibbeler, Structural Analysis, Pearson, New Delhi, 11th Edn, 2023.
5. S. Timoshenko, D. H. Young, Theory of Structures, Tata McGraw Hill, Noida, India, 2nd Edn., 1968.

Course Outcomes: After going through this course, the students will be able to:

- Distinguish between stable and unstable and statically determinate and indeterminate structures.

- Apply equations of equilibrium to structures and compute the reactions.
- Calculate the internal forces in portal frames, cable, and arch-type structures.
- Determine the deflections in determinate structures.
- Use approximate methods for analysis of statically indeterminate structures.
- Evaluate and draw the influence line diagrams for determinate beams and trusses.

Course Code	**:**	**DCE01210**
Course Title	**:**	**Civil Engineering Drawing**
Number of Credits	**:**	**2 (L:1,T:0, P:2)**
Course Category	**:**	**Professional Core Courses**

Course Objective: To provide the basic knowledge and understanding of drawing of plans elevations and sectional elevations of different kind of buildings through rigorous practice.

Course Content:

Unit	Content	Hours
I	Plan, Front elevation and sectional elevation of a residential building (single and double storeyed) with foundation details, Details of doors and windows, DPC and Flooring (Manual and auto cad)	**10**
II	Different types of staircase, Plan and sectional elevation of Dog-Legged stair case, brick work.	**10**
III	Plan and section of RCC slab culvert (Details of abutment and wing wall)	**10**

Recommended Books/References

1. G.H. Cooper, Building construction and Estimating, McGraw-Hill, 1945
2. M.G. Saha, C.M. Kale, Principles of Building Drawing, Macmillan Publishers India Limited, 2000

Course Outcomes: At the completion of this course, students will be able to draw the complete drawings of a building and a culvert required for their execution in the field.

Course Code	**:**	**DCE01305**
Course Title	**:**	**Transportation Engineering I**
Number of Credits	**:**	**4 (L: 3, T: 1, P: 0)**
Course Category	**:**	**Professional Core Course**

Course Objective: To learn the geometry, constructions and materials of roads & railways.

Course Content:

Unit	Content	Hours
I	Highway Development and Planning: Historical Development, road patterns, master plans, road development plans, PMGSY, engineering surveys, highway projects. Highway Geometric Design: Cross section elements, sight distances, horizontal and vertical alignment.	**12**
II	Highway Materials and Testing: Subgrade soil, sub base and base course materials, bituminous materials, testing of soil, stone aggregates and bitumen. Design of Highway Pavements: Stresses in flexible and rigid pavements and their design methodology as per IRC.	**12**
III	Highway Construction, Maintenance: Highway Construction: Construction of various layers, earthwork, WBM, GSB, WMM, various types of bituminous layers, joints in rigid pavements. Highway Maintenance: Various type of failures, evaluation and remedial measures.	**12**
IV	Introduction Permanent Way and Components Rail gauges, permanent way – functions, requirements, locomotives, wheel and axle arrangement, coning of wheels, components – rails, sleepers, ballast and formation. Resistances and Stresses in Tracks, Hauling Capacity Types of resistances to traction, stresses in different components of track, hauling capacity of a locomotive, tractive effort, Joints and Fastenings	**12**
V	Track Geometrics, Turnouts and Crossings Railway alignment, vertical alignment – gradients and grade effects, horizontal alignment – horizontal curves, super-elevation, concepts of cant excess and deficiency, safe permissible speed, transition curves, widening of gauges and track clearances, points and crossings – terminologies, types of turnouts, design of turnouts, types of crossings, track Safety, train operation control systems, interlocking of tracks, high speed tracks, railway systems in urban areas.	**12**

Recommended Books/References

1. S. K. Khanna, C. E. G.Justo, Highway Engineering, Khanna Publisher, 2011
2. L. Kadyali, Highway Engineering, Khanna Publisher, 2018

3. S. P. Bindra, A Course in Highway Engineering, Dhanpat Rai and Sons, New Delhi, 2008
4. R. S. Kumar, Textbook of Highway Engineering, Universities Press.2011
5. R. S. Kumar, Pavement Design, Universities Press. 2013
6. P.S. Kandhal, Bituminous Road Construction in India, PHI Learning, 2016
7. S. P. Arora, S. C. Saxena, A Text Book of Railway Engineering, Dhanpat Rai Publications, 2010
8. N. K. Vaswani, Railway Engineering, Dhanpat Rai and Sons, New Delhi, 2010
9. S. Chandra, M. M. Agarwal, Railway Engineering, Oxford, 2013

Course Outcomes: The students will learn:

- The essential elements of transportation facilities like roads, railways and airways
- To learn the design of roads, railways and airways

Course Code	**:**	**DCE09202**
Course Title	**:**	**Project Management Techniques**
Number of Credits	**:**	**3 (L:3,T:0, P:0)**
Course Category	**:**	**Open Elective Course**

Course Objective: To plan and execute the project within time and available resources.

Course Content:

Unit	Content	Hours
I	Introduction: Functions of Project Management, Project Life Cycle, the Project Environment, Project Selection, Project Proposal, Project Scope, Work Breakdown Structure.	**10**
II	Network Scheduling, Critical Path Method, Program Evaluation & Review Technique, Planning and Scheduling of Activity Networks, Assumptions in PERT Modelling, Time-cost Trade-offs, Linear Programming and Network Flow Formulations, PERT/COST Accounting.	**10**
III	Scheduling with limited resources, Resource Planning, Resource Allocation, Project Schedule Compression, Project Scheduling Software, Precedence Diagrams, Decision CPM, Generalized Activity Networks, GERT	**15**
IV	Estimation of Project Costs, Earned Value Analysis, Monitoring Project Progress, Project Appraisal and Selection, Recent Trends in Project Management.	**10**

Recommended Books/References

10. F. Lawrence, The management of construction: a project life cycle approach, Routledge 2003
11. D. Garold, Project Management for engineering and construction, Vol 2. New York: McGraw-Hill, 1993
12. R. Miller, D. Lessard, The strategic management of Large Engineering Projects: Shaping Institutions, Risks and Governance, The MIT Press, 2001
13. R. Leroy, C. J. Schexnayder, A. Shapira, Construction Planning, equipment and methods, McGraw-Hill, 2010

Course Outcomes: At the end of this course, the students will learn to:

- Compose construction schedules, network diagrams and time estimations for construction projects.
- Evaluate different types of tendering and contract documents of construction projects
- Estimate different costs associated with construction projects.
- Select different engineering equipment's used for specified construction work according to their nature.

Course Code	**:**	**DCE01212**
Course Title	**:**	**Mechanics of Materials and Solids Lab**
Number of Credits	**:**	**1 (L: 0, T: 0, P: 2)**
Course Category	**:**	**Lab Course**

Course Objective: The objectives of the Mechanics of Materials and Solid Laboratory course are to make students knowledgeable regarding material behaviour and properties under different actions by doing hands on experiments.

Course Content:

Experiment No	Title
1	Hardness Tests on Ferrous and Non-Ferrous Metals: Rockwell Test
2	Hardness Tests on Ferrous and Non-Ferrous Metals: Brinnel Test
3	Torsion Test on Mild Steel Circular Bar
4	Deflection of a Simply Supported Beam
5	Deflection of a Cantilever Beam
6	Test on closely coiled helical spring
7	Impact Test: Izod
8	Impact Test: Charpy
9	Tension test on Structural Materials: Mild Steel and Tor steel (HYSD bars)

Recommended Books/References

1. B.C. Punmia, Ashok K. Jain, Arun K. Jain, Mechanics of Materials, Laxmi Publications (P) Ltd., New Delhi, Revised 4th Edn., 2010.
2. R.K. Bansal, A Textbook of Strength of Materials, Laxmi Publications (P) Ltd., New Delhi, Reprint, 2006.
3. S.P. Timoshenko, D.H. Young, Elements of Strength of Materials, East West Press Pvt. Ltd., New Delhi, 5th Edn., 2003.
4. R. Subramanian, Strength of Materials, Oxford University Press, New Delhi , 2nd Edn. (Reprint), 2010.
5. R.C. Hibbeler, Mechanics of Materials, Pearson, New Delhi, Revised 10th Edn. (Reprint), 2016.

Course Outcomes: After going through this course, the students will be able to:

- Illustrate the concept of hardness and explain the procedure and findings of Rockwell and Brinnel hardness test.
- Explain the method of bending tests on mild steel beam.
- Demonstrate the method and findings of Torsion test on mild steel circular bar.
- Demonstrate the concept and procure of calculation of spring constant.
- Demonstrate the method and findings of Izod and Charpy impact tests.
- Demonstrate the method and findings of tension and compression tests on ductile and brittle materials.

Course Code	**:**	
Course Title	**:**	**Environmental Science**
Number of Credits	**:**	**2 (L:2, T:0, P:0)**
Course Category	**:**	**Audit Course**

Course Objective:

- People working in industries or elsewhere essentially require the knowledge of environmental science so as to enable them to work and produce most efficient, economical and eco-friendly finished products.
- Solve various engineering problems applying ecosystem to produce eco – friendly products.
- Use relevant air and noise control method to solve domestic and industrial problems.
- Use relevant water and soil control method to solve domestic and industrial problems.
- To recognize relevant energy sources required for domestic and industrial applications.
- Solve local solid and e-waste problems.

Course Content:

Unit	Content	Hours
I	Ecosystem: Structure of ecosystem, Biotic & Abiotic components. Food chain and food web,Aquatic (Lentic and Lotic) and terrestrial ecosystem. Carbon, Nitrogen, Sulphur, Phosphorus cycle, Global warming - Causes, effects, process, Green House Effect, Ozone depletion.	**10**
II	Air and Noise Pollution: Definition of pollution and pollutant, Natural and manmade sources of air pollution (Refrigerants, I.C., Boiler). Air Pollutants: Types, Particulate Pollutants: Effects and control (Bag filter, Cyclone separator, Electrostatic Precipitator). Gaseous Pollution Control: Absorber, Catalytic Converter, Effects of air pollution due to Refrigerants, I.C., Boiler. Noise pollution: sources of pollution, measurement of pollution level, Effects of Noise pollution, Noise pollution (Regulation and Control) Rules, 2000.	**10**
III	Solid Waste Management, ISO 14000 & Environmental Management, Solid waste generation- Sources and characteristics of Municipal solid waste, Ewaste, biomedical waste. Metallic wastes and Non-Metallic wastes (lubricants, plastics, rubber) from industries. Collection and disposal: MSW (3R, principles, energy recovery, sanitary landfill), Hazardous waste. Air quality act 2004, air pollution control act 1981 and water pollution and control act 1996. Structure and role of Central and state pollution control board. Concept of Carbon Credit, Carbon Footprint. Environmental management in industry. ISO14000: Implementation in industries, Benefits.	**10**

Recommended Books/References

1. S.C. Sharma and M.P. Poonia, Environmental Studies, Khanna Publishing House, New Delhi.
2. C.N. R. Rao, Understanding Chemistry, Universities Press (India) Pvt. Ltd., 2011.
3. Arceivala, Soli Asolekar, Shyam, Waste Water Treatment for Pollution Control and Reuse, Mc-Graw Hill Education India Pvt. Ltd., New York, 2007, ISBN:978-07-062099-
4. Nazaroff, William, Cohen, Lisa, Environmental Engineering Science, Willy, New York, 2000, ISBN 10: 0471144940.
5. O.P. Gupta, Elements of Environmental Pollution Control, Khanna Publishing House, New Delhi
6. C. S. Rao, Environmental Pollution Control and Engineering, New Age International Publication, 2007, ISBN: 81-224-1835-X.
7. M. N. Rao, H.V.N Rao, Air Pollution, Tata Mc-Graw Hill Publication, New Delhi, 1988, ISBN: 0-07- 451871-8.

8. Frank Kreith, Jan F. Kreider, Principles of Solar Engineering, McGraw-Hill, New York; 1978, ISBN: 9780070354760.
9. Aldo Vieira, Da Rosa, Fundamentals of renewable energy processes, Academic Press Oxford, UK; 2013. ISBN: 9780123978257.
10. A.D. Patvardhan, Industrial Solid Waste, Teri Press, New Delhi, 2013, ISBN:978-81-7993-502-6
11. Metcalf and Eddy, Waste Water Engineering, Mc-Graw Hill, New York, 2013, ISBN: 077441206. AICTE Model Curriculum for UG Degree Course in Computer Science and Engineering (Artificial Intelligence and Data Science (AI&DS)) 90
12. Keshav Kant, Air Pollution & Control, Khanna Publishing House, New Delhi (Edition 2018)

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

- Understand the ecosystem and terminology and solve various engineering problems applying ecosystem knowledge to produce eco – friendly products.
- Understand the suitable air, extent of noise pollution, and control measures and acts.
- Understand the water and soil pollution, and control measures and acts.
- Understand different renewable energy resources and efficient process of harvesting.
- Understand solid Waste Management, ISO 14000 & Environmental Management.

Fifth Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1.	OEC	Remote Sensing and GIS in Engineering	2	1	0	3	DCE09301
2.	ESC	Engineering Economics	2	1	0	3	DCE07301
3.	PCC	Steel Structures Design	3	1	0	4	DCE01301
4.	PCC	Engineering Hydrology	3	1	0	4	DCE01303
5.	PCC	Transportation Engineering II	3	0	0	3	DCE01305
	PCC	Structural Analysis II	2	1	0	3	DCE01307
6.	LC	Transportation Engineering Lab	0	0	2	1	DCE01309
7.	MSH 3						
8.	MSH 4						
			Total Credits			22	

Course Code	**:**	**DCE09301**
Course Title	**:**	**Remote Sensing and GIS in Engineering**
Number of Credits	**:**	**3 (L:2, T:1, P:0)**
Course Category	**:**	**Open Elective Course**

Course Objective: To impart knowledge of the principles and applications of remote sensing, GPS, and GIS in engineering problems by providing an in-depth understanding of techniques in digital image processing for remote sensing data analysis.

Course Content:

Unit	Content	Hours
I	Physics of remote sensing, electromagnetic radiation (EMR), Interaction of EMR with atmosphere, earth surface, soil, water and vegetation; Remote sensing platforms – Monitoring atmosphere, land and water resources - LANDSAT, SPOT, ERS, IKONOS and others, Indian Space Programme.	**10**
II	Satellite Data analysis - Visual interpretation – Digital image processing – Image preprocessing – Image enhancement – Image classification – Data Merging.	**12**
III	Basic components of GIS – Map projections and co-ordinate system – Spatial data structure: raster, vector – Spatial Relationship – Topology –	**15**

	Geo-database models: hierarchical, network, relational, object oriented models – Integrated GIS database -common sources of error – Data quality: Macro, Micro and Usage level components - Meta data - Spatial data transfer standards.	
IV	Thematic mapping, Measurement in GIS: length, perimeter and areas, Query analysis, Reclassification, Buffering, Neighborhood functions, Map overlay: vector and raster overlay, Interpolation, Network analysis, Digital elevation modelling, Analytical Hierarchy Process, Object oriented GIS – AM/FM/GIS – Web Based GIS Spatial data sources.	**8**

Recommended Books/References

1. B. Bhatta, Remote Sensing and GIS, Oxford University Press, 2011.
2. I. H., Sarah, Cornelius, S. Carver, An Introduction to Geographical Information Systems, Pearson Education, New Delhi, 2002.
3. P.A., Burrough, R.A. McDonnell, Principles of Geographical Information Systems, Oxford University Press, 1998.
4. T.M. Lillesand, R.W., Kiefer, Remote Sensing and Image Interpretation, John Wiley and Sons, 3rd Edition, 1993.

Course Outcomes: Upon successful completion of the course, the students will be able to:

- Understand and apply the technology and principles of Satellite Imaging to various engineering problems.
- Perform image processing and information extraction from Satellite Data Products and functional elucidation of GIS integrating Satellite Data Products into the GIS platform for Decision making.

Course Code	**:**	**DCE07301**
Course Title	**:**	**Engineering Economics**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Engineering Science Course**

Course Objective: This course aims at providing the student with advanced concepts of engineering economic analysis and its role in engineering decision making. Additionally, the course also covers topics such as depreciation, after tax analysis, replacement analysis, uncertainty, inflation, deflation, and estimation of future events.

Course Content:

Unit	Content	Hours
I	Introduction: Definition, Nature, Scope and Significance of economics for	**15**

	engineers, Demand and Supply: Demand, Types, Determinants, Law of Demand, Elasticity of Demand-Types, Significance, Supply, Market price determination – Case Study in Demand Forecasting, Meaning, Methods – Consumer Survey – Trend Projections – Moving average.	
II	Cost and Revenue: Concepts – Classifications – Short run and long run cost curves – Revenue – Concepts – Measurement of Profit (Case Study). Market Structure: Perfect Competition – Characteristics – Price and output determination in short run and long run – Monopoly – Price Discrimination – Monopolistic Competition – Product Differentiation – Oligopoly and Duopoly.	**15**
III	Market Failure: Causes – Type of Goods – Rivalrous and Non-rivalrous goods – Excludable and Non-excludable goods – Solutions – Government Intervention. Money and Banking: Money – Functions – Quantity theory of money – Banking – Commercial Banks – Functions – Central Bank (RBI) – Functions – Role of Banks in Economic Development. Foreign Exchange: Balance of Payments – Exchange rate determination – Methods of foreign payments – International Institutions – IMF, IBRD. Business Cycle and National Income: Meaning –Phases of business cycle - Inflation – Causes – Control measures - Deflation - National Income – Concepts – Methods of calculating national income – Problems in calculating national income.	**15**

Recommended Books/References

1. K.K. Dewett, M. H. Navalur, Modern Economic Theory, S. Chand and Company Ltd, New Delhi, 24thEdn., 2014.
2. Lipsey & Chrystal, Economics, Oxford University Press, 2010.
3. P. Kapoor, Sociology and Economics for Engineers, Khanna Book Publishing Company Private Limited, 2018.
4. P. A. Samuelson, William, Economics, Tata McGraw Hill, New Delhi, 2012.
5. F. Cherinullem, International Economics, McGraw Hill Education, 2011.
6. A. William, McEachern and Simrit Kaur, Micro ECON, Cengage Learning, 2013.
7. A. William, McEachern and A. Indira, Macro ECON, Cengage Learning, 2014.

Course Outcomes:

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

- Describe the role of economics in the decision making process and perform calculations in regard to interest formulas.
- Estimate the Present, annual and future worth comparisons for cash flows.
- Calculate the rate of return, depreciation charges and income taxes.
- Enumerate different cost entities in estimation and costing.
- Explain the importance of finance functions, financial ratios and solve related problems.

Course Code	**:**	**DCE01301**
Course Title	**:**	**Steel Structures Design**
Number of Credits	**:**	**4 (L:3, T:1, P:0)**
Course Category	**:**	**Program Core Course**

Course Objective: To introduce the students to limit state design of structural steel members subjected to compressive, tensile and bending loads, including connections. Design of structural systems such as roof trusses, gantry girders as per provisions of current code (IS 800 – 2007) of practice for working stress and Limit State Method.

Course Content:

Unit	Content	Hours
I	Properties of materials; loads and stresses, Design of semi-rigid, rigid and moment resistant connections	**15**
II	Built-up sections Design of tension members subjected to axial tension and bending, splicing of tension member, Design of compression members, Beam-column connections, Design of columns and their bases Design of flexural members and Plate girder	**15**
III	Loads, specification and design Industrial buildings; loads, design of purlins, trusses, bracings; gantry girders;	**15**
IV	Introduction to Plastic analysis; Simple cases of beams and frames	**15**

Recommended Books/References

1. N Subramanian., Design of Steel Structures, Oxford University Press, New Delhi, 2013.
2. M. L. Gambhir, Fundamentals of Structural Steel Design, McGraw Hill Education India Pvt. Ltd., 2013
3. S.K. Duggal, Limit State Design of Steel Structures, Tata McGraw Hill Publishing Company, 2005
4. R. Narayanan. et.al, Teaching Resource on Structural Steel Design, INSDAG, Ministry of Steel Publications, 2002
5. K.S. Sai Ram, Design of Steel Structures, Dorling Kindersley (India) Pvt. Ltd., New Delhi, 2nd Edition, 2015
6. M.R. Shiyekar, Limit State Design in Structural Steel, Prentice Hall of India Pvt. Ltd, Learning Pvt. Ltd., 2nd Edition, 2013
7. S.S. Bhavikatti, Design of Steel Structures, By Limit State Method as per IS:800–2007, IK International Publishing House Pvt. Ltd., 2009
8. V.L. Shah., Veena Gore, Limit State Design of Steel Structures, IS 800–2007, Structures Publications, 2009.

9. IS800 :2007, General Construction in Steel – Code of Practice, (Third Revision), Bureau of Indian Standards, New Delhi, 2007
10. SP 6(1) Hand book on structural Steel Sections CE8601 Notes Design of Steel Structural Elements

Course Outcomes: The students will be able to:

- Understand the concepts of various design philosophies
- Design common bolted and welded connections for steel structures
- Design tension members and understand the effect of shear lag.
- Understand the design concept of axially loaded columns and column base connections.
- Understand specific problems related to the design of laterally restrained and unrestrained steel beams.

