KAMARAJ COLLEGE OF ENGINEERING & TECHNOLOGY

(An Autonomous Institution - AFFILIATED TO ANNA UNIVERSITY, CHENNAI)

S.P.G.Chidambara Nadar - C.Nagammal Campus

S.P.G.C. Nagar, K.Vellakulam – 625 701 (Near VIRUDHUNAGAR).

B.E. CIVIL ENGINEERING
REGULATIONS – 2021
AUTONOMOUS SYLLABUS
CHOICE BASED CREDIT SYSTEM
V TO VI SEMESTER CURRICULUM AND SYLLABI

VISION:

To make the Department of Civil Engineering, unique of its kind to promote education and research in the various fields of construction industry.

MISSION:

To impart highly innovative and technical knowledge in the field of Civil Engineering to the urban and rural student folks through "Total Quality Education".

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO 1: Graduates of the program will be creative, able to apply scientific knowledge and computer aided design tools for technical problems in the field of Civil Engineering.

PEO 2: Graduates of the program will be a professional Civil Engineer and/or will pursue higher education in various domains of Civil Engineering by taking competitive examinations.

PEO 3: Graduates of the program will passionately perform as a competent team member, team leader and/or entrepreneur in the development of a sustainable environment.

PROGRAM OUTCOMES:

After going through the four years of study, the Civil Engineering graduates will have the ability to

POs	Graduate Attribute	Programme Outcome
1	Engineering knowledge	Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2	Problem analysis	Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3	Design/Development of solutions	Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4	Conduct investigations of complex problems	Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions
5	Modern tool usage	Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations
6	The engineer and society	Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice
7	Environment and sustainability	Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9	Individual and team work	Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11	Project management and finance	Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12	Life-long learning	Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO1 : Graduating students will be able to deal complex problems in the field of Civil Engineering to achieve design solutions with modern technological approach and application software.

PSO2 : Graduating students will be able to understand the professional Civil Engineering practice and apply contextual knowledge with the appropriate consideration of the society and environment.

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REGULATIONS - 2021

CHOICE BASED CREDIT SYSTEM

B.E. CIVIL ENGINEERING

CURRICULUM AND SYLLABI FOR SEMESTER V TO VI

SEMESTER – V

SI. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	CE2301	Design of Reinforced Concrete Structural Elements	PC	3	3	0	0	3
2.	CE2302	Geotechnical Engineering – II	PC	3	3	0	0	3
3.	CE2303	Structural Analysis	PC	3	3	0	0	3
4.		Professional Elective I	PE	3	3	0	0	3
5.		Professional Elective II	PE	3	3	0	0	3
6.		Professional Elective III	PE	3	3	0	0	3
7.		Audit Course	AU	3	3	0	0	0
PRACTICAL								
8.	CE2304	Environmental Engineering Laboratory	PC	3	0	0	3	1
9.	CE2305	Hydraulic Engineering Laboratory	PC	3	0	0	3	1
10	EM2301	Internship	EM	-	0	0	0	1
			TOTAL	**27**	**21**	**0**	**6**	**21**

SEMESTER VI

SI. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1.	CE2351	Design of Steel Structural Elements	PC	3	3	0	0	3
2.	CE2352	Highway and Railway Engineering	PC	3	3	0	0	3
3.		Professional Elective IV	PE	3	3	0	0	3
4.		Professional Elective V	PE	3	3	0	0	3
5.		Professional Elective VI	PE	3	3	0	0	3
6.		Open elective – I	OE	3	3	0	0	3
PRACTICAL								
8.	CE2353	Concrete and Highway Engineering Laboratory	PC	3	0	0	3	1
9.	CE2354	Mini Project	EM	4	0	0	4	2
			TOTAL	**25**	**18**	**0**	**7**	**21**

Detailed courses in Each Verticals

Sl. No	Vertical 1	Vertical 2	Vertical 3	Vertical 4
	Structures and Construction Practices	**Environmental and Water Resources Engineering**	**Geoinformatics and Transportation Engineering**	**Computer applications in structures**
1.	Prestressed Concrete Structures	Air pollution and control engineering	Airport and Harbour Engineering	Building Information Modeling Techniques
2.	Construction Equipment and Machinery	Climatology for Built Environment	Total Station, GPS And Drone Surveying	Computer Aided Structural Analysis
3.	Structural Dynamics and Earth quake Engineering	Ground Improvement Techniques	Intelligent Transport Systems	Energy Efficient Buildings
4.	Forensic and Retrofitting techniques Engineering	Hydrology and Water resources Engineering	Remote Sensing and GIS Techniques	Digitalized Construction Techniques
5.	Prefabricated Structures	Computational Fluid Dynamics	Smart cities	Introduction to Finite Element Method
6.	Pipeline Engineering and Safety Management	Environmental Impact Assessment	Satellite Image Processing	Sensor Applications in Structural Health Monitoring
7.	Special Concrete Development and Application	Municipal Solid Waste Management	Traffic Engineering and Management	Construction Management with BIM applications