Course Code	**:**	**DCE01303**
Course Title	**:**	**Engineering Hydrology**
Number of Credits	**:**	**4 (L: 3, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: The course aims to establish a strong foundation in engineering hydrology and enable the effective application of technical expertise in subjects such as hydrology and groundwater hydrology. It covers essential concepts including precipitation, infiltration, evaporation, runoff, hydrograph analysis, statistical methods, channel behaviour, and flood routing. The goal is to utilize this knowledge to solve various engineering challenges.

Course Content:

Unit	Content	Hours
I	Introduction: Hydrological cycle, Water budget equation, World water balance, Sources of data, Water resources of India, River basins of India, Forms of precipitation, Weather systems for precipitation, Characteristics of precipitation in India, Measurement of precipitation, Rain gauge of network, Presentation of rainfall data, Mean v over an area, Depth-Area-Duration relationship, Frequency of point rainfall, Maximum Intensity-Duration-Frequency relationship, Probable maximum precipitation.	**10**
II	Abstraction from Precipitation: Evaporation process, Evaporimeters, Empirical evaporation equations, Analytical methods of evaporation estimation, Reservoir evaporation and methods for its reduction, Transpiration, Evapotranspiration, Evapotranspiration equation, Actual evapotranspiration, Interception, Depression storage, Infiltration, Infiltration capacity, Measurement of infiltration, Infiltration indices.	**10**
III	Stream Flow Measurement: Measurement of stage, Measurement of velocity, Area-Velocity method, Dilution technique of streamflow measurement, Electromagnetic method, Ultrasonic method, Indirect	**10**

	method, stage-discharge relationship, Extrapolating of rating curve, Hydrometry stations.	
IV	Runoff and Hydrograph: Runoff characteristics of stream, Flow duration curve, Flow mass curve, Factor affecting flood hydrograph, Components of hydrograph, Base flow separation, Effective rainfall, Unit hydrograph and its analysis, Synthetic unit hydrograph, Instantaneous unit hydrograph.	**15**
V	Floods and Flood Routing: Rational method, Empirical formula, Unit hydrograph method, Flood frequency methods, Gumbel's method, Log-Pearson Type III distribution, Partial duration series, Design floods and storm, Risk, reliability and safety factor, Hydrologic storage routing, Hydraulic method of routing, Clark;s method for IUH, Nash's conceptual model, flood controls in India.	**15**

Recommended Books/References

1. K. Subramaya, Engineering Hydrology, Tata McGraw Hill Pub, New Delhi.
2. V.T. Chow, David R. Maidment, Larry W. MaysApplied Hydrology, McGraw Hill Education (India) Pvt. Limited, 2010.
3. R. S. Varshney, Engineering Hydrology, Nem Chand & Bros., Roorkee
4. Linsley, Kohler and Paulhus, Hydrology for Engineers, McGraw Hill International Co.
5. B. L. Gupta, Engineering Hydrology, Standard Publishers and Distributors, New Delhi

Course Outcomes:

- Describe the basic concepts of hydrology and integrate the physical hydrological processes.
- Describe the various process, measurement and estimation of hydrological components: evaporation, infiltration, stream flow etc.
- To develop runoff and hydrograph estimation and apply into engineering practices.
- Apply various statistical methods for hydrological analysis. Understanding and analysis of channel, flood routing and groundwater hydrology

Course Code	**:**	**DCE08415**
Course Title	**:**	**Transportation Engineering II**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: To learn the traffic characteristics along with design of traffic and airport facilities components.

Course Content:

Unit	Content	Hours
I	Driver behaviour, Traffic information and Control systems, Traffic studies-Volume, Speed and Delay studies, Elements of traffic Flow Theory	**5**
II	Characteristics of Uninterrupted Traffic, Capacity and LOS of Uninterrupted facilities, Characteristics of Interrupted traffic, Traffic characteristics at Unsignalised intersections	**10**
III	Design of signalized intersections, Capacity and LOS of signalized intersections, Actuated signal control, Signal coordination, Design of parking, Lighting and Terminal facilities,	**10**
IV	Introduction, aircraft characteristics and airport selection, air transport development in India, national and international organizations in air transport, aircraft characteristics and their impact on planning of an airport, selection of site for an airport, airport obstruction, imaginary surfaces, runway orientation, clam period and wind coverage.	**10**
V	Geometric designs runway and taxiway geometric designs, exit taxiway, its design and fillet curves, runway configuration, separation clearance, apron layout. Airport Traffic control Aids Visual aids, marking and lighting of runway and apron area, wind and landing direction indicator.	**10**

Recommended Books/References

1. R. P. Roess, W. R. McShane, E. S. Prassas, Traffic Engineering,Prentice-Hall, 1990.
2. L. J. Pignataro, Traffic Engineering – Theory and Practice, Prentice Hall, 1973.
3. C. J. Khisty, B. K. Lall, Transportation Engineering: An Introduction, Prentice-Hall India, 2003.
4. M. Wohl, B. V. Martin, Traffic System Analysis, McGraw-Hill Book Company, 1967.
5. P. Chakroborty, A. Das, Principles of Transportation Engineering, Prentice Hall of India Pvt. Ltd., 2003.
6. S. K. Khanna, M. G. Arora, S. S. Jain, Airport Planning & Design, Nem Chand and Bros, 6th Edition, 2017

7. R. Horonjeff, F. X. McKelvey, Planning & Design of airports, 5th Ed., McGraw Hill, 2010
8. L. R. Kadiyali, Traffic Engineering, Khanna Publishers, 2000.
A. D. May, Traffic Flow Fundamentals, Prentice–Hall, 1990.
9. C.S. Papacostas, Transportation Engineering and Planning, Prentice-Hall India, 2001.
10. Highway Capacity Manual (HCM), Transportation Research Board, USA, 2000.

Course Outcomes: The students will:

- Understand the fundamental concepts and principles of traffic engineering.
- Learn about the importance of traffic engineering in managing transportation systems.
- Study the basics of traffic flow, including parameters like volume, density, speed, and flow rate.
- Understand the runway operation and working.
- Gain knowledge about various techniques for air transport.
- Learn aircraft characteristics and airport selection process.

Course Code	**:**	**DCE01307**
Course Title	**:**	**Structural Analysis- II**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Core Course**

Course Objective: The course will cover the analysis of indeterminate structures, such as continuous beams and frames. The objective is to equip students with the skills to analyze and design indeterminate structures under different static and moving loading conditions.

Course Content:

Unit	Content	Hours
I	Moment distribution method - solution for continuous beams, effect of settlement and rotation of support, frames with or without side sway. Slope-Deflection Method - Method and application in continuous beams and Frames. Cables & Suspension bridges - with three hinged stiffening girders.	**10**
II	Matrix methods in structural analysis - Flexibility and Stiffness method; Elements of matrix algebra; Application of matrix methods to continuous beams Approximate analysis of building frames - Cantilever and portal method	**15**
III	Curved beams analysis - Hooks, Rings, and Bow girders. Un-symmetrical bending. Influence Line Diagram - for Indeterminate structures	**15**
IV	Plastic analysis of structures - Beams and portal Frames	**5**

Recommended Books/References

1. G. S. Pandit, S. P. Gupta, Structural Analysis: A Matrix Approach, Tata McGraw Hill, Noida, India, 2nd Edn., 2008.
2. S. Ramamrutham, Theory of Structures, Dhanpat Rai Publications, New Delhi, 11th Edn., 2014.
3. T.S Thandava Moorthy, Structural Analysis, Oxford University Press, New Delhi, 1st Edn., 2011.
4. C.K. Wang, Intermediate Structural Analysis, Tata McGraw Hill, Noida, India, 5th Edn., 2011.
5. B. C. Punmia, Ashok K. Jain, Arun K. Jain, Theory of Structures, Laxmi Publications (P) Ltd., New Delhi, Revised 12th Edn., 2004.

Course Outcomes: After going through this course, the students will be able to:

- Analyze continuous beams and frames (with and without side-sway) using Moment distribution and Slope-Deflection methods, suspension bridges, and stiffening girders.
- Analyze the indeterminate structures (continuous beams) using matrix methods and building frames using standard methods.
- Apply and analyze the concepts of curved beam analysis in hooks, rings, and Bow girders.
- Develop the concept of unsymmetrical bending.
- Learn to draw ILD for indeterminate structures.
- Develop the fundamental concepts of plastic analysis.

Course Code	**:**	**DCE01309**
Course Title	**:**	**Transportation Engineering Laboratory 1**
Number of Credits	**:**	**1 (L: 0, T: 0, P: 2)**
Course Category	**:**	**Lab Course**

Course Objective:

To learn the laboratory tests needed to know the properties of various materials used in the construction of transportation engineering sectors

Course Content:

Experiment No	Title
1	Ductility Test of Bitumen: Ductility Test of Bitumen using Ductility testing machine
2	Softening Point of Bitumen: Softening Point of Bitumen using Softening point apparatus
3	Penetration Value of Bitumen: Penetration Value of Bitumen Test with Penetrometer apparatus
4	Water content test of bitumen: To determine the Water content of bitumen

5	Flakiness Index and Elongation index of Aggregate: To determination the Flakiness Index and Elongation index of Aggregate with a Elongation gauge Flakiness gauge
6	Crushing Value of Coarse Aggregate: To determine the crushing value of coarse aggregate using compression testing machine

Recommended Books/References

1. S. K. Khanna. C. E. G. Justo, Highway Engineering, Khanna Publisher, 2011
2. L. R. Kadyali, Highway Engineering, Khanna Publisher, 2018
3. S. P. A. Bindra, Course in Highway Engineering, Dhanpat Rai and Sons, New Delhi, 2008
4. Saxena and Arora, A Text Book of Railway Engineering
5. N. K. Vaswani], Railway Engineering, Dhanpat Rai and Sons, New Delhi, 2010
6. R. Srinivasan, Harbour, Dock & Tunnel Engineering, Charotar Publications, Ananda, 2016
7. H. P. Oza, Dock and Harbour Engineering, Charotar Publications, Ananda, 2013

Course Outcomes: The objective of this Laboratory course is

- To familiarize with the perspective students about the laboratory tests needed to test the laboratory properties of transportation engineering.
- To test the essential qualities of materials used in the construction of transportation facilities.

Sixth Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1.	PCC	Civil Engineering Estimating and Costing	2	1	0	3	DCE01302
2.	PCC	Design of RCC Structures-II	3	1	0	4	DCE01304
3.	PCC	Geotechnical Engineering	2	1	0	3	DCE01306
4.	PCC	System Analysis	2	1	0	3	DCE01308
5.	PCC	Environmental Engineering	2	1	0	3	DCE01310
6.	OEC	Watershed Management	3	0	0	3	DCE09302
7.	LC	Geotechnical Engineering Lab	0	0	2	1	DCE01312
8.	LC	Concrete Lab	0	0	2	1	DCE01314
9.	LC	Environmental Engineering Lab	0	0	2	1	DCE01316
10.	PROJ	Seminar & Technical Report Writing	0	0	2	1	DCE05302
11.	MSH 5						
12.	MSH 6						
			Total Credits			23	

Course Code	**:**	**DCE01302**
Course Title	**:**	**Civil Engineering Estimating and Costing**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Core Course**

Course Objective: The course will introduce the overall concepts of estimation, costing and valuation and its importance. The objectives can be summarized as:
1. Understand the types of estimates.
2. Prepare specification of works and analyze rates.
3. Prepare preliminary and detailed estimates for building, roads, etc.
4. Understand and apply methods of valuation of building

Course Content:

Unit	Content	Hours
I	Introduction: Meaning of Estimation; Purpose of Estimation; Cost Planning Types of Estimate-Sanction-Project: Preliminary and Detailed Estimate; Administrative Approval; Technical sanction; Bill of quantities.	**15**

II	Preliminary Estimate: Preparation of preliminary estimate of building. Detailed Estimate: Estimate of wall; Estimate of Building- Long wall and short wall method, Centre line method; Estimate of Road; Calculation of earthwork. Specifications: Principles of general and detailed specifications; Examples of general and detailed specifications; Bar bending schedule, Mass haul diagram.	**15**
III	Rate Analysis: Analysis of rates; Purpose of Rate Analysis; Examples of Rate analysis of typical items Valuation; Meaning of valuation, Purpose of Valuation; Methods of Valuation; Escalation and Depreciation calculations.	**15**

Recommended Books/References

1. B. N. Dutta, Estimating and Costing in Civil Engineering. UBS Publishers' Distributors Pvt. Ltd. Rangwalla. Estimating, Costing and Valuation. Charotar Publishing House Pvt. Ltd.
2. Kohli and Kohli, Estimating and Costing, S. Chand
3. M. Chakraborty, Estimating, Costing, Specification and Valuations in Civil Engineering.

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

- Analyze complex civil engineering problems to prepare specification of works and rates Estimate the Present, annual and future worth comparisons for cash flows.
- Demonstrate the engineering knowledge to find the valuation of buildings.

Course Code	**:**	**DCE01304**
Course Title	**:**	**Design of RCC Structures-II**
Number of Credits	**:**	**4 (L:3,T:1, P:0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: To provide knowledge in the structural design of selected advanced structures of concrete and enable them to design reinforced concrete structures for real-world applications.

Course Content:

Unit	Content	Hours
I	Design of continuous beams and building frames, Moment redistribution, Estimation of wind and seismic loads.	**15**
II	Water tank and staging; Introduction, Design criteria, Design of rectangular and circular water tank using IS code coefficients (IS 3370)-, Staging for overhead tank	**15**
III	Design of Masonry walls and columns,	**15**
IV	Design of cantilever and counterfort type retaining wall; design of rectangular footings, eccentrically loaded rectangular footing- circular	**15**

	footings-detailing-combined footings, rectangular and trapezoidal (design principles only)	

Recommended Books/References

1. N. Krishnaraju, Prestressed Concrete, Tata McGraw Hill, 5e, 2012
2. S.U. Pillai, D. Menon, Reinforced Concrete Design, Tata McGraw Hill Book Co., 2009
3. B. C. Punmia, A.K. Jain, R C C Designs, Laxmi Publications Ltd., 10e, 2015
4. Relevant IS codes (IS 456, IS 875IS 1343, IS 3370, SP 16, SP 34)

Course Outcomes: The students will be able to:

- Design and detail cantilever retaining wall and understand the design principles of Counter.
- Design rectangular and circular water tanks using IS code coefficients (IS 3370).
- Design of different types of foundations

Course Code	**:**	**DCE01306**
Course Title	**:**	**Geotechnical Engineering**
Number of Credits	**:**	**3 (L:2,T:1, P:0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: To provide the basic conceptual understanding of soil types and its behavior under stress.

Course Contents:

Unit	Contents	Hours
1.	Introduction: Structure of soil; soil texture; Size and range of soil particles; shapes of individual sand and clay particles; field identification of soils; Three phase system: representation by Phase diagram-soil solids, water and air; Basic definitions and relationships: specific gravity, Void ratio, Porosity, Water content, Unit weights: bulk, dry saturated and submerged density; Degree of saturation and density index.	**07**
2.	Index Properties and Soil Classification: Particle size distribution, dry and wet analysis, Consistency limits and indices; Activity and Sensitivity of clays, Classification of soils, Textural, Unified and Indian Standard Classifications.	**07**

3.	Soil Moisture Relationship:Capillarity, Permeability and Seepage, Permeability of soils, Darcy's Law, Determination of coefficient of permeability by constant head and falling head tests, factors affecting permeability, Seepage analysis, Two dimensional flow, Laplace equation, Phreatic line in earth dams, Graphical methods of flow net construction, Pore water pressure and the concept of effective stress; Quick condition.	**07**
4.	Compressibility, Compaction and Consolidation:Standard and modified Proctor test, Harvard miniature compactor, sheep foot roller, Factors affecting compaction, field compaction methods and control of compaction. Effects of compaction on the properties of soil. One dimensional consolidation, , spring analogy, Terzaghi's theory of one dimensional consolidation, consolidation of undisturbed and remolded soils, consolidation test in the laboratory, Compression index ,Coefficient of consolidation, coefficient of volume change, degree of consolidation.	**07**
5.	Shear Strength of Soils: Introduction, Theoretical consideration: Mohr's stress Circle, Mohr-Coulomb Failure theory, the effective stress principle, measurement of shear strength, Direct shear test,Triaxial compression test,Unconfined compression test, Vane shear test, Skemton's pore pressure parameters, Shear strength of cohesive soilsHvorslev shear strength parameters, Stress path method, Laboratory experiments	**10**
6.	Stability of Slopes:Introduction: Infinite and finite slopes,Stability analysis of infinite and finite slopes, Culmann's method, the Swedish slip circle method, Stability of slopes of earth dams, Friction circle method, Taylor's stability number and stability curves, Bishop's method of stability analysis	**7**

Recommended Books/References

1. H. F. Winterkorn, F. Yang: Foundation Engineering Handbook, Galgotia Publishers, Indian Reprint, 2010.
2. T. W. Lambe and R. V. Whitman, Soil Mechanics, Wiley Eastern, 2012
3. C. Venkataramaiah, Geotechnical Engineering, New Age Intl., India, 1995
4. B. E. Joseph, Foundation Analysis and Design, McGraw Hill, N. Y., 1997.
5. S. P. Brahma, Foundation Engineering, Tata McGraw Hill, India, 1985
6. E. F. Richart, Jr. J. R. Hall and R. D. Woods, Vibrations of Soils and Foundations, Prentice-Hall, Englewood Cliffs, New Jersey, 1970

Course Outcome: After learning the course the student will be able to identify the types of soil and to determine its shear strength parameters and settlement characteristics which will be very much useful in designing the foundations of different civil engineering structures.

Course Code	**:**	**DCE01308**
Course Title	**:**	**System Analysis**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: To understand the methodology of problem-solving and formulate linear programming problems. To develop formulation skills in transportation models and finding solutions and assignment problems. To know the basics of dynamic programming and simulation.

Course Content:

Unit	Content	Hours
I	System concepts: Boundary, environment, input, output and constraints; Open and closed systems; System modeling, issues in system application; Operation research approach to system analysis	**5**
II	Linear programming: Problem Formulation, Graphical solution, Simplex method.	**10**
III	Artificial variable techniques. Two-phase method, Big-M method, revised simplex and sensitive analysis and Goal programming.	**10**
IV	Transportation problem (TP) and its formulation. finding basic feasible solution of TP using North-West Corner Rule, Least Cost and Vogel's Approximation Method, MODI method for finding optimal solution for TP.	**10**
V	Assignment problem and its formulation, Hungarian method for solving Assignment problem, Transhipment and travelling salesmen problem,	**10**

Recommended Books/References

1. Hamdy. A Taha, Operation Research 10th edition, Pearson Education; Tenth edition, 20119
2. S Vedula and P P Mujumdar, Water Resources Systems Modelling Techniques and Analysis Tata-McGraw Hill, New Delhi, 2005.
3. Rabindran, and Philips, Operation Research, principles and Practises, willy Publisher, 2007
4. J. K. Sharma, Operation Research: Theory and Application, Macmillan Publisher India Ltd, 2012.

Course Outcomes:

- Recognize the importance of linear programming in solving practical problems in industry
- Interpret the transportation models' solutions and infer solutions to real-world problems.
- Gain knowledge of drawing project networks for quantitative analysis of projects

- . Dynamic programming can be applied in real-world problems.

Course Code	**:**	**DCE01310**
Course Title	**:**	**Environmental Engineering**
Number of Credits	**:**	**3 (L:2,T:1, P:0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: Students will have knowledge of Environmental Engineering using basic principles of Fluid mechanics, Biological and Chemical Science to develop basic and empirical equations for Environmental Engineering Applications.

Course Content:

Unit	Content	Hours
I	Environment and Natural Processes; Development (Resource Utilization & Waste Generation); Concept of Sustainable Development; Issues affecting future development (population, urbanization, health, water scarcity, energy, climate change, toxic chemicals, finite resources etc.)	**10**
II	Water –Soil Interaction: Carbonate System (Alkalinity and buffering capacity); Major ions in water; Natural Organic Matter (NOMs); Water quality parameters; Physical processes (Mass Balance): Spatio-temporal variation in quality of river water, lake water, ground water; Water quality standards. Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/ recycle, energy recovery, treatment and disposal). Land pollution and solid waste management. Key issues in waste disposal, disposal options and selection criteria, sanitary landfill, landfill gas emission, leachate formation, environmental effects of landfill, landfill operation issues. Wetlands, water treatment and wastewater treatment	**15**
III	Air –Water interaction: (Liquid phase-gas phase equilibrium) Henry's Law Constant with units, Dimensionless Henry's Law Constant, Types of pollutants, their sources and impacts, air pollution meteorology, air pollution control, air quality standards and limits. Air resources: Atmosphere; Air pollutants; Emissions and control of air pollutants; Atmospheric meteorology and dispersion; Transport of air (global, regional, local); Air/ atmospheric stability; Plume shape; Gaussian modeling; Air quality standards	**10**
IV	Impacts of noise, permissible limits of noise pollution, measurement of noise and control of noise pollution. Ecosystem: Structure and function; Energy flow in ecosystem; Material flow in ecosystem; Biodiversity and ecosystem health; Bio-amplification and bio magnification. Hazardous Waste: Definition; Classification; Storage and management; Site remediation; Environmental Risk: assessment, and management.	**10**

Recommended Books/References

1. J. R. Miheicic, J. B. Zimmerman, Environmental Engineering: Fundamentals, Sustainability, Design, John Wiley and Sons, 2010.
2. M. L. Davis, D. A. Cornwell, Introduction to Environmental Engineering, McGraw Hill, New York, 2008.
3. H.S. Peavy, D.R. Rowe, G. Tchobanoglous, Environmental Engineering, Tata McGraw Hills, New Delhi, 2017
4. S.K. Garg, Environmental Engineering (Vol I), Water Supply Engineering, Khanna Publishers, New Delhi, 1977
5. G.M. Fair, J.C. Geyer, D.A. Okan, Elements of Water Supply and Wastewater Disposal, John Wiley and Sons Inc, 2010
6. J. Terence, McGhee, Water Supply and Sewerage, McGraw Hill Book Co., 1991
7. M.J. Hammer, Water and Waste Water Technology, John Wiley and Sons, New York.2012
8. Manual for Sewer and Sewerage, Central Public Health & Environmental Engineering Organization, Ministry of Housing and Urban Development, Govt. of India, 1993.
9. Manual for water supply and treatment, Central Public Health & Environmental Engineering Organization, Ministry of Housing and Urban Development, Govt. of India, 1999.

Course Outcomes: At the end of this course, the students will learn to:

- Classify the different sources of ground water, surface water with Characterization of physical, chemical and biological properties of water and waste water
- Design of water distribution system and various unit operation for the treatment of water
- Analyze water and waste water characteristics (physical, chemical and biological) from different sources for a given end use.
- Determine optimum dosage of coagulant

Course Code	**:**	**DCE09302**
Course Title	**:**	**Watershed Management**
Number of Credits	**:**	**3 (L: 3, T: 0, P: 0)**
Course Category	**:**	**Open Elective Course**

Course Objective: The course offers practical expertise in analyzing soil and water resource degradation and executing strategies for their conservation. It delivers a comprehensive exploration of engineering practices in watershed management to maximize the advantages derived from effective watershed management techniques.

Course Content:

Unit	Content	Hours
I	Basics: Watershed concept, Identification and characterization of	**5**

	watersheds, Hydrological and geomorphological characteristics of watersheds, Analysis of watershed, Coding of watershed, Land capability classification and soil maps.	
II	Watershed Planning: Planning principles – collection of data – present land use - Preparation of watershed development plan - Estimation of costs and benefits - Financial plan – selection of implementation agency - Monitoring and evaluation system	**10**
III	Watershed erosion processes and its prevention, Instrumentation and measurement of watershed management indicators, Mechanical and vegetative interventions for prevention of erosion and moisture conservation in watersheds; Water quality issues in watersheds, Optimal land use planning in watersheds, Management of saline and alkaline soils	**10**
IV	Water Conservation Practices: In-situ & Ex-situ moisture conservation principle and practices - Afforestation principle - Micro catchment water harvesting - Ground water recharge – percolation ponds -Water harvesting - Farm pond - Supplemental irrigation - Evaporation suppression - Seepage reduction.	**10**
V	Watershed Development Programme: River Valley Project (RVP) - Hill Area Development Programme (HADP) - National Watershed Development Programme for Rainfed Agriculture (NWDPRA) - Other similar projects operated in India – Govt. of India guidelines on watershed development programme - Watershed based rural development – infrastructure development - Use of Aerial photography and Remote sensing in watershed management - Role of NGOs in watershed development.	**10**

Recommended Books/References

1. R. Suresh, Soil and Water Conservation Engineering, Standard Publishers & Distributors, New Delhi, 2005.
2. G. Das, Hydrology and Soil Conservation Engineering", Prentice Hall of India Private Limited, New Delhi, 2000.
3. G. Singh, Manual of soil and water conservation practices, Oxford & IBH publishing Co. New Delhi, 2004.
4. R. Suresh, Land and water management principles, Standard Publishers & Distributors, New Delhi, 2008.
5. R.P Tripathi and H. P. Singh, Soil Erosion and Conservation, Willey Eastern Ltd., New Delhi, 2002.
6. V.V.N. Murthy, Land and Water Management, Kalyani Publishing, New Delhi, 2005.
7. E. M. Tideman, Watershed Management, Omega Scientific Publ. 1996.
8. G. Das, Hydrology and Soil Conservation Engineering, PHI Learning Private Limited, 2009.
9. W.A. Hall and J.A. Dracup, Water Resources Systems Engineering, Mc Graw Hill, 1970.
10. R.W. Hexem and E.O. Heady, Water Production Functions for Irrigated Agriculture, Iowa State University Press, 1978.
11. L.D. James and R. L. Robert, Economics of Water Resources Planning,

Course Outcomes:

After completion of the course,

- The students will have a thorough knowledge on watershed planning, development and management strategies through different soil and water conservation approaches.
- Suggest technical measures for soil erosion control both due to water and wind
- Assess the current status of the watershed at field, by taking up accurate investigation measures and conduct survey

Course Code	**:**	**DCE01312**
Course Title	**:**	**Geotechnical Engineering Lab**
Number of Credits	**:**	**2 (L: 0, T: 0, P: 2)**
Course Category	**:**	**Lab Course**

Course Objective: The main objective of this course is to teach students about the laboratory determination of different soil properties by hands on practice in the laboratory.

Course Content:

Experiment No	Title
1	Determination of moisture content of the given soil sample.
2	Determination of specific gravity of the given soil sample.
3	Grain size analysis of soils using sieve analysis and using hydrometer analysis.
4	Grain size analysis of soils using hydrometer analysis.
5	Determination of Consistency Limits of soil.
6	Determination of compaction parameters (OMC and MDD) of soil sample using Proctor Compaction Test.
7	Determination of coefficient of permeability of a soil using constant head method.
8	Determination of the strength characteristics of the soil by unconfined compression test.
9	Determination of the strength characteristics of the soil by Triaxial compression test.
10	Determination the of consolidation parameters of soil by conducting one dimensional test.

Recommended Books/References

1. B. M. Das, Soil Mechanics Laboratory Manual, 6th ed, 2022
2. IS 2720 (various parts): Methods of test for soils, Bureau of Indian Standards
3. K. H. Head, Manual of soil laboratory testing, Volume: I-II1. Pentech Press, London, 1982

4. J. E. Bowles, Physical and Geotechnical properties of soils, McGraw Hill Publishers, 1979.

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

- Classify the given soil sample.
- Find out the compaction parameters of soil.
- Find out the permeability coefficient of soil.
- Determine the strength characteristics of the soil.
- Determine the amount of consolidation occurring the soil

Course Code	**:**	**DCE01314**
Course Title	**:**	**Concrete Lab**
Number of Credits	**:**	**1 (L:0,T:0, P:2)**
Course Category	**:**	**Lab Course**

Course Objective: The main objective of this course is to familiarize the students with physical properties and mechanical behaviour of concrete and related construction materials.

Course Content:

Experiment No	Title
1	Determination of fineness of cement by dry sieving
2	Determination of setting times of cement.
3	Consistency test on cement.
4	Determination of soundness of cement.
5	Determination of specific gravity of cement.
6	Determination of compressive strength of cement.
7	Sieve analysis of coarse and fine aggregates.
8	Specific gravity and water absorption of fine aggregates.
9	Specific gravity and water absorption of coarse aggregates.
10	To study the bulking of fine aggregate.
11	Measurement of workability of concrete by slump cone test.
12	To determine the compaction factor of concrete mix of given proportion (Compaction factor test).
13	Tests for determination of compressive strength of concrete.
14	Tests for determination of flexural strength of concrete.
15	Tests for determination of splitting tensile strength of Concrete.

Recommended Books/References

1. J. Pielert, Cement and Concrete Reference Laboratory: Promoting Quality in Laboratory Testing, ASTM Standardization, 2002
2. IS codes for cement and concrete.
3. Laboratory manuals of concrete technology lab.

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

- Find out the physical properties of concrete and related materials by laboratory testing.
- Find out the concrete workability.
- Find out the compressive strength of cement and concrete.
- Find out the flexural and splitting tensile strength of concrete.

Course Code	**:**	**DCE01316**
Course Title	**:**	**Environmental Engineering Lab**
Number of Credits	**:**	**1(L:0,T:0, P:2)**
Course Category	**:**	**Lab Course**

Course Objective: Students will have knowledge of Environmental Engineering experiments using basic principles of Fluid mechanics, Biological and Chemical Science in laboratory to develop basic and empirical equations for Environmental Engineering Applications.

Course Content:

Experiment No	Title
1	To find the turbidity and colour of a given sample of water.
2	To determine the pH and conductivity of a given sample of water.
3	To find out total dissolved solid, dissolved solids, settle able solids and suspended solids of the given sample of water.
4	To determine acidity and alkalinity of in a water sample.
5	To find out the concentration of chlorides in the given sample of water and wastewater
6	To estimate the hardness of the given sample of water
7	To find the optimum amount of coagulant required to treat the turbid water by Jar Test.
8	To determine residual chlorine in a given sample of water.
9	To find the quantity of dissolved oxygen (DO) present in the given sample.
10	To determine biochemical oxygen demand (BOD) exerted by the given wastewater sample.
11	To determine Chemical oxygen demand (COD) exerted by the given waste water sample.
12	To determine MPN of coliforms of the given sample.

Recommended Books/References

1. H.S. Peavy, D.R. Rowe, G. Tchobanoglous, Environmental Engineering, Tata McGraw Hills, New Delhi, 2017
2. S.K. Garg, Environmental Engineering (Vol I), Water Supply Engineering, Khanna Publishers, New Delhi, 1977
3. G.M. Fair, J.C. Geyer, D.A. Okan, Elements of Water Supply and Wastewater Disposal, John Wiley and Sons Inc, 2010
4. J. Terence, McGhee, Water Supply and Sewerage, McGraw Hill Book Co., 1991
5. M.J. Hammer, Water and Waste Water Technology, John Wiley and Sons, New York.2012
6. Manual for Sewer and Sewerage, Central Public Health & Environmental Engineering Organization, Ministry of Housing and Urban Development, Govt. of India, 1993.
7. Manual for water supply and treatment, Central Public Health & Environmental Engineering Organization, Ministry of Housing and Urban Development, Govt. of India, 1999.

Course Outcomes: At the end of this course, the students will learn to:

- Classify the different sources of ground water, surface water with Characterization of physical, chemical and biological properties of water and waste water
- Design of water distribution system and various unit operation for the treatment of water
- Analyze water and waste water characteristics (physical, chemical and biological) from different sources for a given end use.
- Determine optimum dosage of coagulant

Course Code	**:**	**DCE05302**
Course Title	**:**	**Seminar & Technical Report Writing**
Number of Credits	**:**	**1 (L:0,T:0, P:2)**
Course Category	**:**	**Professional Core Course**

Course Objective:

1. Identify and compare technical and practical issues related to the area of WRE/TE.
2. Prepare a well-organized report employing elements of technical writing and criticalthinking.
3. Demonstrate the ability to describe, interpret and analyze technical issues and developcompetence in presenting.

Course Outcome: Will help learner to:

- Establish motivation for any topic of interest and develop a thought process for technical presentation.
- Organize a detailed literature survey and build a document with respect to technical

publications.

- Practice effective presentation and improve soft skills.

Seventh Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1.	PCC	Foundation Engineering	**2**	**1**	**0**	**3**	DCE01401
2.	PCC	Open Channel and Fluvial Hydraulics	**2**	**1**	**0**	**3**	DCE01403
3.	PEC	**Elective – I**	**2**	**1**	**0**	**3**	
		Pavement Materials	2	1	0	3	DCE08401
		Intelligent transportation System	2	1	0	3	DCE08403
		Groundwater Hydrology	2	1	0	3	DCE08405
		Urban Water Management	2	1	0	3	DCE08407
4.	PEC	**Elective – II**	**2**	**1**	**0**	**3**	
		Design of Hydraulic Structures	2	1	0	3	DCE08409
		Pavement Soil Mechanics	2	1	0	3	DCE08411
		Freight Transport and Logistics	2	1	0	3	DCE08413
		Hydrologic Systems Modelling	3	0	0	3	DCE08415
5.	PEC	**Elective – III**	**2**	**1**	**0**	**3**	
		Water and Wastewater Engineering	2	1	0	3	DCE08417
		Traffic Engineering	2	1	0	3	DCE08419
		Geometric Design of Transportation Facility	2	1	0	3	DCE08421
		Land & Water Engineering and Management	2	1	0	3	DCE08423
7.	PROJ	Engineering Project I	0	0	10	**5**	DCE05401
8.	PROJ	45 days Summer Internship	0	0	0	1	DCE05403
9.	LC	Traffic Engineering Lab	0	0	2	1	DCE08425
10.	LC	Open Channel and Fluvial Hydraulics Lab	0	0	2	1	DCE01405
11.	MSH 7						
12.	MSH 8						
			Total Credits			22/23	

Course Code	**:**	**DCE01401**
Course Title	**:**	**Foundation Engineering**
Number of Credits	**:**	**3 (L:2,T:1, P:0)**
Course Category	**:**	**Professional Core Course**

Course Objective: The objective of this course is to learn students about different foundation system for civil engineering structures, their functions and design aspects.

Course Content:

Unit	Content	Hours
I	Site investigation and selection of foundation: Scope and objectives, Methods of exploration, Auguring and boring, Wash boring and rotary drilling, Depth and spacing of bore holes, Soil samples, Representative and undisturbed, Sampling methods, Split spoon sampler, Thin wall sampler, Stationary piston sampler, Penetration tests (SPT and SCPT), Data interpretation, Strength parameters, Bore log report and Selection of foundation.	**9**
II	Shallow foundation: Location and depth of foundation, Codal provisions, Bearing capacity of shallow foundation on homogeneous deposits, Terzaghi's formula and BIS formula, Factors affecting bearing capacity. Bearing capacity from in-situ tests (SPT, SCPT and plate load), Allowable bearing pressure, Seismic considerations in bearing capacity evaluation. Determination of Settlement of foundations on granular and clay deposits, Total and differential settlement, Allowable settlements, Codal provision, Methods of minimizing total and differential settlements.	**13**
III	Footings and rafts: types of Isolated footing, Combined footing, Mat foundation, Contact pressure and settlement distribution, Proportioning of foundations for conventional rigid behavior, Minimum thickness for rigid behavior, Applications.	**8**
IV	Pile foundation: Types of piles and their functions, Factors influencing the selection of pile, Carrying capacity of single pile in granular and cohesive soil, Static formula, Dynamic formulae (Engineering news and Hileys), Capacity from insitu tests (SPT and SCPT), Negative skin friction, Uplift capacity-Group capacity by different methods (Feld's rule, Converse, Labarra formula and block failure criterion), Settlement of pile groups, Interpretation of pile load test (routine test only), Under reamed piles, Capacity under compression and uplift, Cohesive, expansive, non-expansive, Cohesion less soils, Codal provisions	**15**

Recommended Books/References

1. V.N.S. Murthy, Text book of Soil Mechanics and Foundation Engineering, CBS Publishers Distribution Ltd., New Delhi. 2014.
2. K.R. Arora, Soil Mechanics and Foundation Engineering, Standard Publishers and Distributors, New Delhi, 7th Edition, 2017 (Reprint).
3. B.C. Punmia, Soil Mechanics and Foundations, Laxmi Publications Pvt. Ltd. New Delhi, 16th Edition, 2017.
4. M. D. Braja, Principles of Foundation Engineering (Eigth edition), Cengage Learning 2014.
5. S.R. Kaniraj, Design aids in Soil Mechanics and Foundation Engineering, Tata McGraw Hill publishing company Ltd., New Delhi, 2014.
6. J. E. Bowles, Foundation Analysis and design, McGraw Hill Education, 5th Edition, 2015.
7. IS Code 6403: Bearing capacity of shallow foundation, Bureau of Indian Standards, New Delhi, 1981 (Reaffirmed 1997)
8. IS Code 8009 (Part 1): Shallow foundations subjected to symmetrical static vertical loads, Bureau of Indian Standards, New Delhi, 1976 (Reaffirmed 1998)
9. IS Code 8009 (Part 2): Deep foundations subjected to symmetrical static vertical loading, Bureau of Indian Standards, New Delhi, 1980 (Reaffirmed 1995)
10. IS Code 2911 (Part 1): Concrete Piles Bureau of Indian Standards, New Delhi, 1979 (Reaffirmed 1997)
11. IS Code 2911 (Part 2): Timber Piles, Bureau of Indian Standards, New Delhi, 1979 (Reaffirmed 1997)
12. IS Code 2911 (Part 3) : Under Reamed Piles, Bureau of Indian Standards, New Delhi, 1979 (Reaffirmed 1997)
13. IS Code 2911 (Part 4) : Load Test on Piles, Bureau of Indian Standards, New Delhi.
14. IS Code 1904: 1986 (Reaffirmed 1995) Design and Construction of Foundations in Soils, Bureau of Indian Standards, New Delhi, 1979 (Reaffirmed 1997)
15. IS Code 2131: Method for Standard Penetration test for Soils, Bureau of Indian Standards, New Delhi, 1981 (Reaffirmed 1997)
16. IS Code 2132: Code of Practice for thin – walled tube sampling for soils, Bureau of Indian Standards, New Delhi, 1986 (Reaffirmed 1997)
17. IS Code 1892 (1979): Code of Practice for subsurface Investigation for Foundations. Bureau of Indian Standards, New Delhi, 1986 (Reaffirmed 1997)

Course Outcomes: The students will be able:

- To know about different foundations and their suitability in different civil engineering constructions.
- To learn the basic design principles of different foundation systems.
- To handle basic projects of foundation.

Course Code	**:**	**DCE01403**
Course Title	**:**	**Open Channel and Fluvial Hydraulics**
Number of Credits	**:**	**3 (L:2 ,T:1, P:0)**
Course Category	**:**	**Professional Core Course**

Course Objective: To understand the different types of open channel flows, forces acting in open channel flow and its applications.

Course Content:

Unit	Content	Hours
I	Basics of free surface flows, velocity and pressure distribution, Uniform Flow, Concept of specific energy, specific force, critical flow, critical depth.	**12**
II	Gradually Varied Flow (GVF); Governing Equation of gradually varied flow and its limitations, flow classification, surface profiles and its characteristics, Control sections, Computation methods and analysis: analytical, graphical and advanced numerical methods.	**15**
III	Rapidly Varied Flow (RVF); Characteristics of rapidly varied flow, Hydraulic jump, types of jump, basic characteristics of jump, length and location of jump, jump as energy dissipation, control of jump, surges, surge channel transitions. Rapidly varied unsteady flow: Equation of motion for unsteady flow, "Celerity" of the gravity wave, deep and shallow water waves, open channel positive and negative surge,	**10**
IV	Spatially Varied Flow (SVF); Basic principles, Differential SVF equations for increasing and decreasing discharge, Classifications and solutions, Numerical methods for profile computation, Flow over side-weir and Bottom-rack.	**8**

Recommended Books/References

1. V.T. Chow, Open channel Hydraulics, McGraw Hill International, 2009
2. F.M. Henderson, Open Channel Flow, McGraw Hill International, 1966
3. K. Subramanya, Flow in Open Channels, Tata McGraw Hill, 2019
4. K.G.R. Raju, Flow through open channels, T.M.H., 2001
5. M. H. Chaudhry, Open Channel Flow, PHI, 2007
6. R.H. French, Open channel Hydraulics, McGraw Hill International, 1985

Course Outcomes: After successful completion of this course, the students will learn:

- To compute the uniform flow and critical flow
- The concepts, computation and application of gradually varied flow, rapidly varied flow and spatially varied

Course Code	**:**	**DCE08401**
Course Title	**:**	**Pavement Materials**
Number of Credits	**:**	**3 (L:3,T:0, P:0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: The objective of this course is to expose students with different pavement materials and their engineering aspects required for pavement construction along with knowledge of bituminous mix design.

Course Content:

Unit	Content	Hours
I	Introduction; Soil as material for embankment and subgrade, classification, properties, laboratory and field test.	**10**
II	Road making aggregates: classification, properties of aggregates, design of aggregate gradation, tests on Road aggregates,	**12**
III	Bituminous road binders: viscosity grade, emulsions, cut backs and modified binders; rheology of bituminous binders, modified binders; resilient modulus of pavement materials;	**15**
IV	Mix design –Marshall method and Super pave procedure; Design of pavement quality concrete mixes, utilization of waste materials in pavements.	**8**

Recommended Books/References

1. G. Correia, Flexible Pavements, A. A. Balkema Publishers, 1996.
2. P. H. Wright, Highway Engineering, John Wiley & Sons, 1996.
3. S. K. Khanna, C. E. G. Justo and AVeeraragavan, Highway Material and Pavement Testing, New Chand & Brothers, 2013.
4. G. N. Durhan, W. A. Marr, and W. L. De Groff, Resilient Modulus Testing for Pavement Components, ASTM International, U.S.A., 2003.
5. S. E. Zoorob, A. C. Collop, and S. F. Brown, Performance of Bituminous and Hydraulic Materials in Pavements, A. A. Balkema Publishers, 2002.
6. R. N. Hunter, Bituminous Mixtures in Road Construction, Thomas Telford Services Ltd., 1995.