PROFESSIONAL ELECTIVE COURSES : VERTICALS

VERTICAL 1: Structures and Construction Practices

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	VCE311	Prestressed Concrete Structures	PE	3	3	0	0	3
2	VCE312	Construction Equipment and Machinery	PE	3	3	0	0	3
3	VCE313	Structural Dynamics and Earth quake Engineering	PE	3	3	0	0	3
4	VCE314	Forensic and Retrofitting Techniques Engineering	PE	3	3	0	0	3
5	VCE315	Prefabricated Structures	PE	3	3	0	0	3
6	VCE316	Pipeline Engineering and Safety Management	PE	3	3	0	0	3
7	VCE317	Special Concrete Development and Application	PE	3	3	0	0	3

VERTICAL 2: Environmental and Water Resources Engineering

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	VCE321	Air pollution and control Engineering	PE	3	3	0	0	3
2	VCE322	Climatology for Built Environment	PE	3	3	0	0	3
3	VCE323	Ground Improvement Techniques	PE	3	3	0	0	3
4	VCE324	Hydrology and Water resources Engineering	PE	3	3	0	0	3
5	VCE325	Computational Fluid Dynamics	PE	3	3	0	0	3
6	VCE326	Environmental Impact Assessment	PE	3	3	0	0	3
7	VCE327	Municipal Solid Waste Management	PE	3	3	0	0	3

VERTICAL 3 : Geoinformatics and Transportation Engineering

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	VCE331	Airport and Harbour Engineering	PE	3	3	0	0	3
2	VCE332	Total Station, GPS and Drone Surveying	PE	3	3	0	0	3
3	VCE333	Intelligent Transport Systems	PE	3	3	0	0	3
4	VCE334	Remote Sensing and GIS Techniques	PE	3	3	0	0	3
5	VCE335	Smart Cities	PE	3	3	0	0	3
6	VCE336	Satellite Image Processing	PE	3	3	0	0	3
7	VCE337	Traffic Engineering and Management	PE	3	3	0	0	3

VERTICAL 4 : Computer Applications in Structures

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	VCE341	Building Information Modeling Techniques[#]	PE	4	2	0	2	3
2	VCE342	Computer Aided Structural Analysis[#]	PE	4	2	0	2	3
3	VCE343	Energy Efficient Buildings	PE	3	3	0	0	3
4	VCE344	Digitalized Construction Techniques[#]	PE	4	2	0	2	3
5	VCE345	Introduction to Finite Element Method	PE	3	3	0	0	3
6	VCE346	Sensor Applications in Structural Health Monitoring	PE	3	3	0	0	3
7	VCE347	Construction Management with BIM applications	PE	3	3	0	0	3

[#] Theory cum Lab

OPEN ELECTIVES

OPEN ELECTIVES I (Offered to AI&DS, BT,CSE, ECE, EEE, IT, MECH, MTR)

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	OCE781	Biomass Conservation And Biorefinery	OE	3	3	0	0	3
2	OCE782	Fundamentals of Fire Safety Engineering	OE	3	3	0	0	3
3	OCE783	Sustainable Construction	OE	3	3	0	0	3

VERTICAL FOR MINOR DEGREE – Environment and Sustainability

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	CONTACT PERIODS	L	T	P	C
1	MCE101	Sustainable Biomaterials	OE	3	3	0	0	3
2	MCE102	Environmental Quality Monitoring and Analysis	OE	3	3	0	0	3
3	MCE103	Sustainable Infrastructure Development	OE	3	3	0	0	3
4	MCE104	Green Technology	OE	3	3	0	0	3
5	MCE105	Sustainable Agriculture and Environmental Management	OE	3	3	0	0	3
6	MCE106	Energy Efficiency For Sustainable Development	OE	3	3	0	0	3

Course Code	Course Name	L	T	P	C
CE2301	DESIGN OF REINFORCED CONCRETE STRUCTURAL ELEMENTS	3	0	0	3

Category: Professional Core

a. Preamble

This course introduces the different types of philosophies related to design of basic structural elements such as slab, beam, column and footing which form part of any structural system with reference to Indian standard code of practice.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the various design concepts and design RC rectangular beams by working stress and limit state methods.	K2
CO2	Understand the design of flanged beams , design for shear and torsion, and anchorage and development length.	K2
CO3	Develop a RC slabs and staircase and draw the reinforcement detailing.	K3
CO4	Solve short columns for axial, uni-axial and bi-axial eccentric loadings.	K3
CO5	Solve wall footings, isolated footings and combined rectangular footing.	K3

c. Course Syllabus **Total : 45 Periods**

METHODS OF DESIGN OF CONCRETE STRUCTURES **9**

Concept of Elastic method, ultimate load method and limit state method – Working stress method as detailed in IS code - Design of Singly Reinforced beam by working stress method - Limit State philosophy as detailed in IS code - Advantages of Limit State Method over other methods - Analysis and design of singly and doubly reinforced rectangular beams by Limit State Method. Introduction to computer aided RC design – Preparation of spreadsheet for design of singly reinforced beam for moment.