Course Outcomes: The students will learn:

- To assess the essential materials required for construction of any pavement.
- The essential engineering properties which must be satisfied by any pavement material to be used for pavement construction.
- Different experiments to be conducted for checking the engineering properties of pavement materials.
- The bitumen mix design for construction of road pavement.

Course Code	**:**	**DCE08403**
Course Title	**:**	**Intelligent Transportation System**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: ITS aims to streamline the operation of vehicles that manages vehicle traffic, assists drivers with safety and other information, along with provisioning of convenience applications for passengers and road safety.

Course Content:

Unit	Content	Hours
I	Introduction to Intelligent Transportation Systems (ITS) – Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI)	**10**
II	Geographic Information Systems (GIS), video data collection. Telecommunications in ITS – Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Vehicle – Road side communication – Vehicle Positioning System, ITS functional areas – Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO)	**15**
III	Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS).ITS User Needs and Services – Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.	**15**
IV	Automated Highway Systems - Vehicles in Platoons – Integration of Automated Highway Systems.ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries, smart vehicles using internet of things (IOT), infrastructures design for e-vehicles and their charging points.	**5**

Recommended Books/References

1. K.P. Chen, J. Miles, ITS Hand Book: Recommendations for World Road Association (PIARC), 2000
2. J. M. Sussman, Perspective on ITS, Artech House Publishers, 2005.
3. National ITS Architecture Documentation, US Department of Transportation, 2007 (CD-ROM).

4. S. Ghosh, T.S. Lee, Intelligent Transportation Systems: New Principles and Architectures, CRC Press, 2000.
5. M. A. Chowdhury, A. Sadek, Fundamentals of Intelligent Transportation Systems Planning, Artech House, Inc., 2003.
6. R.P Roess, E.S. Prassas, W.R. McShane. Traffic Engineering, Pearson Educational International, Third Edition, 2004.

Course Outcomes: The students will learn to:

- Understand the concept and significance of Intelligent Transportation Systems.
- Learn how ITS technologies and solutions contribute to improving transportation efficiency and safety.
- Explore various components of ITS, such as sensors, communication systems, data processing, and control centers.
- Study technologies like GPS, wireless communication, vehicle-to-vehicle (V2V), and vehicle-to-infrastructure (V2I) communication
- Learn how ITS facilitates real-time traffic monitoring, congestion management, and adaptive traffic signal control.
- Understand the role of predictive analytics in optimizing traffic flow and reducing congestion.

Course Code	**:**	**DCE08405**
Course Title	**:**	**Groundwater Hydrology**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: The course aims to empower students with the skills needed to elucidate groundwater occurrences, categorize aquifers, and understand aquifer properties within diverse geological settings. Students will conduct thorough analyses of hydrological flow systems in groundwater contexts. They will also develop the ability to conduct in-depth groundwater balances, interpret concepts of recharge, storage, and discharge, and comprehend steady-state and transient groundwater flow processes. Application of analytical solutions for solving groundwater management issues will also be covered.

Course Content:

Unit	Content	Hours
I	Occurrence of Groundwater: Rock properties affecting groundwater, Vertical distribution of groundwater, Zone of aeration, Zone of saturation, Geologic formation as aquifers, Types of aquifers, Storage coefficient, Springs, Hydrothermal phenomena.	**10**
II	Groundwater Movement: Darcy's law, Permeability, Hydraulic conductivity, Heterogeneity and anisotropy, Groundwater flow rates,	**10**

	Groundwater flow direction, Dispersion, Groundwater tracer, General flow equation, Unsaturated flow, Kinematic wave, Infiltration-The Green –Ampt Method.	
III	Groundwater and Well Hydraulics: Steady unidirectional flow, Steady radial flow to a well, Unsteady radial flow in a confined aquifer, Unsteady radial flow in an unconfined aquifer, Unsteady radial flow in a leaky aquifer, well flow near aquifer boundaries, Multiple well system, partially penetrating wells, Well flow for special conditions.	**15**
IV	Groundwater Resources Assessment: Geological /geophysical exploration/ remote sensing / electric resistivity /seismic refraction-based methods for surface investigation of ground water	**10**

Recommended Books/References

1. D. K. Todd and L. F. Mays, Groundwater Hydrology, John Wiley and Sons. 2005
2. K. R. Karanth, Hydrogeology, Tata McGraw Hill Publishing Company,1989
3. S. Ramakrishnan, Ground water,
4. C.W. Fetter, Applied Hydrogeology, 2nd Edition, CBS Publishers and Distributors, New Delhi, 1990
5. D.B. McWhorter and D.K. Sundada, Ground-Water Hydrology and Hydraulics, Water Resources Publications, 1977.
6. H.M. Raghunath, Groundwater, 2nd Edition Wiley Eastern Ltd. 1987.
7. A.K. Rastogi, Numerical Groundwater Hydrology, Penram International Publishing Pvt. Ltd., Bombay. 2008.

Course Outcomes:

- Comprehend the basic concepts and techniques used in groundwater hydrology
- Understand how to gather and use information to apply the learned concepts outside of class
- Develop skills to approach complex problems that do not have a single correct answer

Course Code	**:**	**DCE08407**
Course Title	**:**	**Urban Water Management**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective:

To learn the techniques of managing urban water this includes supplying water for urban consumption and role of climate change in urban water availability

Course Content:

Unit	Content	Hours
I	Urban water management system; Need of urban water management system and its effect due to climate change. Urban water economics. Urban water quality parameters: Physical, chemical and biological parameters of natural water bodies like lake, river and estuary; Water quality standards, Eutrophication; Sources of pollution, mass bathing impacts, waste load allocation.	**10**
II	Wastewater Quantity Estimation in urban areas: Generation and collection of wastewater, Estimation of wastewater quantity; Variation in quantity of wastewater; Wastewater Collection Systems: Sanitary, storm and combined sewerage systems, Quantities of sanitary wastes and storm water, Design and analysis of wastewater conveyance system	**10**
III	Urban water quality monitoring: Physical, chemical and biological monitoring of urban water; Guidelines for sample size and location of monitoring stations, Sample analysis	**15**
IV	Water purification in urban areas: Physical, chemical and biological processes, response of streams to biodegradable organic waste; Engineered systems for water and waste water purification	**10**

Recommended Books/References

1. S. C. Chapra, Surface Water Quality Modeling, Waveland Press, 2008.
2. A. David, Chin, Water Quality Engineering in Natural Systems, Wiley Interscience, 2006.
3. D. P. Loucks, J. R. Stedinger and D. A. Haith, Water Resource Systems Planning and Analysis, PH.1981.
4. G. T. Orlob, Mathematical Modelling of Water Quality- Streams, Lakes, and Reservoirs, John Wiley, 1983.
5. R. V. Thomn and J. A. Mueller, Principles of Surface Water Quality Modelling, Harper and Row Publishers, 1987.

Course Outcomes: The students after studying this will able to learn:

- The essential techniques used in urban water management
- The effective measures to supply drinking water to urban people and reduce hazard

involved in urban water supply

Course Code	**:**	**DCE08407**
Course Title	**:**	**Design of Hydraulic Structures**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objectives: To impart knowledge on Analysis and Design Aspects of different Components of Hydraulic Structures and Irrigation and Drainage Systems.

Course Content:

Unit	Content	Hours
I	Design of Hydraulic structures on permeable foundation including weir and barrage, determination of afflux and discharge intensity, waterway and looseness factor, stilling basin level and length, uplift pressure and exit gradient, fllor thickness and protection works.	**10**
II	Types of Dams, storage capacity, Reservoir planning, Gravity Dams-general features, forces acting on gravity dams, gallaries and their functions, stability analysis, roller compacted RCC dams.	**10**
III	Earth dams-homogeneous and zoned section, filter design and stability analysis. Spillways- layout and design of various types of spillways, design of energy dissipaters.	**10**
IV	Intake Structures-trash racks and their cleaning and handling devices; stop log arrangements, intake entrance, aeration vent, gate control. Tunnels-Classification, rock cover, hydraulic design and supporting systems; concrete lining; portals and plugs; underground cavities.	**10**
V	Gate- Various types of gates for barrages; spillways; intakes; sluices; structural design considerations for vertical lift and radial gates.	**5**

Recommended Books/References

1. S. K. Garg, Irrigation Engineering and hydraulic structures, Khanna Publishers, 1976
2. P.N. Modi, Irrigation, water Resources and Water Power Engg, Standard Book House, Delhi-6, 2020
3. S. M. Challa. Water Resources Engineering Principle and practice, New Age Internation (P) Ltd. Publishers. New delhi, 2020
4. US Department of the Interior Bureau of Reclamation, Design of Small Dams, McGraw Hill,1987
5. R.S. Varsney, Concrete Danms, Oxford & I & H Publishing Co. New Delhi, 1978
6. R. S. Varshney, S. C. Gupta, Theory and Design of Irrigation Structures Vol I, 2009
7. R. S. Varshney, Theory and Design of Irrigation Structures Vol II Canal and Storage Works, 2007
8. B.C. Punmia, A. K. Jain, A. K. Jain, Irrigation and Water Power Engineering, 2009

Course Outcome: Students will be able to understand the Structural and Hydraulic Design of various components of hydraulic structures.

Course Code	**:**	**DCE08409**
Course Title	**:**	**Pavement Geotechnics**
Number of Credits	**:**	**3(L: 3, T: 0, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: The objectives of this course are to learn the student about the different engineering properties, behaviour of the soil which is used for pavement application.

Course Content:

Unit	Content	Hours
I	Introduction; Compaction behavior of soil, effect of compaction, laboratory and field compaction.	**6**
II	Stress-strain behavior of soils; Mohr Circle of Stress; Principal Stresses. Shear strength of soil; drained and undrained shear strength of soils, Significance of pore pressure parameters; Determination of shear strength; Interpretation of triaxial test results.	**13**
III	Stress path; Drained and undrained stress path; Stress path with respect to different initial state of the soil; Stress path for different practical situations.	**13**
IV	Critical state soil mechanics; Critical state parameters; Critical state for normally consolidated and over consolidated soil; Behavior of sands; Critical void ratio; Effect of dilation in sands; introduction to yielding and hardening;	**13**

Recommended Books/References

1. J.H. Atkinson, P.L. Bransby, The Mechanics of Soils: An introduction to critical soil mechanics, McGraw Hill, 1978.
2. J.H. Atkinson, An introduction to the Mechanics of soils and Foundation, McGraw-Hill Co., 1993.
3. B.M. Das, Advanced Soil Mechanics, Taylor and Francis, 2nd Edition, 1997
4. D.M. Wood, Soil Behavior and Critical State Soil Mechanics, Cambridge University Press, 1990.
5. R.F. Craig, Soil Mechanics, Van Nostrand Reinhold Co. Ltd., 1987.
6. K. Terzaghi, R.B. Peck, Soil Mechanics in Engineering Practice, John Wiley & Sons, 1967.
7. T.W. Lambe, R.V. Whitman, Soil Mechanics, John Wiley & Sons, 1979.

Course Outcomes: The students will be able to:

- Find out the compaction and strength aspect of soil to be used for pavement.
- Analyze the laboratory results of soil to be used for pavement.

- Able to know about the critical state behavior of soil

Course Code	**:**	**DCE08413**
Course Title	**:**	**Freight Transport and Logistics**
Number of Credits	**:**	**3 (L: 3, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: To learn how Freight and Logistics works together. From streamlining the logistics process to reducing costs, improving efficiency, and ensuring safe and reliable delivery, freight forwarders provide a valuable service to companies.

Course Content:

Unit	Content	Hours
I	Introduction to Freight and Logistics: Evolution of freight and logistics; Interrelationships between society, environment and freight transport; Survey methodologies to understand freight movement.	**15**
II	Cost study of freight and logistics : Cost measurement: Production, Holding, Transportation, Handling; Effect of internal and external variables on cost; Demand forecasting; Inventory planning and management	**15**
III	Network and Distribution: Transportation and distribution network: Design, Reverse Logistics. Development, Management; Ware house operations; Pricing: Perishable, seasonal demand, uncertainty issues;	**15**
IV	Vehicle routing: One-to-one distribution, One-to-many distribution, Shortest path algorithm, Quickest time algorithm; Logistics information system; Designing and planning transportation networks; City logistics	**15**

Recommended Books/References:

1. R. C. Larson, A. R. Odoni, Urban Operations Research, Prentice Hall, 1981.
2. G. Ghiani, G. Laporte, R. Musmanno, Introduction to Logistics Systems Management (2nd edition), Wiley, 2013.
3. M. S. Daskin, Network and Discrete Location: Models, Algorithms, and Applications (2 nd edition), Wiley, 2013.

Course Outcomes: At the end of this course, students should be able to:

- Understand the fundamentals of supply chain and logistics
- Forecast demand in logistics network
- Model facility locations in logistics network
- Manage warehouse and plan inventory

- Model and design transportation and distribution network
- Solve vehicle routing problems (VRP)

Course Code	**:**	**DCE08415**
Course Title	**:**	**Hydrologic Systems Modelling**
Number of Credits	**:**	**3 (L: 3, T: 0, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: The Hydrologic Systems Modeling course is designed to teach a student hydrologic cycle in the nature and how to quantitatively describe those processes using models. The student will learn the fundamentals of hydrology including basic concepts, precipitation, snow and snowmelt, evapotranspiration, subsurface flow, infiltration and soil water movement, and runoff and streamflow. This cause pays equivalent attention to theories and hands-on practices on model application (SWAT) for watershed scale. The students will be taught how to set up and execute weather data driven physical based models, both at a point-scale and a watershed scale, to predict, evapotranspiration, infiltration, soil water distribution, subsurface drainage, runoff, and stream flow in hydrologic systems.

Course Content:

Unit	Content	Hours
I	Introduction, nature of problems in hydrology, physical and systems approach, systems view of hydrologic cycle, hydrologic continuity equation	**5**
II	Linear systems theory, response functions of linear systems, lumped and distributed catchment systems, response function of hydrologic systems for discrete and continuous inputs, derivation of unit hydrograph	**15**
III	Linear conceptual models, linear reservoir and linear channel, Nash, Clarke models, derivation of non-parametric unit hydrograph, derivation of synthetic unit hydrograph Flood routing, hydraulic and hydrologic flood routing, linear, kinematic wave and dynamic wave routing models, parameter estimation of flood routing models	**15**
IV	Hydrologic simulation models (SWAT), modeling of various hydrological processes, overview of standard hydrologic simulation models	**10**

Recommended Books/References

1. V.T. Chow, D.R. Maidment, and L.W. Mays, Applied Hydrology, McGraw Hill Inc. N York, 2010
2. R. H. McCuen., Hydrologic Analysis and Design, Prentice Hall Inc. N York, 2005
3. V.P. Singh, Hydrologic Systems, Prentice Hall Inc., N York, 1986.

Course Outcomes:

- Classify forecasting and prediction problems in hydrology.
- Formulate and solve flood routing models for linear and nonlinear hydrologic systems
- Develop and solve rainfall-runoff models using transformation and simulation techniques.
- Develop synthetic unit hydrograph for un-gauged watersheds.

Course Code	**:**	**DCE08413**
Course Title	**:**	**Water and Wastewater Engineering**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: To introduce students to various components and designs of water supply schemes, water treatment methods, water storage distribution systems, sewage treatment and disposal and deign of intake structures and sewerage systems

Course Content.

Unit	Content	Hours
I	Domestic and industrial usage of water, Generation of contaminated water and its environmental effects, Introduction to Wastewater Treatment: Over view of wastewater treatment, different categories of treatment – preliminary, primary, secondary, tertiary, sludge handling and disposal, General principles for wastewater treatment, objectives and goals for different units of wastewater treatment process.	**10**
II	Wastewater Characterization: Physical, chemical and biological characterization. Suspended, dissolved and volatile solids, biodegradability of the organics, BOD and its concepts, Measurement procedures, CBOD and NBOD, kinetics, COD, ThOD, TOC, Total and Kjeldahl nitrogen, Phosphate, Sources of microbes and pathogens in wastewater, Concept of indicator organism, Method of determination of indicator organism, Quantification methods- Thomas equation, Poisson's distribution	**10**
III	Effect of discharge of contaminated wastewater into surface water: Mixing of wastewater with surface water, diffusion of dissolved organic matters, degradation, and re-aeration, deduction of Streeter-Phelps model/equation, Sludge handling, digestion, dewatering and disposal: Sludge thickening, dewatering (Mechanical and sludge drying beds), disinfection, different stages of anaerobic digestion, methane gas generation, design principles for the anaerobic digesters, operation and maintenance.	**5**
IV	Wastewater Collection: Generation and estimation of community Sewage,	**10**

	flow variations, storm water flow, estimation of storm-water flow in urban and semi urban setup - Rational formula, time of concentration, time of entry, time of flow, types of sewers, design considerations, open channel flow- Manning's formula, alternate systems for sewage collection and conveyance- small bore system, shallow sewer systems, sewer appurtenances- different types of manholes and their constructions, functions, weirs as controlling devices, street inlets, gully traps, siphons, oil and grease traps, outfall structures, design considerations, design of hydraulically equivalent sections.	
V	Preliminary and Primary Treatment: Bar screens, grit chambers, oil and grease removal, primary sedimentation tank – circular and rectangular types, sizing, inlet and outlet arrangements, design of collection launders; Low-cost and On-site Treatment processes: Waste stabilization ponds- aerobic, anaerobic and facultative ponds, Septic Tanks; Aerated lagoons Secondary Treatment: Overview of bacterial growth and decay in pure and mixed cultures, Monod's equation, activated sludge process- analysis, concept of MCRT, SVI, theoretical oxygen requirement, aeration processes and their 9 design, secondary sedimentation tank – zone settling theory and design of secondary settling tank. fixed film growth systems like trickling filters, rotating biological contactor, anaerobic treatment process fundamentals, UASB process, UASB post treatment. Tertiary treatment & Recent Advances: basic principles of nutrients removal from treated wastewater, nitrogen removal process- nitrification and denitrification, combined nitrification- denitrification process, Bardenpho process, extended aeration and oxidation ditches, Phosphorus removal- A/O, A2/O processes. MBR, MBBR and Microbial fuel cells	**10**

Recommended Books/References

1. S.K. Garg, Environmental Engineering, Vol.I Khanna Publishers, New Delhi, 2010.
2. P.N. Modi, Water Supply Engineering, Vol.I Standard Book House, New Delhi, 2016.
3. S.K. Garg, Environmental Engineering Vol.II, Khanna Publishers, New Delhi, 2015.
4. K.N. Duggal, Elements of Environmental Engineering, S. Chand and Co. Ltd., New Delhi, 2014.
5. B.C. Punmia, A.K. Jain, Environmental Engineering, Vol.II, Laxmi Publications, 2010.
6. B.C. Punmia, A. Jain, A. Jain, Water Supply Engineering, Laxmi Publications (P) Ltd., New Delhi 2010.
7. Manual on Water Supply and Treatment, CPHEEO, Ministry of Urban Development, Government of India, New Delhi, 1999.
8. S. Qasim, E. Motley, G. Zhu, Water Works Engineering Planning, Design and Operation, Prentice Hall of India Learning Private Limited, New Delhi, 2009.
9. Metcalf and Eddy –Waste water Engineering – Treatment and Reuse, Tata Mc.Graw – Hill Company, New Delhi, 2010.

10. Syed R. Qasim "Waste water Treatment Plants", CRC Press, Washington D.C.,2010
11. Gray N.F, "Water Technology", Elsevier India Pvt. Ltd. New Delhi, 2006.

Course Outcomes: The students will learn to:

- Understand the various components of water supply scheme and design of intake structure and conveyance system for water transmission
- Understand on the characteristics and composition of sewage, ability to estimate sewage generation and design sewer system including sewage pumping stations
- Understand the process of conventional treatment and design of water and wastewater treatment system and gain knowledge of selection of treatment process and biological treatment process

Course Code	**:**	**DCE08415**
Course Title	**:**	**Traffic Engineering**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective:

1. To understand the concepts of highway capacity
2. To be aware of various methods of collecting traffic data
3. To understand the basics of highway planning and design, and workout problems in design of road geometrics
4. To learn the principles of intersection design
5. To learn the importance of road safety

Course Content:

Unit	Content	Hours
I	Driver behaviour, traffic information and control systems, traffic studies-volume, speed and delay studies, elements of traffic flow theory, Statistical application in traffic engineering, Probability functions, Hypothesis Testing.	**10**
II	Speed Studies, Accident and Pedestrian Studies, Characteristics of uninterrupted traffic, Capacity and LOS of Uninterrupted facilities, Characteristics of Interrupted traffic, traffic characteristics at unsignalised intersections	**10**
III	Design of signalized intersections, Capacity and LOS of signalized intersections, Actuated signal control, Signal coordination, Design of parking, lighting and terminal facilities.	**10**
IV	Shock waves, Coordinated Signal Control system, Smart and connecterd mobility, Traffic Flow relations.	**10**
V	Simulation of traffic systems, statistics and probability in traffic engineering, trends in traffic engineering, Traffic Calming, Congestion pricing, ITS.	**5**

Recommended Books/References

1. R. P. Roess, W. R. McShane, E. S. Prassas, Traffic Engineering,Prentice-Hall, 1990.
2. L. J. Pignataro, Traffic Engineering – Theory and Practice, Prentice Hall, 1973.
3. C. J. Khisty, B. K. Lall, Transportation Engineering: An Introduction, Prentice-Hall India, 2003.
4. M. Wohl, B. V. Martin, Traffic System Analysis, McGraw-Hill Book Company, 1967.
5. P. Chakroborty, A. Das, Principles of Transportation Engineering, Prentice Hall of India Pvt. Ltd., 2003.
6. L. R. Kadiyali, Traffic Engineering, Khanna Publishers, 2000.
7. A. D. May, Traffic Flow Fundamentals, Prentice–Hall, 1990.
8. C.S. Papacostas, Transportation Engineering and Planning, Prentice-Hall India, 2001.
9. Highway Capacity Manual (HCM), Transportation Research Board, USA, 2000.

Course Outcomes: The students will learn to:

- Understand the fundamental concepts and principles of traffic engineering.
- Learn about the importance of traffic engineering in managing transportation systems.
- Study the basics of traffic flow, including parameters like volume, density, speed, and flow rate.
- Explore the relationships between these parameters and their impact on roadway performance.
- Gain knowledge about various techniques for collecting traffic data, such as loop detectors, cameras, and surveys.
- Learn how to analyze traffic data to assess congestion, travel patterns, and peak periods.

Course Code	**:**	**DCE08417**
Course Title	**:**	**Geometric Design of Transportation Facility**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: Study of Geometric Design of Transportation Facility provides opportunities for understanding the transportation problems and identification of the needs.

Course Content:

Unit	Content	Hours
I	Geometric design provisions for various transportation facilities as per AASHTO, IRC and other guidelines; discussion of controls governing geometric design, route layout and selection, elements of design	**10**
II	sight distances, horizontal alignment, transition curves, super elevation and side friction; vertical alignment: - grades, crest and sag curves	**15**

III	highway cross-sectional elements and their design for rural highways, urban streets and hill roads; at-grade inter-sections – sight distance consideration and principles of design, channelization, mini round-abouts, layout of round-abouts	**15**
IV	Inter-changes: major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, bicycle and pedestrian facility design; parking layout and design.	**5**

Recommended Books/References

1. M. Rogers, Highway Engineering, Blackwell Publishing, 2003.
2. P. H. Wright, Highway Engineering, John Wiley & Sons, 1996.
3. C. H. Oglesby, R. G. Hicks, Highway Engineering, John Wiley & Sons, 1982.
4. R. L. Brockenbrough, K. J. Boedecker, Highway Engineering, McGraw-Hill,1996.
5. P. Chakroborty, A. Das, Principles of Transportation Engineering, Prentice Hall of India Pvt. Ltd., 2003.
6. L. R. Kadiyali, Traffic Engineering, Khanna Publishers, 2000.
7. A. D. May, Traffic Flow Fundamentals, Prentice–Hall, 1990.
8. C.S. Papacostas, Transportation Engineering and Planning, Prentice-Hall India, 2001.

Course Outcomes: The students will learn to:

- Understand the importance of geometric design in creating safe and efficient transportation facilities.
- Learn about the various elements and factors that influence geometric design decisions.
- Study design controls and guidelines established by transportation authorities to ensure safe and consistent designs.
- Understand the role of design speed, sight distance, and other parameters in geometric design.

Course Code	**:**	**DCE08419**
Course Title	**:**	**Land & Water Engineering and Management**
Number of Credits	**:**	**3 (L:2, T:1, P:0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: to plan and execute the project within time and available resources.
Course Content:

Unit	Content	Hours
I	Rainfall-runoff-infiltration interactions, Rainfall erosivity indices and calculations, Runoff measurements and calculations, Peak discharges. Soil Erosion: Types and processes, Factors affecting water and wind erosion, Soil erodibility, Soil loss measurements and calculations	**10**
II	Conservation tillage, Terrace design, layout and construction, Gully/stream bank stabilization, Open channels and drainage systems/structures, Drainage for runoff diversion and salinity control, Land reclamation and improvement	**12**

III	Water quantity/quality assessment and management, Water conservation measures, Water-harvesting structures, Reduction of water losses	**12**
IV	Land cover management; Farming systems, Afforestation, Watershed-related problems and opportunities, Soil-Conservation Strategies; Concept of land husbandry, Field-level and watershed-level strategies. Indigenous technologies, Soil Erosion Modeling and Soil-Conservation Research.	**11**

Recommended Books/References

1. N.W. Hudson, FAO Soils Bulletin No. 68: Field Measurement of Soil Erosion and Runoff, FAO, Rome, 1993
2. N.W. Hudson, B. T. Batsford, Soil Conservation, London, UK, 1992
3. N.W. Hudson, B. T. Batsford, Land Husbandry, London, UK, 1992
4. R. Lal, Soil Erosion Research Methods, Soil and Water Conservation Society Ankeny, USA, 1994
5. R.P.C. Morgan, Soil Erosion and Conservation, 2nd Ed. Longmam Scientific and Technical, Burnt Hill, UK, 1995
6. F.J. Pierce, W. W. Frye, Advances in Soil and Water Conservation, Ann Arbor Press, Michigan, 1998
7. G. O. Schwab, D. D. Fangmeier, W. J. Elliot, R. K. Frevert, Soil and Water Conservation Engineering, 4th Ed. John Wiley and Sons Inc., USA, 1993
8. A.D. Ward, W. J. Elliot, Environmental Hydrology, CRC Press Inc. Boca Raton, Florida, 1995

Course Outcomes: At the end of this course, students will learn to:

- Evaluate different types of tendering and contract documents of construction projects
- Estimate different costs associated with construction projects.
- Select different engineering equipment's used for specified construction work according to their nature.

Course Code	**:**	**DCE08421**
Course Title	**:**	**Traffic Engineering Lab**
Number of Credits	**:**	**1 (L: 0, T: 0, P: 2)**
Course Category	**:**	**Lab Course**

Course Objective: Transportation Engineering Laboratory fulfills the needs of analyzing the traffic movements and testing the pavement materials. In this section 2, the analysis of traffic movement is to be done.

Course Content:

Experiment No	Title

1	To acquire information on daily travel characteristics to understand travel behaviour of individuals.
2	To find out instantaneous speed of the different vehicle at a given stretch along with its characteristics.
3	To carry out classified traffic volume counts and calculate peak hour factor for the observation.
4	To identify the three fundamental parameters of a stream
5 (a)	To find out parking load, parking accumulation and parking index using patrol method.
5 (b)	To find out parking load, parking accumulation and Parking index using in-out survey method.

Recommended Books/References

1. ITE Manual of Transportation Engineering Studies, 2nd edition
2. L. R. Kadiyali,Traffic Engineering and Transportation Planning, Khanna Publishers, New Delhi, 1987
3. C. J. Khisty, B. K. Lall, Transportation Engineering: An Introduction, Prentice-Hall India, 2003.
4. M. Wohl, B. V. Martin, Traffic System Analysis, McGraw-Hill Book Company,1967.
5. P. Chakroborty, A. Das, Principles of Transportation Engineering, Prentice Hall of India Pvt. Ltd., 2003.
6. L. R. Kadiyali, Traffic Engineering, Khanna Publishers, 2000.
7. C.S. Papacostas, Transportation Engineering and Planning, Prentice-Hall India, 2001.
8. Highway Capacity Manual (HCM), Transportation Research Board, USA, 2000.

Course Outcome: At the end of this laboratory course, students will learn to:

- Understand the fundamental concepts and principles of traffic engineering.
- Learn about the importance of traffic engineering in managing transportation systems.
- Study the basics of traffic flow, including parameters like volume, density, speed, and flow rate.
- Explore the relationships between these parameters and their impact on roadway performance.

Course Code	**:**	**DCE01405**
Course Title	**:**	**Open Channel and Fluvial Hydraulics Lab**
Number of Credits	**:**	**1 (L: 0, T: 0, P: 2)**
Course Category	**:**	**Lab Course**

Course Objective: To understand the practical utility of hydraulics of channel flow.

Course Content:

Experiment No	Title
1	Determination of coefficient of discharge of rectangular and triangular notch
2	Determination of depth of uniform flow in various cross sections
3	Determination of depth of critical flow in various cross sections
4	Determination of roughness coefficients of open channels
5	Measurement of velocity and pressure profiles in open channels
6	To observe the phenomena of Hydraulic jump

Recommended Books/References

1. V. T. Chow, Open Channel Hydraulics, McGraw-Hill International Book Co., Singapore, 1973.
2. K. Subramanya, Flow in Open Channels, Tata McGraw Hill, 2009
3. K.G. Ranga Raju, Flow through open channels, T.M.H, 1993

Course Outcomes: After successful completion of this course, students will learn:

- Computation of Uniform flow and critical flow
- Concepts and applicability of hydraulic jump
- Variation of velocity in natural channels

Eighth Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1.	PEC	**Elective – V**	**2**	**1**	**0**	**3**	
		Irrigation and Drainage Engineering	2	1	0	3	DCE08402
		Ground Improvement Techniques	2	1	0	3	DCE08404
		Advanced Soil and Water Conservation Engineering	2	1	0	3	DCE08406
		Airport System Planning & Design	2	1	0	3	DCE08408
2.	PEC	**Elective – VI**	**2**	**1**	**0**	**3**	
		Water resources Planning and Management	2	1	0	3	DCE08410
		Intersection Design and Analysis	2	1	0	3	DCE08412
		Stochastic Hydrology	2	1	0	3	DCE08414
		Mass Transit Systems					DCE08416
4.	PEC	**Elective - VII**	**2**	**1**	**0**	**3**	
		Flood Forecasting and Flood Hazard Management	2	1	0	3	DCE08418
		Modeling, Analysis and Simulation	2	1	0	3	DCE08420
		Transportation Economics	3	0	0	3	DCE08422
		Pavement Analysis and Design	2	1	0	3	DCE08424
5.	PROJ	Engineering Project II	0	0	20	10	DCE05402
6.	LC	Irrigation and Drainage Engineering lab	0	0	2	1	DCE08426
8.	MSH 9						
9.	MSH 10						
			Total Credits			19/20	

Course Code	**:**	**DCE08402**
Course Title	**:**	**Irrigation and Drainage Engineering**
Number of Credits	**:**	**3 (L:2 ,T:1, P:0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: to understand the basic concepts of irrigation, crop water requirement, irrigation efficiencies, design and evaluation of water application methods, efficient drainage and management of drainage water and salt affected land.

Course Content:

Unit	Content	Hours
I	Necessity of irrigation- scope of irrigation engineering- benefits and ill effects of irrigation- irrigation development in India- types of irrigation systems, Soil-water plant relationship: Classification of soil water- soil moisture contents-depth of soil water available to plants permanent and ultimate wilting point, Crop water requirement: Duty, delta base period, irrigation efficiencies, consumptive use, net irrigation requirement, frequency of irrigation; canal capacity, rotational delivery, conveyance and seepage losses.	**15**
II	Alignment- canal capacity- losses- FSL of canal- design of canal in alluvial soil and non-alluvial soils- Kennedy's silt theory- Lacey's regime theory-balancing depth- use of Garrets diagrams and Lacey's Regime diagrams-lining of irrigation channels- design of lined canal drainage behind lining. Water logging: Causes, Measures: surface and sub-surface drains, land reclamation	**10**
III	Diversion head works: Types- selection of the suitable site for the diversion headwork components of diversion headwork- Causes of failure of structure on pervious foundation- Khosla's theory- Design of concrete sloping glacis weir, Cross drainage works: Types- selection of suitable type of CD works-aqueduct and Syphon aqueduct- determination of maximum flood discharge and waterway for drain, fluming of canal- uplift pressure on underside of barrel roof and at the floor of the culvert- design of bank connections.	**10**
IV	Planning and Design of Irrigation Systems: Design and evaluation of surface irrigation systems, Volume balance surface irrigation system design, Land grading and earthwork calculations, Canal regulation works: Canal fall-necessity and location- types of falls- Cross regulator and distributary head regulator- their functions, Silt control devices, Canal escapes- types of escapes. Surface drainage and subsurface drainage, water logging, effect, causes and preventive measures, drainage water use, salt affected soil and salinity control.	**10**

Recommended Books/References

1. M.M. Das and S. Das, Irrigation and Water Power Engineering, PHI Lerning Pvt Ltd.2009
2. K.N Sharma, water Power Engineering, Vikas Publishing House, 2013
3. C.A. Black, Methods of Soil Analysis, 2nd Ed. ASA Monograph. Madison Wisconsin, 1986
4. R.H. Cuenca, Irrigation, System Design: An Engineering Approach, Prentice Hall, NJ., 1989
5. B. Singh, Fundamentals of Irrigation Engineering, Nem Chand and Brothers, Roorkee, 2005
6. A.M. Michel, Irrigation Theory and Practices, Vikash Publishing House, 2008
7. D. Hillel, Fundamentals of Soil Physics, Academic Press, 1980
8. G. J. Hoffman, T.A. Howell and K.H. Solomon, Management of Farm Irrigation Systems (Monograph), ASAE, 1990

Course Outcomes: At the end of this course, students will learn:

- To visualize basic concepts of irrigation and estimation of crop water requirement.
- To design and evaluation of water application methods.
- To design efficient drainage and management of drainage water and salt affected land.
- To manage surface and groundwater for sustainable development.

Course Code	**:**	**DCE08404**
Course Title	**:**	**Ground Improvement Techniques**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: The objective of this course is to provide knowledge about the different methods of ground improvement, their field application, suitability for different soils and site.

Course Content:

Unit	Content	Hours
I	Site investigation and subsoil exploration; Methods of boring and sampling; Field tests; Engineering properties of soft, weak and compressible deposits	**10**
II	Static and Dynamic compaction; Preloading; Vertical drains; Granular piles	**14**
III	Lime stabilization and injection; Grouting; Soil nailing; Anchors; Vacuum consolidation; Thermal, electrical and chemical methods	**14**
IV	Electro-osmosis; soil freezing; vacuum consolidation, Case histories.	**7**

Recommended Books/References

1. J.E. Bowles, Foundation Analysis and Design, McGraw-Hill International Edition, 1997.
2. M.R. Hausmann, Engineering Principles of Ground Modification, McGraw-Hill International Editions, 1990.
3. R. Yonekura, M. Terashi, and M. Shibazaki, Grouting and Deep Mixing, A.A. Balkema, 1966.
4. M.P. Moseley, Ground Improvement, Blackie Academic & Professional, 1993.
5. P.P. Xanthakos, L.W. Abramson, D.A. Bruce, Ground Control and Improvement, John Wiley & Sons, 1994.

Course Outcomes: The students will be able to:

- Identify the poor site/soil to be used for infrastructure development.
- Choose the specific technique for treatment of any poor soil to be used for construction purposes.
- Treat existing foundation soil so that the safety of the structure can be maintained.

Course Code	**:**	**DCE08406**
Course Title	**:**	**Advanced Soil and Water Conservation Engineering**
Number of Credits	**:**	**3 (L:2, T:1, P:0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: to understand the basic concepts soil erosion caused and types and to design of various management practices i.e. agronomical and engineering measures for as per suitability

Course Content:

Unit	Content	Hours
I	Soil erosion, problems caused by erosion, Soil erosion types; geological and accelerated erosion, agents of erosion. Water erosion, Factors affecting water erosion, classification of water erosion, mechanics of water erosion.	**5**
II	Gullies- classification of gullies, stages of gully development. Universal Soil Loss Equation (USLE), determination of USLE parameters, Modified USLE, numerical, Measurement of soil erosion, runoff plots, soil samplers.	**7**
III	Land capability classification, Water erosion control measures-agronomic measures, contour farming, strip cropping, conservation tillage, mulching,	**5**
IV	Engineering measures-contour bund, design criteria, numerical, surplussing arrangement, Engineering measures-graded bund, design criteria, numerical, compartmental bunding.	**7**
V	Terraces- level and graded broad base terraces, Bench terraces-planning, design and layout procedure, Contour stone wall and trenching (CCT, SCT, & deep CCT)	**7**
VI	Gully and ravine reclamation-Principles of gully control, vegetative	**7**

	measures, Grassed waterways and design, numerical	
VII	Wind erosion- control measures - vegetative, mechanical measures, wind breaks and shelter belts and stabilization of sand dunes.	**7**

Recommended Books/References

1. R.K. Frevert, G.O. Schwab, T.W. Edminster, K.K. Barnes, Soil and Water Conservation Engineering, 4th Edition, John Wiley and Sons, New York, 2009
2. N. Hudson, Soil Conservation. Cornell University Press, Ithaka, New York, USA, 1985.
3. G. Singh, C. Venkataraman, G. Sastry, B.P. Joshi, Manual of Soil and Water
4. Conservation Practices. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi, 1996.
5. R. Suresh, Soil and Water Conservation Engineering.Standard Publisher Distributors, New Delhi, 2014.
6. A.M. Michael, T.P. Ojha, Principles of Agricultural Engineering. Volume II. 4th Edition, Jain Brothers, New Delhi, 2003.
7. V.V.N. Murthy, Land and Water Management Engineering. 4th Edition, Kalyani Publishers, New Delhi, 2002.

Course Outcomes: At the end of this course, students will learn:

- Basic concepts of soil erosion cause and its types
- Computation of soil erosion using various methods
- Suggest efficient management for soil and water conservation
- Design of various management practices like strip cropping, buffer strip cropping, contour cropping, bunding, trenching, terracing, grassed water as per requirement.

Course Code	**:**	**DCE08408**
Course Title	**:**	**Airport Systems Planning and Design**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: Gain a comprehensive understanding of the various components that constitute an airport system, including airside, landside, terminals, runways, taxiways, and navigational aids.

Course Content:

Unit	Content	Hours
I	Visual Aids: Airport Day time markings, airport lighting, visibility, visual aids	**10**
II	Structural design of airport pavements: Design Factors, Design of flexible	**15**

	and rigid pavements using FAARFIELD.	
III	Airside capacity and delay: mathematical models for capacity and delay, space time concept, models for mixed traffic. Air Traffic Control: Importance of flight rules, navigational aids.	**15**
IV	Air Traffic Control: controls, obstruction and clearance requirements. Design of heliports.	**5**

Recommended Books/References

1. R. Horonjeff, F. X. McKelvey, Planning & Design of Airports, McGraw Hill, Inc, 1993
2. S. K. Khanna, M. G. Arora, S. S. Jain, Airport Planning & Design, Nem Chand and Bros, Roorkee 2004
3. N. Ashford, P. H. Wright, Airport Engineering, John Wiley & Sons, NY., 1992
4. ICAO, Aerodrome Design Manual, International Civil Aviation Organization, Montreal, Canada, 2020

Course Outcomes: The students will learn to:

- Understand the various components of airport systems, including airside and landside operations, terminals, runways, and taxiways.
- Grasp the foundational principles of airport planning, including site selection, capacity assessment, and long-term master planning.
- Gain insights into terminal layout, passenger flow optimization, baggage handling systems, and security considerations.

Course Code	**:**	**DCE08410**
Course Title	**:**	**Water Resources Planning and Management**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: Water resource use that is important socially, economically viable, and environmentally sustainable. Additionally, they aim to maximize the advantages and minimize the risks associated with the current hydraulic infrastructure.

Course Content:

Unit	Content	Hours
I	Introduction and Basic Concepts of Water Resources Planning: System Components, Planning and management of water resources systems, systems concept, Advantages and limitations of systems approach, Modeling of Water Resources Systems, Economics in water resources	**5**
II	Introduction to Optimization Techniques in Water Resources: Objective	**10**

	functions, Constraints, Maxima, Minima and saddle points, convex and concave functions, General form of LP, Standard and Canonical forms of LP, Elementary transformations, Graphical method, Feasible and infeasible solutions, Simplex method, Dual and sensitivity analysis,	
III	Dynamic Programming and Applications: Introduction, multistage decision problem, Recursive Equations, Principle of optimality, Discrete DP, Water allocation problem, Capacity expansion problem, Reservoir sizing and Reservoir operation using LP and NLP approaches,	**10**
IV	Constrained and unconstrained optimization in water resources planning, Lagrange multipliers, Kuhn-Tucker conditions	**10**
V	Multi-objective Optimization: Introduction, Non-inferior solutions, Trade-off analysis, Pareto optimal solutions, multipurpose reservoir operation, Weighted and constraint methods, Other methods, Chance constrained LP (CCLP), CCLP for reservoir operation	**10**

Recommended Books/References

1. S.K Jain and V.P Singh, Water Resources Systems Planning and Management, Elsevier Publication, 2003
2. Wurbs and James, Water Resources Engineering, Prentice Hall India Learning Private Limited, 2015
3. J. K. Sharma, Operation Research: Theory and Application, Macmillan Publisher India Ltd, 2012.
4. Rabindran, and Philips, Operation Research, principles and Practises, willy Publisher, 2007
5. S Vedula and P P Mujumdar, Water Resources Systems Modelling Techniques and Analysis," Tata-McGraw Hill, New Delhi, 2005.