LIMIT STATE DESIGN OF BEAMS **9**

Analysis and design of flanged beams – Use of design aids for Flexure - Behaviour of RC members in bond and Anchorage - Design requirements as per current code - Behaviour of

RC beams in shear and torsion - Design of RC members for combined bending, shear and torsion - serviceability.

LIMIT STATE DESIGN OF SLABS AND STAIRCASE **9**

Analysis and design of cantilever, one way, two way and continuous slabs subjected to uniformly distributed load for various boundary conditions- Types of Staircases – Design of dog-legged Staircase – Introduction to Flat Slab, Composite Slab and Grid Floor - Applications.

LIMIT STATE DESIGN OF COLUMNS **9**

Types of columns – Design of short Rectangular and circular columns for axial, uniaxial and biaxial bending.

LIMIT STATE DESIGN OF FOOTINGS **9**

Design of wall footing – Design of axially and eccentrically loaded rectangular pad and sloped footings – Design of combined rectangular footing for two columns only.

d. Activities

Students shall be exposed to different reinforced concrete structural elements through models and field visit.

e. Learning Resources

Text Books

1. Krishnaraju.N, *Design of Reinforced Concrete Structures*, CBS Publishers & Distributors Pvt. Ltd., New Delhi, 2015.
2. Gambhir. M.L, *Fundamentals of Reinforced Concrete Design*, Prentice Hall of India Private Limited, New Delhi, 2006.

Reference Books

1. Sinha, S.N, *Reinforced Concrete Design,* Tata McGraw Hill Publishing Company Ltd., New Delhi, 2002.
2. UnnikrishnaPillai, S, DevdasMenon, *Reinforced Concrete Design*, Tata McGraw Hill Publishing Company Ltd, 2009.
3. IS456:2000, *Code of practice for Plain and Reinforced Concrete,* Bureau of Indian Standards, New Delhi
4. SP16, IS456:1978 *Design Aids for Reinforced Concrete,* Bureau of Indian Standards, New Delhi

Course Code	Course Name	L	T	P	C
CE2302	GEOTECHNICAL ENGINEERING – II	3	0	0	3

Category: Professional Core

a. Preamble

- Investigate beneath the surface and choose a foundation based on the soil's condition.
- Calculate the soil bearing capacity and estimate the pressure distribution for shallow foundation design.
- Determine the pile capacity to carry loads both individually and collectively.
- Examine the stability of the retaining wall at various ground pressures.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Outline the appropriate site investigation techniques and suitable foundations.	K2
CO2	Demonstrate settlement and shear failure of shallow foundation.	K2
CO3	Identify safe dimensions for shallow footings.	K3
CO4	Summarize load carrying capacity and settlement of single and pile groups.	K2
CO5	Develop stability analysis of retaining walls	K3

c. Course Syllabus **Total : 45 Periods**

SITE INVESTIGATION AND SELECTION OF FOUNDATION **9**

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.

SHALLOW FOUNDATION **9**

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.

FOOTINGS AND RAFTS **9**

Types of Isolated footing, Combined footing, Mat foundation – Contact pressure and settlement distribution – Proportioning of foundations for conventional rigid behaviour – Minimum thickness for rigid behaviour – Applications – Compensated foundation – Codal provision.

PILE FOUNDATION **9**

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 – Cohesionless soils – Codal provisions.

RETAINING WALLS **9**

Plastic equilibrium in soils – Active and passive states – Rankine's theory – Cohesionless and cohesive soil – Coulomb's wedge theory – Condition for critical failure plane – Earth pressure on retaining walls of simple configurations – Culmann's Graphical method – Pressure on the wall due to line load – Stability analysis of retaining walls – Codal provisions.

d. Activities

Students shall be exposed to the different field test for selection of foundation inside the college premises.

e. Learning Resources

Text Books

1. Murthy, V.N.S., *Text book of Soil Mechanics and Foundation Engineering,* CBS Publishers Distribution Ltd., New Delhi. 2014.
2. Punmia, B.C., *Soil Mechanics and Foundations,* Laxmi Publications Pvt. Ltd. New Delhi, 16th Edition 2017.

Reference Books

1. Arora, K.R., *Soil Mechanics and Foundation Engineering*, StandardPublishers and Distributors, New Delhi, 7th Edition, 2017 (Reprint).
2. Braja M Das, *Principles of Foundation Engineering*, (Eighth edition), Cengage Learning 2014.