Course Outcomes: The students will learn to:

- Understanding the Water Resources Systems and Modelling Techniques fundamentals necessary to formulate, solve and analyze engineering problems.
- To develop analytical skills to formulate and solve problems for decision-making under uncertainty
- Students must in a position to formulate and solve optimization models for the design and operation of water resources systems

Course Code	**:**	**DCE08412**
Course Title	**:**	**Intersection Design and Analysis**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: to calculate intersection design and signal.

Course Content:

Unit	Content	Hours
I	Types of intersections, Principles of design, types of maneuvers, relative speed, conflict points and area.	**10**
II	Intersection geometrics and their influence on design/operation. Concept of capacity and LOS, Operational analysis of two-way and all-way stop controlled intersections and Roundabouts by US and Indian methods, mini roundabouts.	**15**
III	Analysis of signal-controlled intersections by US, British and Swedish methods, delay and its evaluation. Types of signals, Design of signals by Indian, US and British methods, signal coordination.	**15**
IV	Grade separated intersections and interchanges, weaving sections and their operational evaluation, Intersection signs, marking and lighting	**5**

Recommended Books/References

1. C. S. Papacostas, P. D. Prevedouros, Transportation Engineering & Planning, Prentice Hall of India Private Limited, New Delhi 2001.
2. F. L. Mannering, W. P. Kilareski, S. S. Washburn, Principles of Highway Engineering and Traffic Analysis, Wiley India, 2007.
3. C. J. Khistya, B. K. Lall, Transportation Engineering, Prentice Hall of India Private Limited, New Delhi, 2006.
4. C. A. O. Flaherty, Transport Planning and Traffic Engineering, Hodder Headline Group, London 1997.
5. Highway Capacity Manual of US, Transportation Research Board, Washington DC, 2010.

Course Outcomes: The students will learn to:

- Utilize traffic simulation tools to model intersection operations.
- Implement sustainable transportation concepts in intersection design.
- Analyze real-world case studies of successful and unsuccessful designs.
- Comply with regulatory and design guidelines in intersection planning.
- Collaborate on group projects for intersection design challenges.
- Communicate solutions through technical reports and presentations.
- Consider ethical, social, and community impacts of designs.

Course Code	**:**	**DCE08414**
Course Title	**:**	**Stochastic Hydrology**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: The objective of this course is to introduce the concepts of probability theory and stochastic processes with applications in hydrologic analysis and design.

Unit	Content	Hours
I	Deterministic and Stochastic Hydrology, Probability axioms, Random variables and their properties, Probability distribution and probability density function, Continuous and Discrete distributions	**15**
II	Moments and expectations of distributions, Parameter estimation, Analysis of hydrologic extremes, Frequency analysis, Regional flood frequency analysis	**15**
III	Transformations, Hypothesis Testing, Goodness test of fit tests, Chi Square test and KS test, Multivariate regression analysis, Correlation coefficient and its significance in regional analysis, Modelling hydrologic uncertainty	**5**
IV	First order Markov process, Markov chain, Data generation, Hydrologic Time Series Analysis, Modelling of Hydrologic Time Series	**10**

Recommended Books/References

1. Charles T. Haan, Statistical Methods in Hydrology, East West Publishers, 1998.
2. N.T. Kotteguda, Stochastic Water Resources Technology, The Macmillan Press, New York, 1982.
3. R.H. McCuen, Hydrologic Analysis and Design, Prentice Hall Inc. N York, 2005.
4. N.T. Kotteguda and Renzo Resso, Statistics, Probability and Reliability for Civil and Environmental Engineers, McGraw Hill Companies Inc., New York, 1998.

Course Outcomes: Students would be equipped with methodologies of addressing uncertainties in hydrologic systems and one step ahead forecasting. Students will be able to:

- Statistically characterize water resources data;
- Perform a frequency analysis to estimate the magnitude of an event having a given frequency of occurrence or to estimate the frequency of occurrence of an event having a given magnitude;
- Analyze hydrologic time series by identifying the proper model, estimating the model

parameters, verifying the assumptions of the model and generating synthetic series that resemble the data;

- Perform an analysis of spatially referenced data including the estimate of values at locations where measurements are not available and the estimate of the associated uncertainty.

Course Code	**:**	**DCE08416**
Course Title	**:**	**Mass Transit Systems**
Number of Credits	**:**	**3 (L:3, T:0, P:0)**
Course Category	**:**	**Professional Elective Course**

Course Objective:

Main objectives of this course is to teach students about handling of huge intra-city traffic for highly populated urban areas by application of optimum construction methodologies for intra-city Transportation systems along with railway safety, Railway alignment and track design.

Course Content:

Unit	Content	Hours
I	Mass transit concepts trip interchanges and assignments Urban transportation problems, Modes of mass transit- their planning, construction and operation, Case studies of existing mass transit systems	**15**
II	Technical and economic evaluation of mass transit projects History and role of public transportation in urban development Urban passenger transport modes Vehicle characteristics and motion Highway transit modes: Buses and trolley buses	**15**
III	Rail transit modes: street cars, light rail, rapid transit and regional rail New concepts and proposed modes Bus rapid transit system Principles of bus rapid transit system Lane priority Contraflow lanes	**10**
IV	Bus rapid transit: a sustainable approach to mass transit Rapid transit systems Para-transit system Transportation systems.	**5**

Recommended Books/References:

1. C. S. Papacostas and P. D. Prevedouros, Transportation Engineering and Planning, PHI Publication, 2001.
2. S. Grava, Urban Transportation Systems, Mc. Graw Hill Professional, 2003.
3. J. D. Fricker and R.K. Whitford, Fundamentals of Transportation Engineering, Pearson, PH, 2004.
4. J. E. Anderson, Transit Systems Theory, Lexinton Books, 1978.

Course Outcomes:

After completion of this course students will have mastery on efficient Transportation system operation and will

- Handle huge intra-city traffic for highly populated urban areas

- Know about the optimum construction methodologies for intra-city Transportation systems
- Have knowledge on Railway safety
- Have knowledge on Railway alignment and track design

Course Code	**:**	**DCE08418**
Course Title	**:**	**Flood Forecasting and Flood Hazard Management**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective:
To learn the different techniques used for flood forecasting and flood hazard management

Course Content:

Unit	Content	Hours
I	Definition of flood, Annual and inter annual variations of flood, Indian Monsoons and flood. Theory of flash flood events, Estimation of Flood Peak, Design Flood Estimation, Guidelines for the Estimation of Design Flood for the Design of Cross Drainage Works, PMF	**10**
II	Flood Forecasting: Travel time, gage and discharge forecasting. Flood Management and Remote Sensing Flood plain mapping and zoning, use of satellite imageries and topo-sheets for DEM generation for flood plain zone mapping Numerical models of flood propagation. HEC-RAS Model and its use in Flood Forecasting, Application of HEC-RAS model for River Restoration	**15**
III	Flood analysis, Flood routing in channels and reservoirs: Muskingum Method of Channel Routing, Modified Pul's Method of Reservoir Routing, Urban flooding and Management, Real-time flood warning and flood forecasting.	**10**
IV	Flood Control Measures: Structural Measures, Non- Structural Measures, Flood Control Economics: Assessment of Flood Protection Costs and Benefits	**10**

Recommended Books/References

1. M.C. Anderson, T.P. Burt, Manual on flood forecasting, New Delhi, 1985.
2. Central Water Commission, Hydrological forecasting, John Willy and Sons, 1989.
3. WMO, Automatic collection and transmission of hydrological observations, Operational Hydrology report no. 2, Geneva Switzerland, 1973.
4. K. Subramanian, Engineering Hydrology; TMH Publication, 2017.

Course Outcomes: The students will learn:

- The essential elements of Flood analysis and flood control measures
- To know about Flood routing and use of software HEC-RAS

Course Code	**:**	**DCE08420**
Course Title	**:**	**Modeling, Analysis and Simulation**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: The objective of this course is to familiarize the prospective engineers with techniques in modelling and simulation. The course shall give a comprehensive and state-of-the-art treatment of all the important aspects of a simulation study, including modeling, simulation software, model verification and validation, input modeling, random number generators, generating random variates and processes, statistical design and analysis of simulation experiments.

Course Content:

Unit	Content	Hours
I	Taxonomy of model types, steps in model building, Simulation, Algorithms and Heuristics, Simulation languages. Relationships via physical laws, Relationships via Curve fitting, Parameter estimation problems, State transition models. Modeling in Water Resources, Types of Models, Mathematical models, Systems Concept, Practical Models	**5**
II	Physical Modeling, Concepts, scale factor, practical considerations, model study. Digital Elevation Models: Creation of digital elevation models, Visualization, Mapping of water and environmental features, Watersheds, streams and aquifers delineation,	**10**
III	Neighborhood and distances, Cluster analysis, Individual and group preference patterns. Graphical models and matrix models, Input-Output type models, Decomposition of large systems, Routing problems. Block diagram representation, State space models, Stability, System Control.	**15**
IV	Discrete and continuous growths, Limits to growth, Competition among species, Growth process and integral equations, Discrete event approach, Population planning. Monte Carlo methods, Stochastic simulation, System identification, Inverse problems, Virtual reality.	**15**

Recommended Books/References

1. Lillesand, T.M. and Kieffer R.W., Remote Sensing and Image Interpretation. John Wiley and Sons, Inc., U.S.A, 2000.
2. Burrough, P.A and McDonnell R.A., Principles of Geographic Information Systems. Oxford Press, U.K, 1998.
3. Sankhua R N, Practical GIS in WR, Pune Vidyarthi Griha Prakashan, 2012

Course Outcomes: Students should be able to apply the GIS and other tool to analysis for planning of water resources systems and minor levels.

Course Code	**:**	**DCE08418**
Course Title	**:**	**Transportation Economics**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: The main objective of this course is to give broad insight into the different facets of transportation systems, while providing a solid introduction to transportation demand and cost analyses. Covers the key principles governing transportation planning.

Course Content:

Unit	Content	Hours
I	Overview of Transportation Economics; Transportation Investments and economic Development.	**10**
II	Basics of Engineering economics, marginal analysis, opportunity cost, shadow price, money value of time, discounted cash flow, Page 2 NPV, ROR, benefit-cost analysis.	**15**
III	Road User Costs; Public transportation economics; Social Cost of Transportation; Cost of congestion, pollution, traffic accidents.	**15**
IV	Taxation, regulations, financing Transport Systems; Legal framework for transportation sector, case studies.	**5**

Recommended Books/References

1. R. Neufville, Applied Systems Analysis: Engineering Planning and Technology Management, Mcgraw-Hill International, 1990
2. D. W. Pearce, R.K. Turner, Economics of Natural Resources and the environment,The John Hopkins University Press,USA, 1990
3. E. Quinet, R. Vickerman, Principles of Transport Economics, Edward Elgar Publishing, 2004
4. C. Nash, B. Matthews, Measuring the marginal Social Cost of transport, Research in transportation Economics, vol.14, Elsevier, 2005.
5. K.A. Small, Urban Transportation economics, Harwood Academic Publishers, 1992.
6. J. D. Sergio, Transport Economic Theory, Elsevier, 2007.

Course Outcomes: The students will learn:

- Critically assess transportation policies and regulations from an economic standpoint.
- Grasp the economic implications of different financing options and investment decisions in transportation.
- Comprehend the spatial dimensions of transportation economics and its role in regional development.

- Consider environmental factors in transportation decision-making and assess sustainable alternatives.

Course Code	**:**	**DCE08420**
Course Title	**:**	**Pavement Analysis and Design**
Number of Credits	**:**	**3 (L:2 ,T:1, P:0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: The objective of this course is to taught students about the analysis of road pavement and teach them the design of both rigid and flexible pavement as per IRC.

Course Content:

Unit	Content	Hours
I	Types of Pavements :Factors affecting design of pavements, wheel loads, ESWL Concept, tyre pressure, contact pressure, Material characteristics, Environmental and other factors	**10**
II	Stresses in flexible pavement: layered systems concept, one layer system, Business Two layer system, Burmister Theory for Pavement Design. Stresses in rigid pavements: relative stiffness of slab, modulus of sub-grade reaction, Westergaard's stresses due to warping, stresses due to loads, stresses due to friction.	**15**
III	Pavement design: CBR Method of Flexible Pavement Design- IRC method of flexible pavement design, AASHTO Method of Flexible Pavement design, IRC:58-2002, IRC:58-2015.	**10**
IV	IRC method of Rigid pavement design: Importance of Joints in Rigid Pavements, Types of Joints, Use of Tie Bars and Dowell Bars. AASHTO method of Rigid pavement design.	**10**

Recommended Books/References

1. Y. H. Huang, Pavement Analysis and Design, Pearson Prentice Hall, 2004.
2. Yoder and Witzech, Pavement Design, McGraw-Hill, 1982.
3. Sharma and Sharma, Principles and Practice of Highway Engg., Asia Publishing House, 1980.
4. Teng, Functional Designing of Pavements, McGraw- Hill, 1980.

Course Outcomes: The students will be able to:

- Explain about pavement material characterization.
- Outline pavement design principles and traffic consideration.
- Discuss about analysis and design of flexible pavement.
- Discuss about analysis and design of concrete pavement.

Course Code	**:**	**DCE08422**
Course Title	**:**	**Irrigation and Drainage Engineering lab**
Number of Credits	**:**	**1 (L: 0, T: 0, P: 2)**
Course Category	**:**	**Lab Course**

Course Objective: to determine the soil properties, infiltration rate, soil moisture, wilting point and irrigation water measurement.

Course Content:

Experiment No	Title
1	Measurement of soil moisture: moisture content, density, mass wetness, volume wetness
2	Measurement of infiltration characteristics by using double ring infiltrometer: Basic infiltration rate, accumulated infiltration rate, infiltration velocity, infiltration rate
3	Measurement of soil moisture tension: soil moisture, matric potential, pressure potential, gravitational potential
4	Determination of bulk density, field capacity and wilting point
5	Measurement of irrigation water using weir, flume and orifice

Recommended Books/References

1. Das and Saikia, Irrigation and Hydropower Engineering, PHI Learning Pvt Ltd.
2. K.N Sharma, Water Power Engineering, Vikas Publishing House
3. A. Michael, Irrigation Theory and Practice-2Nd Edn, Vikas publishing house, 2009.
4. S. K. Garg, Irrigation Engineering and Hydraulic Structures: Water Resources Engineering (Vol. II). Khanna Publisher, 2020.
5. V.V.N. Murty, and T. Kei, Land and water development for agriculture in the Asia-Pacific region. Science Publishers, Inc., 1996.

Course Outcomes: at the successful completion the course, the students will learn:

- To determine the basic properties of soil.
- To determine the infiltration rate
- Concept of water constants, soil water potentials etc.

Course Code	**:**	**DCE08424**
Course Title	**:**	**Modelling in Water Resources Engineering Lab**
Number of Credits	**:**	**1 (L: 0, T: 0, P: 2)**
Course Category	**:**	**Lab Course**

Course Objective: The objective of this course is to familiarize prospective engineers with techniques in water resources modelling. It aims to equip the students to deal with advanced level of applications that would be essential for their disciplines.

Course Content:

Experiment No	Title
1	Digital database creation: point, line and polygon feature
2	Data processing: dissolving and merging, clipping, intersection, union, buffering techniques;
3	Spatial and attribute query; Spatial analysis and modeling; Digital terrain modeling
4	Geometric Rectification, Spatial Enhancements;
5	Spectral Enhancements; Unsupervised Classification; Supervised Classification; Accuracy Assessment

Recommended Books/References

1. T.M. Lillesand, R.W. Kieffer, Remote Sensing and Image Interpretation, John Wiley and Sons, Inc., U.S.A, 2000.
2. P.A. Burrough, R.A. McDonnell, Principles of Geographic Information Systems, Oxford Press, U.K, 1998.
3. R. N. Sankhua, Practical GIS in WR, Pune Vidyarthi Griha Prakashan, 2012

Course Outcomes:

- Ability to know the application of various hydrological techniques in water resources engineering.
- Functions of hydrological tools of a complex variable that are used in various techniques dealing with engineering problems.

Ninth Semester

Sl. No	Category	Course Title	Periods Per Week			Credit	Subject Code
			L	T	P		
1.	PEC	**Elective – IX**	**2**	**1**	**0**	**3**	
		Environmental Impact Assessment	2	1	0	3	DCE08501
		Railways and Waterways	2	1	0	3	DCE08503
		Hydropower Engineering	2	1	0	3	DCE08505
		Sediment Transportation	2	1	0	3	DCE08507
		Road safety	3	0	0	3	DCE08509
2.	PEC	**Elective – X**	**2**	**1**	**0**	**3**	
		Reinforced Soil Structures	2	1	0	3	DCE08511
		Water Policy and Auditing	2	1	0	3	DCE08513
		Integrated River Basin Planning and Management	2	1	0	3	DCE08515
		GIS application is Transportation Engineering	3	0	0	3	DCE08517
3.	PCC	Research Methodology and IPR	2	0	0	2	DCE01501
4.	PROJ	Dissertation I				12	DCE05501
			Total Credits			20	

Course Code	**:**	**DCE08501**
Course Title	**:**	**Environmental Impact Assessment**
Number of Credits	**:**	**3 (L: 3, T: 0, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: The course aims to introduce the concepts, procedures and methodology of Environmental Impact Assessment (EIA), to develop a critical awareness of factors which affect the use of EIA as part of project management in the legislative and regulatory context of recently- industrialized or less - industrialized countries, and to expose the students to the need for environmental impact assessments and how to prepare the various documents required by State and Central Government Regulations.

Course Content:

Unit	Content	Hours
I	Introduction of environmental impact assessment: Definition of Environmental Impact Assessment, Need for environmental impact assessment (EIA); Requirements and levels of EIA. EIA and Sustainable Development.	**15**
II	Environmental Impact Assessment Process: Environmental Assessments, Environmental Impact Statement, Basic Steps in the Process: Alternative, Screening, Scoping, Impact analysis, Mitigation, Follow up, Public Participation and EIA.	**15**
III	Impact prediction methodologies and mitigation measures: Air, Surface and ground water, Noise, Cultural and socioeconomic. EIA Monitoring and Auditing, Environmental Clearance: Guidelines, acts and legislations, codes and country practices.	**15**

Recommended Books/References

1. J. Glasson, R. Therivel, A. Chadwi, Introduction to Environmental Impact Assessment - Principles and procedures, process, practice and prospects, UCL Press, 3rd Edition, 2005.
2. P. Morris, R. Therivel, Methods of Environmental Impact Assessment, Routledge, 3rd Edition, 2009.
3. B. Carroll, T. Turpin, Environmental Impact assessment handbook - A practical guide for planners, developers and communities, Thomas Telford, 2nd Edition, 2009.
4. J. Petts, Handbook of Environmental Impact Assessment - Vol 1 (Environmental Impact Assessment: Process, Methods and Potential, Wiley, 2005.
5. P. Wathern, Environmental Impact Assessment: Theory and Practice, Routledge Publishers,1990.
6. B. Marriott, Environmental Impact Assessment: A Practical Guide, McGraw-Hill Publication, 1997.

7. A. K. Shrivastava, Nicola Baxter, Jacob Grimm, Environmental Impact Assessment, APH Publishers, 2003.
8. Y. Anjaneyulu, Valli Manickam, Environmental Impact Assessment Methodologies, CRC Press, 2011.
9. J. Glasson, Riki Therivel, Andrew Chadwick, Introduction to Environmental Impact Assessment, Oxford Brookes University, 2012.