Course Code	Course Name	L	T	P	C
CE2303	STRUCTURAL ANALYSIS	3	0	0	3

Category: Professional Core

a. Preamble

- To introduce the students to basic theory and concepts of classical methods of structural analysis.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Construct influence lines for statically determinate beams.	K3
CO2	Apply slope defection method in continuous beams and rigid frames.	K3
CO3	Apply moment distribution method in continuous beams and rigid frames with and without sway.	K3
CO4	Construct bending moment and shear force diagrams for various types of arches.	K3
CO5	Solve the suspension bridges, stiffening girders and space trusses.	K3

c. Course Syllabus **Total : 45 Periods**

INFLUENCE LINES FOR DETERMINATE BEAMS **9**

Introduction to moving loads, Concept of Influence Lines, Influence lines for reactions in statically determinate structures –Influence lines for shear force and bending moment in beam section – Calculation of critical stress resultants due to concentrated and distributed moving loads - Influence lines for member forces in pin jointed plane frames.

SLOPE DEFLECTION METHOD **9**

Slope deflection equations – Equilibrium conditions - Analysis of continuous beams and rigid frames – Rigid frames with inclined members - Support settlements - symmetric frames with symmetric and skew-symmetric loadings. Comparison of analysis results with software (demo only).

MOMENT DISTRIBUTION METHOD **9**

Stiffness - distribution and carry over factors – Analysis of continuous Beams- Plane rigid frames with and without sway – Support settlement - symmetric frames with symmetric and skew-symmetric loadings.

ARCHES **9**

Arches - Types of arches – Analysis of three hinged, two hinged and fixed arches - Parabolic and circular arches – Settlement and temperature effects.

SUSPENSION BRIDGES AND SPACE TRUSSES **9**

Analysis of suspension bridges – Unstiffened cables and cables with three hinged stiffening girders – Influence lines for three hinged stiffening girders - Introduction to analysis of space trusses using method of tension coefficients.

d. Activities

Students shall be exposed to analyse various structures for different loading conditions.

e. Learning Resources

Text Books

1. Punmia. B.C, Ashok Kumar Jain &Arun Kumar Jain, *Theory of structures*, Laxmi Publications, New Delhi,2012.
2. Bhavikatti,S.S, *StructuralAnalysis,Vol.1,&2,*Vikas Publishing House Pvt.Ltd., New Delhi-4, 2014.

Reference Books

1. Bhavikatti, S.S, *Matrix Method of Structural Analysis*, I. K. International Publishing House Pvt.Ltd., New Delhi-4,2014.
2. Vazrani.V.NAndRatwani, M.M, *Analysis of Structures*, Khanna Publishers, 2015.

Course Code	Course Name	L	T	P	C
CE2304	ENVIRONMENTAL ENGINEERING LABORATORY	0	0	3	1

Category: Professional Core

a. Preamble

- This course demonstrates the analysis of the physico-chemical characteristics of water and wastewater.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Identify the physical parameters of water and wastewater.	K3
CO2	Apply coagulation and flocculation process in water and wastewater.	K3
CO3	Identify the organic materials in water and wastewater.	K3
CO4	Experiment with the inorganic ions in water and wastewater.	K3
CO5	Identify the disinfectant characteristics.	K3

c. Course Syllabus **Total: 45 Periods**

1. Determination of pH, Turbidity and conductivity
2. Determination of Hardness
3. Determination of Alkalinity and Acidity
4. Determination of Chlorides
5. Determination of Phosphates and Sulphates
6. Determination of iron and fluoride
7. Determination of Optimum Coagulant dosage
8. Determination of residual chlorine and available chlorine in bleaching powder
9. Determination of suspended, settleable, volatile and fixed solids
10. Determination Dissolved Oxygen and BOD for the given sample
11. Determination of COD for given sample

d. Activities

Students will be analyzing the different water and wastewater samples from different sources and interpret the results with the drinking water standards and wastewater disposal standards.

e. Learning Resources

Reference Books

1. APHA, *Standard Methods for the Examination of Water and Wastewater*, 22nd Ed. Washington, 2012.
2. H.H. and Krist,H. *Laboratory Manual for the Examination of water, wastewater soil Rump*, – Second Edition, VCH, Germany, 3rd Edition, 1999.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	pH meter	2
2.	Nephelometer	2
3.	Conductivity meter	1
4.	UV Spectrophotometer	1
5.	Jar test apparatus	2
6.	DO meter	2
7.	BOD incubator	1
8.	COD digester	2
9.	Imhoff cone	4
10.	Water bath	2
11.	Hot air oven	1
12.	Weighing machine (0.0001g)	1
13.	Weighing machine (0.001g)	1
14.	Refrigerator	1
15.	Muffle furnace	1

Course Code	Course Name	L	T	P	C
CE2305	HYDRAULIC ENGINEERING LABORATORY	0	0	3	1

Category: Professional Core

a. Preamble

- This course aims to verify the principles studied in theory by performing the experiments in lab.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Experiment with techniques used to measure the flow of fluids.	K3
CO2	Identify the various frictional losses in pipe flow.	K3
CO3	Apply the concept to develop characteristics types of pumps.	K3
CO4	Apply the concept to develop characteristics types of turbines.	K3
CO5	Make use of the technique to determine meta centric height.	K3

c. Course Syllabus **Total: 45 Periods**

A. FLOW MEASUREMENT

1. Calibration of Rotameter

2. Calibration of Venturimeter / Orificemeter

3. Bernoulli's Experiment

4. Calibration of V notch

B. LOSSES IN PIPES

5. Determination of friction factor in pipes

6. Determination of minor losses

C. PUMPS

7. Characteristics of Centrifugal pumps

8. Characteristics of Gear pump

9. Characteristics of Submersible pump

10. Characteristics of Reciprocating pump

D. TURBINES

11. Characteristics of Pelton wheel turbine

12. Characteristics of Francis turbine/Kaplan turbine

E. DETERMINATION OF METACENTRIC HEIGHT

13. Determination of Metacentric height of floating bodies

d. Activities

Students shall be exposed to the hands on experience on different Flow measurement devices, Pumps and Turbines in the college premises.

e. Learning Resources

Text Books

1. Sarbjit Singh, *Experiments in Fluid Mechanics*, Prentice Hall of India Pvt. Ltd, Learning Private Limited, Delhi, 2009.
2. *Hydraulic Laboratory Manual*, Centre for Water Resources, Anna University, 2004.

Reference Books

1. Modi P.N. & Seth S.M, *Hydraulics and Fluid Mechanics,* Standard Book House, New Delhi, 2000.
2. Subramanya K, *Flow in open channels*, Tata McGraw Hill Publishing Company, 2001.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Rotameter	01
2.	Venturimeter/Orifice meter	01
3.	Bernoulli's Experiment set up	01
4.	Centrifugal Pump	01
5.	Gear Pump	01

S.No.	Description of Equipment	Quantity Required
6.	Submersible pump	01
7.	Reciprocating Pump	01
8.	Pelton Wheel turbine	01
9.	Francis turbines/one set of kaplon turbine	01
10.	Equipment for determination of Metacentric height of floating bodies	01
11.	Set up for determination of friction factor in pipes	01
12.	Set up for determination of minor losses.	01

Course Code	Course Name	L	T	P	C
EM2301	INTERNSHIP	0	0	0	1

Category: Employability Enhancement courses

a. Preamble

- To train the students in field work so as to have a firsthand knowledge of practical problems in carrying out engineering tasks. To develop skills in facing and solving the field problems.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the broad principles of industrial projects.	K2
CO2	Make use of the advanced tools and techniques encountered during industrial training.	K2
CO3	Interact with industrial personnel to clarify about the field practices.	K2
CO4	Build interpersonal and team skills.	K3
CO5	Develop professional work reports and presentation.	K3

Total : 80 Hours

c. STRATEGY

(2 Weeks)

The students individually undergo training in reputed industry/ research institutes /

laboratories for the specified duration. After completion of the training, a detailed report should be submitted within ten days from the commencement of next semester. The evaluation will be done as per the Regulations. Credits shall be awarded to the students who satisfy the clauses for industrial training/ internship of the Regulation concerned.

d. Activities

Students shall be exposed to the latest technologies in reputed organization.

Course Code	Course Name	L	T	P	C
CE2351	DESIGN OF STEEL STRUCTURAL ELEMENTS	3	0	0	3

Category: Professional Core

a. Preamble

- This course introduces 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.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Recognize the design philosophy of steel structures and identify the different failure modes of bolted and welded connections, and determine their design strengths.	K2
CO2	Solve the problems in design tension members and understand the effect of shear lag.	K3
CO3	Apply the principles, procedures and current code requirements to the analysis and design of axially loaded columns and column bases.	K3
CO4	Solve the problems in design of laterally restrained and unrestrained steel beams.	K3
CO5	Identify the design loads in Industrial structures and gantry girder.	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO STRUCTURAL STEEL AND DESIGN OF CONNECTIONS **9**

General -Types of Steel -Properties of structural steel - I.S. rolled sections - Concept of Limit State Design - Design of Simple and eccentric Bolted and welded connections - Types of failure and efficiency of joint – prying action - Introduction to HSFG bolts.

LIMIT STATE DESIGN OF TENSION MEMBERS **9**

Behaviour and Design of simple and built-up members subjected to tension - Shear lag effect- Design of lug angles - tension splice.

LIMIT STATE DESIGN OF COMPRESSION MEMBERS 9

Behaviour of short and long columns - Euler's column theory-Design of simple and built-up compression members with lacings and battens - Design of column bases - slab base and gusseted base.

LIMIT STATE DESIGN OF BEAMS 9

Design of laterally supported and unsupported beams - Design of built-up beams - Design of plate girders.

INDUSTRIAL STRUCTURES 9

Design of roof trusses – loads on trusses – purlin design using angle and channel sections – truss design, Design of joints and end bearings–Design of gantry girder – Concepts of pre-engineered buildings and its applications.

d. Activities

Students shall be exposed to different steel structural elements and its connections through models and field visit.

e. Learning Resources

Text Books

1. Duggal S.K, *Design of Steel Structures*, Tata McGraw Hill, Publishing Co. Ltd., New Delhi, 2010
2. Bhavikatti S.S, *Design of Steel Structures*, By Limit State Method as per IS:800– 2007, IK International Publishing House Pvt. Ltd, New Delhi, 2017.