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

- Connect perspectives from ecological and social sciences to understand complex socio-ecological issues in developmental projects at multiple spatial scales
- Analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence during Project Scoping for EIA
- Communicate research findings effectively through written, media materials and colloquia in Public hearing for project based EIA
- Assess social and environmental impacts of different policies, plans, and programs (PPP) for strategic environmental assessment (SEA)

Course Code	**:**	**DCE08503**
Course Title	**:**	**Railways and Waterways**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: To learn the construction procedures of railways and waterways

Course Content:

Unit	Content	Hours
I	Introduction, Formations and Subgrade: Track Component: Formation width requirement and sub grade improvement; Cross sections of railway track.	**08**
II	Rails – Function, Composition and requirement of rail section Corrugated rails, Hogged rails, buckling of rails, Creep of rails, Wear on rails, Rail joints. Sleepers: Functions and requirements of sleepers, Classification of sleepers; Spacing of sleepers and sleeper density, Ballast: Functions and requirements of ballast, Types of ballast, Size and section of ballast	**10**
III	Gradients, Speed, Radius of curve, Super elevation, Maximum and Minimum super elevation, Equilibrium super elevation, Cant deficiency, Negative super elevation; Turnouts, Points and switches, Crossing number and angle of crossing, types of track junctions, Design of diamond crossing and cross-over	**10**
IV	Water transportation; Types of water transportation; Advantages and disadvantages, selection of site for harbours; Essential features of a good	**7**

	harbour – size, depth, turning basin, harbour entrances.	
V	Harbour works: Breakwaters – different types and their construction, Wharves, Piers, Jetties; Quays – Forces on quay walls, construction, Berthing Structures – Dolphins, Trestles, Moles, Moorings accessories, Apron, Transit sheds and Warehouses – essential features	**10**

Recommended Books/References

1. N. K. Vaswani, Railway Engineering, Roorkee Publishing House, Roorkee, 1971
2. S.C. Rangwalla, Railway Engineering, Charotar Publishing House (P) Ltd, 2017
3. R. Srinivasan, Harbour, Dock & Tunnel Engineering, Charotar Publishing House (P) Ltd, 2016
4. H. P. Oza, Dock and Harbour Engineering, Charotar Publishing House (P) Ltd, 2016

Course Outcomes: The students will learn:

- The essential elements of railways as well as waterways as well as construction procedures involved.
- The construction procedures involved in construction of railways as well as waterways

Course Code	**:**	**DCE08505**
Course Title	**:**	**Hydro Power Engineering**
Number of Credits	**:**	**3 (L:2, T:1, P:0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: To introduce the fundamentals of hydropower, transient analysis, and various components of a hydropower plant.

Course Content:

Unit	Content	Hours
I	Water Power: Introduction, sources of energy, role of hydropower in a power system, Estimation of Water Power Potential: Flow duration curves of gauge and ungauged streams, load curve, load factor, capacity factor, utilization factor, diversity factor, load duration curve, firm power, secondary power, prediction of load.	**10**
II	Types of Hydro-power Plants: Run of river plants, general arrangement of run of river plants, valley dam plants, diversion canal plants, high head diversion plants, storage, and pondage, pumped storage power plants, Penstocks: General classification, design criteria, economic diameter, losses, anchor blocks, valves, bends and manifolds. Trash racks: Types, losses, design, stability. Intakes: Types, losses, air entrainment, anti-vortex device, air vent, power channels, forebay, and tunnel.	**15**

III	Turbines: Introduction, types of turbines, hydraulics of turbines, velocity triangles, draft tubes, cavitation in turbines, turbine model testing, characteristics of turbines.	**15**
IV	Water Hammer and Surges: Introduction, water hammer, transients caused by turbine, load acceptance and rejection, resonance in penstocks, surge tanks, channel surges.	**5**

Recommended Books/References

1. H. K. Barrows, Water Power Engineering, Tata McGraw Hill Publishing Company Ltd., 1943.
2. M. H. Choudhary, Applied Hydraulic Transients, Springer New York, 2013.
3. M. M. Dandekar, and K.N. Sharma, Water Power Engineering, Vikas Publishing House Pvt. Ltd., 2013.
4. M. M. Deshmukh, Water Power Engineering, Dhanpat Rai & Sons, 1978.
5. P. S. Nigam, Hydro Electric Engineering, Nem Chand & Bros., 2001.
6. R. S. Varshney, Hydro Power Structures, Nem Chand & Bros., 2001.

Course Outcomes: Upon successful completion of this course, the students will be able to:

- Able to prepare a load curve and calculate firm power and secondary power from power duration curve.
- Understand types and principal components of hydropower plants, types and working of turbines, water hammer, and surges and their effect on the operation of hydropower units, determine the economical diameter of penstocks and, estimate energy generation.
- Understand the layout and components of the underground powerhouse and surface powerhouse.

Course Code	**:**	**DCE08507**
Course Title	**:**	**Sediment Transportation**
Number of Credits	**:**	**3 (L:2, T:1, P:0)**
Course Category	**:**	**Professional Elective Course**

Course Objective:

To impart knowledge of properties of sediments, methods of sediment transportation estimation and reservoir sedimentation.

Course Content:

Unit	Content	Hours
I	Definition and properties of sediment particles, bulk properties of sediments, cohesive and non-cohesive sediments.	**10**
II	Sediment transport processes, Incipient motion, Shields diagram.	**15**
III	Resistance to flow and bed forms with rigid boundary and movable	**15**

	boundary, factors affecting bed forms.	
IV	Sediment load, types, transport processes and estimation, reservoir sedimentation, estimation of sediment yield, methods to control sediment inflow to reservoir, and erosion control.	**5**

Recommended Books/References

1. C., T. Yang. Sediment Transport: Theory and Practice, McGraw-Hill, USA, 1996.
2. R. J. Garde, K. G. R. Raju, Mechanics of sediment transportation and Alluvial streams, New Age International Publishers, 1985.

Course Outcomes: Upon successful completion of this course, the students will be able to gain knowledge of sediment transportation theories and evolution, and methods to reduce the bed load as well as reservoir sedimentation.

Course Code	**:**	**DCE08509**
Course Title	**:**	**Road Safety**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: To learn the procedures road safety and its evaluation techniques

Course Content:

Unit	Content	Hours
I	Introduction to safety: Road accidents, Trends, Causes, Collision and Condition diagrams, Highway safety, Human factors, Vehicle factors Road Safety Management System: Multi causal dynamic systems approach to safety, Crash vs accident, Road safety improvement strategies, Elements of a road safety plan, Safety Data Needs.	**08**
II	Statistical Interpretation and Analysis of Crash Data: Before-after methods in crash analysis, advanced statistical methods. Black Spot Identification & Investigations, Case Studies.	**10**
III	Road Safety Audits: Key elements of a road safety audit, Road Safety Audits & Investigations, Crash investigation and analysis, Describe methods for identifying hazardous road locations, Case Studies	**10**
IV	Crash Reconstruction: Describe the basic information that can be obtained from the roadway surface, Understand basic physics related to crash reconstruction, speed for various skid, friction, drag, and acceleration scenarios, variables involved in jump and flip crashes, variables involved in pedestrian crashes.	**7**
V	Mitigation Measures: Accident prevention by better planning, Accident	**10**

	prevention by better design of roads, Crash Countermeasures, Highway operation and accident control measures, Highway Safety Measures during construction, Highway geometry and safety.	

Recommended Books/References

1. S. K. Khanna, C. E. G. Justo, Highway Engineering, Khanna Publisher, 2011
2. L.R. Kadyali, Highway Engineering, Khanna Publisher, 2018
3. S. P. Bindra, A Course in Highway Engineering, Dhanpat Rai and Sons, New Delhi, 2008
4. Saxena and Arora, A Text Book of Railway Engineering, Dhanpat Rai and Sons, New Delhi, 2010
5. N. K. Vaswani, Railway Engineering, Dhanpat Rai and Sons, New Delhi, 2010
6. R. Srinivasan, Harbour, Dock & Tunnel Engineering, Charotar Publications, Ananda, 2016
7. H. P. Oza, Dock and Harbour Engineering, Charotar Publications, Ananda, 2013

Course Outcomes: The students will learn:

- The essential elements of road safety measures and its evaluation methods followed.
- To learn how to prevent accidents by better planning roads.

Course Code	**:**	**DCE08511**
Course Title	**:**	**Reinforced Soil Structures**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: The objective of this course is to teach students about the different reinforcement, their function and application and about reinforced soil structure design for different civil engineering infrastructure.

Course Content:

Unit	Content	Hours
I	Historical background; Principles, concepts and mechanism of reinforced earth; Design consideration for reinforced earth and reinforced soil structures	**10**
II	Geosynthetics-their composition, manufacture, properties, functions, testing and applications in reinforced earth structures	**10**
III	Design of reinforced soil structures like retaining walls, embankments, foundation bed	**15**
IV	Designing for Separation, Filtration, Drainage and Roadway Applications; Designing for Landfill Liners and Barrier Applications; Case histories of applications	**10**

Recommended Books/References

1. C.R.I. Clayton, J. Milititsky, R.I. Woods, Earth Pressure and Earth Retaining Structures, Blackie Academic & Professional, 1993.
2. T. Ingold, Reinforced Earth, Thomas Telford Ltd., 1982.
3. C.J.F.P Jones, Earth Reinforcement and Soil Structures, Butterworth, 1985.
4. R.M. Koerner, Designing with Geosynthetics, Prentice Hall, 1993

Course Outcomes: The students will be able to:

- Know about the different reinforcement and their working mechanism.
- Design reinforced soil structures like pavement, retaining structures, and embankment.
- Tackle project on reinforced soil.

Course Code	**:**	**DCE08513**
Course Title	**:**	**Water Policy and Auditing**
Number of Credits	**:**	**3 (L: 3, T: 0, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: The main objective of this course is to increase knowledge about water law, polices, and auditing. After completing this course, participants will understand how policies are developed and what are stages of development of policies. Further, students will be taught how water auditing can improve decision making around water management and water governance.

Course Content:

Unit	Content	Hours
I	Water Law in India; An overview of water law in India - evolution of water law, key features of water law, evolving water law and policy, water sector reforms, water law reforms, the mosaic of water law.	**15**
II	National and International Framework for Water Law; Basic structure of water law - International water law documents directly relevant in India, human right to water. Basic topics of water law, including the fundamental right to water and the basic constitutional scheme for determining the jurisdiction over water, from the local to the national level. Basic principles and concepts of water law.	**15**
III	Government policies documents for drinking water in general and rural water supply. Policies for urban drinking water supply and irrigation, and details of existing legislation as well as policy documents proposing a new framework for water supply, to include a focus on cost recovery and the involvement of the private sector.	**15**

Recommended Books/References

1. P. Cullet and S. Koonan, Water Law in India- An Introduction to Legal Instruments, Oxford Scholarship, 2011.
2. J. Sturman, Goen Ho, Kuruvilla Mathew, Water Auditing and Water Conservation, IWA Publishing, 2004.
3. S. Bogdanovic, Water policy and law in the Mediterranean – an evolving nexus, Faculty of Law of the university business academy in Novi Sad, 2011.

Course Outcomes: The students will learn:

- Development of policies, stages of development
- How policies affect the water governance
- Various National Water Policies and a comparative study.

Course Code	**:**	**DCE08515**
Course Title	**:**	**Integrated River Basin Planning and Management**
Number of Credits	**:**	**3 (L:2, T:1, P:0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: To impart the knowledge of fundamentals of integrated planning and management, issues, concerns and implementation.

Course Content:

Unit	Content	Hours
I	Introduction, concerns, scale issues, river basin inventory, need, characteristics, functions and principles of integrated planning and management.	**10**
II	Decision making in IRBPM, levels of decision making, characterizing individual decision making, role of physio-social variables in individual decision making.	**15**
III	Protocols for an adaptive IRBPM, components of IRBPM plan, Information system for IRBPM and problems, types of information systems, stakeholder driven IRBPM information exchange.	**15**
IV	Social dimensions, institutional arrangements and performance measurement for IRBPM, choosing the best plan and its implementation.	**5**

Recommended Books/References

1. B. P. Hooper, Integrated River Basin Governance- Learning from International Experience, IWA publishing, 2005.
2. B.P. Hooper, C. Lant, Integrated, Adaptive Watershed Management, Oxford University Press, 2007

3. K. Hanna, D. S. Slocombe (Eds.), Fostering Integration: Concepts and Practice in Resource and Environmental Management, Oxford University Press, Oxford and Toronto, 2007.
4. I. W. Heathcote, Integrated Watershed Management: Principles and Practice, John Wiley and Sons, 1998.

Course Outcomes: Upon successful completion of the course, the students will be able to:

- Understand the appraisal and use of water management modelling concepts and integrated water management principles.
- Formulate and analyze a management problem in a given water management system.
- Understand the implementation of catchment conservation practices.

Course Code	**:**	**DCE08517**
Course Title	**:**	**GIS application in Transportation Engineering**
Number of Credits	**:**	**3 (L: 2, T: 1, P: 0)**
Course Category	**:**	**Professional Elective Course**

Course Objective: Familiarize students with the fundamental concepts, principles, and components of Geographic Information Systems. Develop a strong foundation in transportation engineering principles, including traffic flow, transportation modes, and infrastructure components. techniques for acquiring, managing, and processing spatial data relevant to transportation networks, such as road networks, traffic counts, and transportation-related attributes.

Course Content:

Unit	Content	Hours
I	Definition, Components of Remote Sensing, Energy, Sensor, Interacting Body, Active and Passive Remote Sensing, Platforms, Aerial and Space Platforms, Balloons, Helicopters, Aircraft and Satellites, Electromagnetic Radiation, EMR Spectrum.	**10**
II	Basic Concept and Components, Hardware, Software, Data Spatial and non-spatial, Geo-referencing, Map Projection, Types of Projection, Simple Analysis, Data retrieval and querying Database, Raster and Vector data structures, Data storage, run length, Chain and Block coding, Vector data storage, Topology	**15**
III	GIS Modeling - Raster and Vector data analysis– Buffering and overlaying techniques – Network Analysis – Spatial Analysis.Highway and Railway Alignment, location of transport Terminals and roadside facilities, bus stops – Route optimization – Bus route rationalization – Accident analysis – Applications of Aerial Photography and Satellite Imageries.	**15**
IV	GIS as an integration technology – Integration of GIS, GPS and Remote Sensing Techniques – Advanced Traveller Information System (ATIS) –	**5**

	Automatic Vehicle Location System (AVLS).LIDAR and Drone based surveys.	

Recommended Books/References

1. Reddy, Remote Sensing and Image Interpretation, John Wiley and Sons Inc. New York, 1987.
2. M.G. Srinivas, Remote Sensing Applications, Narosa Publishing House, 2001
3. P.A. Burrough, Principles of GIS for Land Resources Assessment, Oxford Publication, 1994.
4. J. Star and J. Ester, Geographical Information System – An Introduction, Prentice Hall Inc.,Englewood Cliff, 1990.
5. D.F. Marble, H.W. Calkins, Penquest, Basic Readings in GIS, Speed System Ltd., New York, 1984.
6. S.K. Ghosh, A.M Chandra, Remote Sensing and GIS, Narosa Publications House, 2015
7. T. J. Claude, Geographical Information Systems in Transportation Research, Pergamon, 2000.
8. D. O‟sullivan, Geographic Information Analysis, John Wiley & Sons, 2003.
9. P. A. Longley, M. J. Barnsley , D. Jean-Paul, Remote Sensing and Urban Analysis, Taylor & Francis, 2001.

Course Outcomes: The students will learn to:

- Understand the basic principles of Geographic Information Systems (GIS), including spatial data representation, coordinate systems, and map projections.
- Learn how to analyze transportation networks, including roadways, highways, and public transit systems, using GIS tools.
- Acquire skills in collecting, processing, and managing spatial data related to transportation infrastructure, traffic volumes, and travel patterns.
- Explore various spatial analysis techniques to identify traffic congestion, assess accessibility, and analyze transportation demand.

Course Code	**:**	**DCE01501**
Course Title	**:**	**Research Methodology and IPR**
Number of Credits	**:**	**2 (L: 2, T: 0, P: 0)**
Course Category	**:**	**Program Core Course**

Course Objective: To impart knowledge on formulation of research problem, research methodology, ethics involved in doing research and importance of IPR protection

Course Content:

Unit	Content	Hours
I	Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Problem Identification & Formulation: Research Question, Investigation Question, Measurement Issues, Hypothesis: Qualities of a good Hypothesis, Null Hypothesis & Alternative, Hypothesis Testing – Logic & Importance.	**5**
II	Research Design: Features of a good research design, Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. Qualitative and Quantitative Research: Qualitative research, Quantitative research, Model evaluation guidelines.	**5**
V	Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Water Resources/Transportation Engineering, Impact factor of Journals, Ethical issues related to publishing, Plagiarism and Self-Plagiarism, Reference Management Software like Mendeley.	**5**
VI	Understanding basics of IPR, Types of patent application and claim construction, Patent search, Procedure and managements of patents, Assessment of new idea, its patentability and patent filing procedure	**5**

Recommended Books/References

1. C. Douglas, Montgomery, Design and Analysis of Experiments, Willey, India, 2007.
2. C. R. Kothari, Research Methodology- Methods and Technique, New Age International, New Delhi, 2004
3. C. Douglas, G. C. Runger, Applied Statistics and Probability for Engineers, Willey, India, 2007
4. S. Melville and Wayne Goddard, Research Methodology: An introduction for Science & Engineering Students, Juta and Co. Limited, 1996
5. R. Kumar, Research Methodology: A Step by Step Guide for Beginners, Pearson India, 2nd Edition, 2005.
6. D. J. Halbert, Resisting Intellectual Property, Taylor & Francis Ltd, 2007.

Course Outcomes: At the end of this course, students will be able to

- Understand research problem formulation & Analyze research related information and Follow research ethics
- Correlate the results of any research article with other published results. Write a review article in the field of engineering.
- Appreciate the importance of IPR and protect their intellectual property. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits

Minor Specialization Courses

MSH 1	Subsurface Investigation and Instrumentation	3	1	0	4	DCE02202
MSH 2	Finite Element Methods	3	1	0	4	DCE02204
MSH 3	Hill Road	3	1	0	4	DCE02301
MSH 4	Climate Change Impact on Water Resources	3	1	0	4	DCE02303
MSH 5	Evaluation and Strengthening of Pavement	3	1	0	4	DCE02302
MSH 6	Geomatics in Water Resources Planning and Management	3	1	0	4	DCE02304
MSH 7	Highway Construction Practice	3	1	0	4	DCE02401
MSH 8	Statistics for Engineers	3	1	0	4	DCE02403
MSH 9	Solute Transport Modeling	3	1	0	4	DCE02402
MSH 10	Road Safety	3	1	0	4	DCE02404

Course Code	**:**	**DCE02202**
Course Title	**:**	**Subsurface Investigation and Instrumentation**
Number of Credits	**:**	**4 (L:3, T:1, P:0)**
Course Category	**:**	**Minor Specialization Course**

Course Objective: To impart the knowledge to understand the importance of site investigation, planning of sub soil investigation, and interpretation of investigated data to design a suitable foundation system.

Course Content:

Unit	Content	Hours
I	Scope and objectives, planning of exploration program - methods of exploration - exploration for preliminary and detailed design, spacing and depth of bores, data presentation.	**8**
II	Geophysical exploration and interpretation - reflection, refraction and resistivity: Spectral analysis of surface waves (SASW), Multichannel Analysis of Surface Waves (MASW), cross hole – up hole - down hole methods.	**12**
III	Methods of boring and drilling, non-displacement and displacement methods, drilling in difficult subsoil conditions, offshore drilling, limitations of various drilling techniques, stabilization of boreholes, bore logs.	**15**
IV	Sampling Techniques – quality of samples – factors influencing sample quality - disturbed and undisturbed soil sampling advanced sampling techniques, offshore sampling, shallow penetration samplers, preservation and handling of samples.	**15**
V	Instrumentation in soil engineering, functional components of data acquisition system - strain gauges, resistance and inductance type, load cells, earth pressure cells, settlement and heave gauges, pore pressure measurements - slope indicators, sensing units, case studies.	**10**

Recommended Books/References

1. R. I. Clayton, M. C. Matthews and N. E. Simons, Site Investigation, Second Edition Halsted Press, 1982.
2. A. Singh, and G.R. Chowdhary, Soil Engineering in Theory and Practice, Volume-2, CBS Publishers and Distributors, New Delhi, 2006.
3. H.Y. Fang, Foundation Engineering Hand Book, Springer, US, 2013.
4. J. Dunnicliff, G.E. Green, Geotechnical Instrumentation for Monitoring Field Performance, John Wiley, 1993.

5. J.E. Bowles, Foundation Analysis and Design, Fifth Edition, The McGraw-Hill companies, Inc., New York, 1995.
6. R.E. Hunt, Geotechnical Engineering Investigation Manual, McGraw Hill,1984.
7. R.J. Nair, and P.M. Wood, Pressuremeter Testing Methods and Interpretation, Butter-worths, 1987.
8. R.N. Dey, Geotechnical and Foundation Engineering, Design and Construction, McGraw- Hill, 1999.
9. T.H. Hanna, Field Instrumentation in Geotechnical Engineering, Trans Tech., 1985.

Course Outcomes: Upon successful completion of this course, the students will be able to:

- Plan the subsurface investigation program for a given project for real time Soil Mechanics and Foundation Engineering problems.
- Apply the knowledge of different methods of exploration to select appropriate methods of boring for investigating real field conditions.
- Apply the knowledge of different sampling techniques to collect, store and transport soil samples from onshore and offshore to meet specified needs and also to characterize the soil.
- Carry out appropriate field tests to arrive at required soil parameters for the design of geotechnical structures considering all the influential parameters, and monitor the performance to ensure their stability during their lifetime.

Course Code	**:**	**DCE02204**
Course Title	**:**	**Finite Element Methods**
Number of Credits	**:**	**4 (L: 3, T: 1, P: 0)**
Course Category	**:**	**Minor Specialization Course**

Course Objective: The course intends to present numerical techniques for solving governing equations in mechanical systems. It encompasses a range of challenges, including 1D and 2D structural, thermal, and fluid problems. Additionally, it covers beams and frames issues. The curriculum also introduces concepts related to non-linear and dynamic problems.