Reference Books

1. Gambhir M L, *Fundamentals of Structural Steel Design*, McGraw Hill Education India Pvt Limited, 2013.
2. Subramanian N, Design of Steel Structures, Oxford University Press, New Delhi, 2016
3. IS800:2007, *General Construction in Steel - Code of Practice, (Third Revision)*, Bureau of Indian Standards, New Delhi.
4. SP 6(1) Hand book on structural Steel Sections
5. IS:816 - 1969, *Code of practice for use of metal arc welding for general construction in mild steel*.

6. IS:808 – 1989 *Dimensions For Hot Rolled Steel Beam, Column, Channel and Angle Sections.*
7. www.steel-insdag.org

Course Code	Course Name	L	T	P	C
CE2352	**HIGHWAY AND RAILWAY ENGINEERING**	**3**	**0**	**0**	**3**

Category: Professional Core

a. Preamble

- To give an overview about highway and railway engineering with respect to, planning, design, construction and maintenance as per IRC standards, specifications and methods.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Plan a highway according to the principles and standards adopted in various institutions in India.	K2
CO2	Design the geometric features of road network and components of pavement.	K3
CO3	Test the highway materials and construction practice methods and know its properties and able to perform pavement evaluation and management.	K2
CO4	Identify the methods of route alignment and design elements in railway planning and constructions.	K3
CO5	Understand the construction techniques and maintenance of track laying and railway stations.	K2

c. Course Syllabus **Total : 45 Periods**

HIGHWAY PLANNING **9**

History of road development in India - Institutions for Highway planning, design and construction at different levels - Classification of highways — factors influencing highway alignment –Typical cross sections of Urban and Rural roads – Engineering surveys for alignment- Conventional and Modern method

DESIGN OF HIGHWAY ELEMENTS **9**

Cross sectional elements – Horizontal curves, super elevation, transition curves, widening of curves – Sight distances – Vertical curves, gradients– pavement components and their role - Design practice for flexible and rigid pavements (IRC methods only) - Joints in rigid pavements.

HIGHWAY CONSTRUCTION AND MAINTENANCE **9**

Highway construction materials, properties, testing methods – Construction practice of flexible and concrete pavement- Highway financing principles - Highway drainage – Evaluation - Surface and structural evaluation methods - Maintenance of pavements- Defects in flexible and rigid pavements - Symptoms, causes and treatments.

RAILWAY PLANNING AND DESIGN **9**

Elements of permanent way – Rails, Sleepers, Ballast, rail fixtures and fastenings, Selection of gauges - Track Stress, coning of wheels, creep in rails, defects in rails – Route alignment surveys, conventional and modern methods-Geometric design of railway, gradient, super elevation, widening of gauge on curves (Problems)-Railway drainage- Level Crossings-Signaling.

RAILWAY TRACK CONSTRUCTION MAINTENANCE AND OPERATION **9**

Points and Crossings - Design of Turnouts, Working Principle-Track Circuiting - Construction & Maintenance – Conventional, Modern methods and Materials, Lay outs of Railway Stations and Yards, Rolling Stock, Tractive Power, Track Resistance - Role of Indian Railways in National Development – Railways for Urban Transportation – LRT & MRTS Feasibility study, Planning and construction.

d. Activities

Students shall be exposed to the onsite road construction and nearby railway junction.

e. Learning Resources

Text Books

1. S.K Khanna, and C E G. Justo and A. Veeraragavan, *Highway Engineering*, New Chand and Bros, Roorkee, 10th edition, 2015.
2. S C Saxena, S P Arora , *Text Book of Railway Engineering*, Dhanpat Rai Publications, 2015

Reference Books

1. Kadiyali, L.R., *Principles and Practice of Highway Engineering*, Khanna Publishers Ltd. New Delhi, 2011.

2. Satishchandra, Agarwal M M, *Railway Engineering*, Oxford University Press,2010
3. Venkatappa Rao. G, *Principles of Transportation and Highway Engineering*, Tata McGraw Hill Pub.Co, Ltd, New Delhi, 2000.
4. Indian Road Congress (IRC), *Guidelines for the Design of Flexible Pavements*, (Third Revision), IRC:37-2012
5. Indian Road Congress (IRC), *Guidelines for the Design of Plain Jointed Rigid Pavements for Highways*, (Third Revision), IRC:58-2012

Course Code	Course Name	L	T	P	C
CE2353	CONCRETE AND HIGHWAY ENGINEERING LABORATORY	0	0	3	1

Category: Professional Core

a. Preamble

- To simplify the learning of how construction materials behave.
- To become familiar with the guidelines and processes for assessing highway materials.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Identify aggregate qualities using various testing techniques.	K3
CO2	Make use of codal provision for concrete mix design.	K3
CO3	Experiment with concrete in its natural environment and assess its workability.	K3
CO4	Identify the characteristics of hardened concrete.	K3
CO5	Select the proper grade of bitumen for road construction.	K3

Total : 45 Periods

c. Course Syllabus

1. Test on Aggregates
    a) Specific Gravity Test
    b) Sieve Analysis Test
    c) Los Angels Abrasion Test
    d) Water Absorption Test
    e) Impact Test
    f) Crushing Test
    g) Flakiness and Elongation Test
2. Mix Proportioning
    a) Mix Proportioning by BIS Method

3. Test on Fresh Concrete
    a) Slump Test
    b) Compaction Factor Test
    c) Vee-Bee Consistometer Test
    d) Flow Table Test
4. Test on Hardened Concrete
    a) Compression Strength Test
    b) Split Tensile Strength Test
5. Test on Bitumen
    a) Penetration Test
    b) Softening Point Test
    c) Ductility Test
    d) Demonstration on Viscosity Test
    e) Demonstration on Binder Content Test
    f) Demonstration on Marshal Stability

d. Activities

Students shall be exposed to the hands on experience on different grades of concrete and the can be made test on it based on the respective grades.

e. Learning Resources

Text Books

1. M.S.Shetty, *Concrete Technology. Theory and Practice,* S.Chand Publications, 2019.
2. S.K.Khanna and C.E.G.Justo, *Highway Engineering,* Nem Chand & Bros, 1990.

Reference Books

1. IS 10262:2009, *Guideines for Concrete Mix Design Proportioning.*
2. M.L. Gambhir, Neha Jamwal, *Building and Construction Materials – Testing and Quality Control (Lab Manual),* McGraw Hill Education, 2017.

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

S.No.	Description of Equipment	Quantity Required
1.	Concrete cube moulds	6
2.	Concrete cylinder moulds	3
3.	Concrete Prism moulds	3

S.No.	Description of Equipment	Quantity Required
4.	Sieves	1
5.	Concrete Mixer	1
6.	Slump cone	3
7.	Flow table	1
8.	Vibrator	1
9.	Trowels and planers	1
10.	UTM - 400 kN capacity	1
11.	Vee Bee Consistometer	1
12.	Aggregate impact testing machine	1
13.	CBR Apparatus	1
14.	Blains Apparatus	1
15.	Los - Angeles abrasion testing machine	1

Course Code	Course Name	L	T	P	C
CE2354	MINI PROJECT	0	0	4	2

Category: Employability Enhancement courses

a. Preamble

- Developing the ability to solve a specific problem by identifying it through literature review and proceeding to successful solution by formulating proper methodology.
- Working together in a team to solve any problem statement involving theoretical and experimental studies related to civil engineering.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Identify the practical problem by conducting literature survey/patent search.	K3
CO2	Develop the proper methodology as per standards available.	K3
CO3	Solve the problem using suitable experimental/analytical studies	K3
CO4	Make use of tools and packages for problem solving	K3
CO5	Develop documentation skills for reporting the outcomes.	K3

c. Course Syllabus **Total : 60 Periods**

1. The students shall form a team with not more than 3 members.
2. The students shall select a technical problem and do a detailed study of it.
3. The students shall then conduct a detailed literature review related to the selected problem.
4. Based on the literature survey, the students shall formulate the study objectives and methodology.
5. The students shall conduct the required experiments/analyses to arrive at the solution.
6. The final report shall be submitted by the students for review and assessment.

VERTICAL 1: Structures and Construction Practices

Course Code	Course Name	L	T	P	C
VCE311	PRESTRESSED CONCRETE STRUCTURES	3	0	0	3

Category: Professional Elective

a. Preamble

- To understand the methods and types of prestressing and to enable the students to design prestressed concrete structural elements and systems.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Illustrate the concepts of prestressing, methods of prestressing, and performance of prestressed elements.	K2
CO2	Understand the codal provisions to gain knowledge on the design of prestressed concrete elements for flexure and shear.	K2
CO3	Develop knowledge on short term deflection, long term deflection and determination of anchorage zone stresses.	K3
CO4	Solve the stresses in composite beams and continuous beams.	K3
CO5	Utilize the codal provisions for the design of pipes and tanks.	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION – THEORY AND BEHAVIOUR **9**

Basic principles of prestressing – Classification and types – Advantages over ordinary reinforced concrete – Materials – High strength concrete and high tensile steel – Methods of prestressing – Freyssinet, Magnel, Lee-McCall and Gifford Udall anchorage systems –

Analysis of sections of stresses by stress concept, strength concept and load balancing concept – Losses of prestress in post -tensioned and pre-tensioned members.

DESIGN FOR FLEXURE AND SHEAR **9**

Basic assumptions of flexural design – Permissible stresses in steel and concrete as per I.S.1343 Code – Different Types of sections - Design of sections of Type I and Type II post-tensioned and pre-tensioned beams – Check for flexural capacity based on I.S. 1343 Code – Influence of Layout of cables in post-tensioned beams – Location of wires in pre-tensioned beams – Design for shear based on I.S. 1343 Code.