Course Content:

Unit	Content	Hours
I	The basic concepts in FEM: - Introduction: Finite difference method (FDM), finite element method (FEM), advantages of FEM over FDM, One-dimensional problems, Axial deformations of a bar, Strong and weak forms, Essential vs. natural boundary conditions, Variational formulations (Principle of virtual work, principle of minimum potential energy), Approximations (Rayleigh-Ritz & Galerkin). Weighted Residual Methods: Collocation, sub-domain, Galerkin's and least square, Finite element basis functions (linear and quadratic elements), Assembly, Problems with smooth and non-smooth solutions, Convergence.	**15**

II	Bars, Trusses and Beams: Relevance of finite element analysis in design, Modelling and discretization, Shape functions, elements and Degrees-of-Freedom, Strain–displacement relation, Local and Global equations, Applications of FEA. ISO-Sub-Super parametric formulations. 1D Elements Structural Problems: Linear and Quadratic elements, Elimination and Penalty Approach, Properties of global stiffness matrix. Formulation of Truss element, Plane truss. Beam: Element formulation, plane frames, various loading and boundary conditions.	**15**
III	Two-Dimensional Problems: Two-Dimensional Problems of elasticity, Plain stress problem, plain strain problem, Stiffness matrix for constant strain triangle, equivalent nodal force vector, linear strain triangle, four noded rectangular element.	**15**
IV	Shape function: Shape function for one-dimensional element-cartesian coordinates, natural coordinates, Shape function for two-dimensional element-rectangular and triangular element, elements in three dimension – rectangular prism, tetrahedral elements.	**15**

Recommended Books/References

1. E. B. Becker, G. F. Carey and J. T. Oden, Finite Elements: An Introduction, Volume I, Prentice Hall, 1981.
2. R D Cook, D S Malkus, M E Plesha, and R J Witt, Concepts and Applications of Finite Element Analysis, Wiley.
3. P. Seshu, Text book of Finite Element Analysis, PHI.
4. K. J. Bathe, Finite Element Procedures, PHI.
5. T. R. Chandrupatla and A. D. Belegunda. Introduction to Finite Elements in Engineering, PHI.
6. P. N. Godbole, Introduction to finite Element Method, I. K. International Publishing House Pvt. Ltd., 2013.

Course Outcomes: Students will be able to:

- Understand the concept of finite element method and develop algorithms for analysis of mechanical systems.
- Apply the knowledge of FEM for 1D stress analysis, modal analysis, heat transfer analysis and flow analysis.
- Formulate and solve problems of trusses, beams and frames, students will also be able to use commercial packages for complex problems

Course Code	**:**	**DCE02301**
Course Title	**:**	**Hill Road**
Number of Credits	**:**	**4(L: 3, T: 1, P: 0)**
Course Category	**:**	**Minor Specialization Course**

Course Objective: The objective of this course is to make students to gain knowledge on designing roads in hilly and rural areas.

Course Content:

Unit	Content	Hours
I	Importance of Hill roads, Classification, Terrain classification, Planning and Alignment: Data base for master plan, Concept of network planning, Road alignment, Governing factors for route selection, Factors controlling alignment, Special considerations while aligning hill roads, Surveys, Detailed project report, Environmental issues.	**10**
II	Geometric Design: Introduction, Design speed, Basic principles of geometric design, Elements, Horizontal and vertical alignment, Alignment compatibility, Lateral and vertical clearances. Road Materials: General, Soil and material surveys, Soil as road construction material, Stabilized soils, Aggregates for pavement courses, New materials and stabilizers, Materials for bituminous construction, Materials for semi-rigid and rigid pavement, Materials for special pavements Climatic suitability of concrete materials.	**15**
III	Pavement Design: Introduction, Design parameters, Pavement components, Design of flexible pavement, Design of semi-rigid pavement, Design of rigid pavement, Design of special pavements, ,	**15**
IV	Drainage and Shoulders Specifications and Construction: General, Selection of construction materials and methodology, Earthwork, Sub-base, Base course, Bituminous constructions, Semi-rigid pavement construction, Concrete pavements,	**15**
V	Construction of special pavements, Equipment required for different operations	**5**

Recommended Books/References

1. IRC: SP 20-2002 "Rural Roads Manual".
2. IRC: SP 72-2007 "Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads".
3. IRC: SP 62-2004 "Guidelines for the Design and Construction of Cement Concret Pavements for Rural Roads".
4. IRC "Specifications for Rural Roads", MoRD, 2004.
5. CRRI "Various Reports on Use of Waste Materials".

Course Outcomes: The students will learn:

- About the hill road, its type, factors controlling route selection, alignments and survey.
- About the geometric design of hill road.
- About the design of different types of pavement of hill road.
- About the equipment used in hill road construction.

Course Code	**:**	**DCE02303**
Course Title	**:**	**Climate Change Impacts on Water Resources**
Number of Credits	**:**	**4 (L:3, T:1, P:0)**
Course Category	**:**	**Minor Specialization Course**

Course Objective: The course emphasizes on the history of earth's climate, climate change, climate change impacts and vulnerability. It also covers the significant influence of anthropogenic and developmental activities on global warming and climate change. Several climate change models are also introduced. The student gains the knowledge of climate change mitigative measures, emission trading and its monitoring.

Course Content:

Unit	Content	Hours
I	Introduction; Global warming aggravations, Earth's climate, climate change, drivers of climate change, Models for climate change, GCMs, RCMs, climate change scenarios; Sector models – water resources, Agricultural, forestry, energy, GHG prediction models	**15**
II	Climate change impacts; Impacts of climate change on water sector, agriculture sector, infrastructure and energy systems with case studies Vulnerability/adaptation: Need for vulnerability assessment; generic steps, approaches and tools of assessment; adaptation to climate change by various sectors Mitigation: Mitigation measures for climate change, CDM and case studies	**15**
III	Climate change and India; impacts, sectoral and regional vulnerability in India, Evaluation of model simulation over India;	**15**
IV	Emission trading; Evolution of emission trading and design features, trading mechanisms Cost-effective permit markets, the role of transaction costs, the role of technical change, Consequences of emission trading	**15**

Recommended Books/References

1. P.R. Shukla, etal., Climate Change and India: Vulnerability Assessment and Adaptation, Universities Press, 2004
2. K. Soyez, H. Grabl, Basic Facts, Evaluation and Technological Options, Springer Publications, 2008
3. H. T. Tietenberg, Emissions trading: principles and practice, REF Press book, 2006

4. N. D. Nevers, Air Pollution Control Engineering, McGraw Hill International Editions, Civil Engineering Series, McGraw Hill, 2000
5. K. Wark, C.F. Warner, W.T. Davis, Air Pollution – Its Origin and Control",Third Edition, Prentice Hall of India Publishers, 1997

Course Outcomes: On successful completion of the course the students will be able to, the students will learn:

- Earth's climate change, identifies the causes for climate change and describes the climate change models and their application.
- Impacts of climate change on various environmental compartments and stresses the need for vulnerability assessment and its approach.
- Indian scenario of climate change and its impact and reviews various impact predictive models.
- Emission trading, distinguishes different types of emission trading,understands the consequences of emission trading., Highlight the need for emission trading, Describe emission trading mechanisms

Course Code	**:**	**DCE02302**
Course Title	**:**	**Evaluation and Strengthening of Pavement**
Number of Credits	**:**	**4 (L:3,T:1, P:0)**
Course Category	**:**	**Minor Specialization Course**

Course Objective: To understand the process of pavement maintenance and rehabilitation techniques in logical sequence involving existing pavement structural evaluation and condition assessment, distress mechanisms, assignment of feasible alternatives and overall design.

Course Content:

Unit	Content	Hours
I	Introduction and definitions. Types of pavement distress.	**7**
II	Techniques for functional and structural evaluation of pavements, network and project survey and evaluation,	**15**
III	Pavement rehabilitation techniques, overlay design procedures, recycling of flexible and rigid pavements,	**15**
IV	Maintenance of paved and unpaved roads, pavement management systems.	**8**

Recommended Books/References

1. R. Robinson, and B. Thagesan, Road Engineering & Development, Spon Press, 2004.
2. Y. H. Huang, Pavement Analysis and Design, Pearson Prentice Hall, 2004.
3. Yoder and Witzech, Pavement Design, McGraw-Hill, 1982.
4. K. Atkinson, Highway Maintenance Handbook, Thomas Telford, 1997.
5. C. A. O. Flaherty, Highways – The Location, Design, Construction, & Maintenance of Pavements, Butterworth Heinemann, 2002.
6. Pavement Maintenance and Rehabilitation, National Highway Institute. Federal Highway Administration Report NHI-97-024, July 1998.

7. H. R. W. R. Hudson, J. P. Zaniewski, Modern Pavement Management, Krieger Publishing Company. Malabar, Florida, 1994

Course Outcomes: The students will learn:

- Classify fundamental types of distresses and their mechanisms in flexible and rigid pavements
- Define steps in condition surveys and data collection procedures for pavement maintenance and rehabilitation.
- Identify feasible maintenance and rehabilitation methods for flexible and rigid pavements
- Prepare design project based on feasible alternatives of maintenance and rehabilitation for flexible pavements

Course Code	**:**	**DCE02304**
Course Title	**:**	**Geomatics in Water Resources Planning and Management**
Number of Credits	**:**	**4 (L:3, T:1, P:0)**
Course Category	**:**	**Minor Specialization Course**

Course Objective: To impart the advanced knowledge of Geoinformatics tools and techniques to understand, monitor, mapping and management of Water Resources in various aspects.

Course Content:

Unit	Content	Hours
I	Physics of remote sensing: Electromagnetic spectrum, atmospheric effects, energy interaction with earth surface features.	**8**
II	Introduction, history of remote sensing, sensors, Photographic camera, scanners, earth resources satellites, active and passive microwave sensors	**10**
III	Image interpretation virtual and digital; Image rectification, image enhancement, image classification and accuracy assessment, use of image processing software.	**15**
IV	Geographical information system (GIS), definition, essential components of GIS, spatial data structure- raster and vector, spatial and non-spatial relationship, geographic database concepts and analysis, GIS packages and salient features	**12**
V	Use of remote sensing and GIS techniques in agriculture, vegetation cover mapping, crop acreage estimation and disease detection. Application of remote sensing and GIS for estimation of surface and groundwater irrigation potential, erosion hazard assessment, water quality assessment, flood inundation mapping and modeling; Drought monitoring; performance evaluation of irrigation commands; Selection of site for artificial recharge, agricultural management and planning.	**15**

Recommended Books/References

1. A. M. J. Meijerink, H. A. M. De Brouner, C. M. Mannerts, C. Valenguala, Introduction to the Use of Geographic Information System for Practical Hydrology, ITC Netherlands, 1994.
2. R.K. Farsworth, E.C. Bawetl, and M.S. Dhanju, Application of Remote Sensing to Hydrology including Groundwater, IHP, UNESCO, 1984.
3. R.N. Colwell (ed.), Manual of remote sensing, American Society of Photogrammetry and Remote sensing, Falls Church, VA, Sheridan Press, 1983.
4. T.M. Lillesand, Kieffer, Remote Sensing and Image Interpretation, Joh Wiley and Sons, 1987.

Course Outcomes: Upon successful completion of the course, the students will be able to:

- Identify appropriate methods for studying and/or solving the problems related to the hydrological cycle, estimation of hydrological parameters, and water budget with the help of RS and GIS.
- Apply geo-information science and earth observation technology to watershed management and prioritization with the help of hands-on training on geoinformatics tools and techniques in the application of water resources.

Course Code	**:**	**DCE02401**
Course Title	**:**	**Highway Construction Practice**
Number of Credits	**:**	**4 (L:3, T:1, P:0)**
Course Category	**:**	**Minor Specialization Course**

Course Objective:

To learn the different techniques and procedures adopted for the construct highways using rigid as well as flexible pavements

Course Content:

Unit	Content	Hours
I	Introduction; Construction of Embankments. Construction of Subgrade. Construction of granular sub-base. Construction of granular layer. Procedures followed for construction and materials used.	**15**
II	Procedure for construction of dry lean concrete sub-base. Construction procedures for construction of rigid as well as flexible pavements. Guidelines of IRC for use of dry lean concrete for use in sub-base for rigid pavements.	**15**
III	Construction of bituminous layers – bituminous Mcadam, Dense bituminous Mcadum, bituminous concrete etc. Procedures followed and	**15**

	materials used; IRC guidelines for construction of bituminous macadam. Construction of concrete Pavements. Construction procedures as well as materials used for non-conventional pavements. IRC guidelines and procedures followed.	
IV	Recycle aggregate pavement as per IRC:120 (RAP), Cold in place (CIP), Hot in place (HIP), plant mix technology, Methodology of construction, Cold mix technology as per IRC SP100, White topping – Conventional, Ultra-thin white topping as per IRC SP-76, , Stone matrix asphalt as per IRC SP-79, Warm mix asphalt as per IRC SP 101, Micro surfacing ,slurry seal as per IRC SP-81.	**15**

Recommended Books/References

1. M.C. Anderson, and T.P. Burt, Manual on flood forecasting, New Delhi, 1985.
2. Central Water Commission, 'Hydrological forecasting', John Willy and Sons, 1989.
3. WMO, Automatic collection and transmission of hydrological observations, Operational Hydrology report no. 2, Geneva Switzerland, 1973
4. M. Subramanian, Engineering Hydrology, TMH Publication, 2017

Course Outcomes: The students will learn:

- The essential elements for the construction of roads
- To know about the construction practises adopted for rigid as well as flexible pavements

Course Code	**:**	**DCE02403**
Course Title	**:**	**Statistics for Engineers**
Number of Credits	**:**	**4 (L: 3, T: 1, P: 0)**
Course Category	**:**	**Minor Specialization Course**

Course Objective: The course aims to develop the skills to analyse data for a given problem and present it in mathematical and statistical formats. It also strives to foster the ability to methodically solve problems using probability understanding, distribution knowledge, sampling techniques, and hypothesis formulation. Additionally, the course seeks to cultivate the capability to conduct hypothesis tests and apply concepts of correlation, regression, goodness of fit, and various distributions.

Course Content:

Unit	Content	Hours
I	Introduction to Statistics: Introduction, collection, classification and representation of data, various databases related to civil engineering applications (like hydrological, structural audit, etc), measures of central value (mean, median, mode), measures of dispersion, skewness, moment,	**10**

	Kurtosis	
II	Probability and Distributions: Probability and probability distributions including binomial, Poisson, normal: examples based on each distribution preferably based on various civil engineering problems	**15**
III	Data Sampling: Population, sampling: meaning, 4 types of sampling, importance of population sampling, sample size determination, Chi-square test, Z test, student T test, examples to be framed and solved based on various databases related to civil engineering applications (like hydrological, structural audit, etc)	**15**
IV	Test of Hypothesis: Test of hypothesis: three parts of hypothesis, steps in hypothesis testing: assumptions, test statistics, rejection region, calculations and conclusions, characteristics and qualities of a good hypothesis, students may use hypothesis (if any) from their PBL topic from SE civil curriculum, or any other suitable hypothesis example pertaining to civil engineering applications.	**10**
V	Correlation and Regression: Correlation analysis, regression analysis, coefficient of correlation, probable error, single and multiple regression, sample examples to be developed through data collected in unit iii and carry out correlation regression analysis for the same.	**10**

Recommended Books/References

1. S. P. Gupta, Statistical Methods, Sultan and Chand Sons
2. B. S. Grewal, Higher Engineering Mathematics, Khanna Publishing House.
3. Richard A. Johnson, Probability and Statistics for Engineers,
4. R. Lymann Ott, Michael Longnecker, Jackie Miller, An Introduction to Statistical Methods and Data Analysis, Student Solutions Manual,
5. Rudolf Freund, William Wilson, Statistical Methods, Academic Press USA
6. S C Gupta, Fundamentals of Statistics, Himalaya Publishing House

Course Outcomes: On successful completion of this course, the student will able to;

- Understand the basic concepts of Statistics and perform statistical data analysis;
- Understand the concept of probability and fit Binomial, or Poisson or Normal distribution to the given data;
- Understand concept of sampling and perform chi-square test, z test, Student T test;
- Perform hypothesis test.
- Carry out correlation and regression analysis for the given data
- Calculate variance and perform K-S test for goodness of fit

Course Code	**:**	**DCE02402**
Course Title	**:**	**Solute Transport Modeling**
Number of Credits	**:**	**4 (L: 3, T: 1, P: 0)**
Course Category	**:**	**Minor Specialization Course**

Course Objective: The objective of this course is to teach the students about modelling the transport of groundwater contamination in one-layered and two-zoned porous medium flows by an analytical approach. The one-dimensional advection–dispersion equation (ADE) has usually been used to describe the problems of pollutant transport in a water environment.

Course Content:

Unit	Content	Hours
I	Basic concepts of transport in groundwater- Transport phenomena, Transport equation, Analytical solutions of the transport equation, Pathlines and travel times.	**15**
II	Advection & Dispersion, Hydrodynamic Dispersion in Homogenous Medium, Derivation of the 1D Advection-Dispersion Equation (ADE)	**15**
III	Numerical transport models: Grid methods, Stability and accuracy of solutions, Particle tracking methods, Random-walk method, Method of characteristics	**15**
IV	Finite Difference Discretization: Explicit Formulation, Implicit Formulation, Weighted Formulation, Extension of ADE to Higher Dimensions , Groundwater Pathline & Particle Tracking, Solute Macrodispersion in Heterogeneous Media, Alternatives to ADE	**15**

Recommended Books/References

1. Ye Zhang, Groundwater Flow and Solute Transport Modeling, Dept. of Geology & Geophysics University of Wyoming, 2011.
2. D. K. Todd and L. F. Mays, Groundwater Hydrology, John Wiley and Sons.
3. C.W. Fetter, Applied Hydrogeology, 2nd Edition, CBS Publishers and Distributors, New Delhi, 1990
4. A.K. Rastogi, Numerical Groundwater Hydrology, Penram International Publishing Pvt. Ltd., Bombay. 2008.

Course Outcomes: After completion of the course;

- The students will have a thorough knowledge on contaminant movement under different condition.
- The students will be able model the solute transport using different numerical methods.

Course Code	**:**	**DCE02404**
Course Title	**:**	**Road Safety**
Number of Credits	**:**	**4 (L: 3, T: 1, P: 0)**
Course Category	**:**	**Minor Specialization Course**

Course Objective: To learn the procedures road safety and its evaluation techniques

Course Content:

Unit	Content	Hours

I	Introduction to safety: Road accidents, Trends, Causes, Collision and Condition diagrams, Highway safety, Human factors, Vehicle factors Road Safety Management System: Multi causal dynamic systems approach to safety, Crash vs accident, Road safety improvement strategies, Elements of a road safety plan, Safety Data Needs.	**08**
II	Statistical Interpretation and Analysis of Crash Data: Before-after methods in crash analysis, advanced statistical methods. Black Spot Identification & Investigations, Case Studies.	**10**
III	Road Safety Audits: Key elements of a road safety audit, Road Safety Audits & Investigations, Crash investigation and analysis, Describe methods for identifying hazardous road locations, Case Studies	**10**
IV	Crash Reconstruction: Describe the basic information that can be obtained from the roadway surface, Understand basic physics related to crash reconstruction, speed for various skid, friction, drag, and acceleration scenarios, variables involved in jump and flip crashes, variables involved in pedestrian crashes.	**7**
V	Mitigation Measures: Accident prevention by better planning, Accident prevention by better design of roads, Crash Countermeasures, Highway operation and accident control measures, Highway Safety Measures during construction, Highway geometry and safety.	**10**

Recommended Books/References

1. S. K. Khanna and C. E. G. Justo, Highway Engineering, Khanna Publisher, 2011
2. L.R. Kadyal., Highway Engineering, Khanna Publisher, 2018
3. S. P. A. Bindra, Course in Highway Engineering, Dhanpat Rai and Sons, New Delhi, 2008
4. Saxena and Arora, A Text Book of Railway Engineering, Dhanpat Rai and Sons, New Delhi, 2010
5. N. K. Vaswani, Railway Engineering, Dhanpat Rai and Sons, New Delhi, 2010
6. R. Srinivasan, Harbour, Dock & Tunnel Engineering, Charotar Publications, Ananda, 2016
7. H. P. Oza., Dock and Harbour Engineering, Charotar Publications, Ananda, 2013

Course Outcomes: The students will learn:

- The essential elements of road safety measures and its evaluation methods followed.
- To learn the how to prevent accidents by better planning roads.

Engineering Project

Engineering Project I and II will be done by students for the fulfilment of B.Tech. degree. If the students continues for Integrated M.Tech, same topic/work may be continued for Dissertation I & Dissertation II.

45 days Summer Internship

Completion of 1 credit by performing 45 days duration internship in industry is mandatory

for students. Students shall be facilitated at the end of 4^{th} and 6^{th} semester for Academic/Industry Internship. Students shall be required to make presentation with a copy of Report and Certificate in 7^{th} Semester. ----------**********----------