DEFLECTION AND DESIGN OF ANCHORAGE ZONE **9**

Factors influencing deflections – Short-term deflections of uncracked members – Prediction of longterm deflections due to creep and shrinkage – Check for serviceability limit states. Determination of anchorage zone stresses in post-tensioned beams by Magnel's method, Guyon's method and I.S. 1343 code – design of anchorage zone reinforcement – Check for transfer bond length in pretensioned beams– design of anchorage zone reinforcement.

COMPOSITE BEAMS AND CONTINUOUS BEAMS **9**

Analysis and design of composite beams – Shrinkage strain and its importance – Differential shrinkage - Methods of achieving continuity in continuous beams – Analysis for secondary moments – Concordant cable and linear transformation – Calculation of stresses – Principles of design.

MISCELANEOUS STRUCTURES **9**

Role of prestressing in members subjected to Tensile forces and compressive forces – Design of Tension members and Compression members - Design of Tanks and Pipes – Partial prestressing – methods of achieving partial prestressing, merits and demerits of partial prestressing

d. Activities

Students shall be exposed to manufacturing of Prestressed concrete sleepers through industrial visit.

e. Learning Resources

Text Books

1. Krishna Raju N., *Prestressed concrete*, 5th Edition, Tata McGraw Hill Company, New Delhi, 2012.

2. Pandit.G.S. and Gupta. S.P., *Prestressed Concrete* , CBS Publishers and Distributers Pvt. Ltd, 2014

Reference Books

1. Lin T.Y. and Ned.H.Burns, *Design of prestressed Concrete Structures*, Third Edition, Wiley India Pvt. Ltd., New Delhi, 2013.
2. Rajagopalan.N, *Prestressed Concrete*, Narosa Publishing House, 2017.
3. Dayaratnam.P., *Prestressed Concrete Structures* , Oxford and IBH, 2017.
4. Sinha.N.C. And Roy.S.K. *Fundamentals of Prestressed Concrete*, S.Chand and Co. Ltd., 2011

Course Code	Course Name	L	T	P	C
VCE312	CONSTRUCTION EQUIPMENT AND MACHINERY	3	0	0	3

Category: Professional Elective

a. Preamble

- To make the students to learn about the various types of equipments used for earthwork, tunneling, drilling, blasting, dewatering, material handling conveyors and its applications in construction projects.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Interpret knowledge on planning of equipment and selection of equipment.	K2
CO2	Explain the knowledge on fundamentals of earth work operations, earth moving operations and types of earth work equipment.	K3
CO3	Outline the knowledge on special construction equipments.	K2
CO4	Outline about the asphalt and concrete machinery.	K2
CO5	Apply the knowledge and select the proper materials handling equipment.	K3

c. Course Syllabus **Total : 45 Periods**

CONSTRUCTION EQUIPMENT SELECTION **9**

Identification – Planning of equipment – Selection of Equipment - Equipment Management in Projects - Maintenance Management – Equipment cost – Operating cost – Cost Control of Equipment - Depreciation Analysis – Replacement of Equipment- Replacement Analysis - Safety Management.

EQUIPMENT FOR EARTHWORK **9**

Fundamentals of Earth Work Operations - Earth Moving Operations - Types of Earth Work Equipment - Tractors, Motor Graders, Scrapers, Front end Waders – Dozer, Excavators, Rippers, Loaders, trucks and hauling equipment, Compacting Equipment, Finishing equipment.

OTHER CONSTRUCTION EQUIPMENTS **9**

Equipment for Dredging, Trenching, Drag line and clamshells, Tunneling – Equipment for Drilling and Blasting - Pile driving Equipment - Erection Equipment - Crane, Mobile crane - Types of pumps used in Construction - Equipment for Dewatering and Grouting – Equipment for Demolition.

ASPHALT AND CONCRETING EQUIPMENTS **9**

Aggregate production- Different Crushers – Feeders - Screening Equipment - Handling Equipment - Batching and Mixing Equipment - Pumping Equipment – Ready mix concrete equipment, Concrete pouring equipment. Asphalt Plant, Asphalt Pavers, Asphalt compacting Equipment.

MATERIALS HANDLING EQUIPMENT **9**

Forklifts and related equipment - Portable Material Bins – Material Handling Conveyors – Material Handling Cranes- Industrial Trucks.

d. Activities

Students shall be exposed to industrial visit to study the performance about various construction equipments.

e. Learning Resources

Text Books

1. Peurifoy, R.L., Schexnayder, C. and AviadShapira., *Construction Planning, Equipment and Methods*, McGraw Hill, Singapore, 2010.

2. Granberg G.,Popescu M, *Construction Equipment and Management for Engineers Estimators and Owners*, Taylor and Francis Publishers, New York, 2006.

Reference Books

1. Deodhar, S.V. *Construction Equipment and Job Planning*, Khanna Publishers, New Delhi, 2001.
2. Arora S.P. and Bindra S.P., *Building Construction, Planning Techniques and Method of Construction,* DhanpatRai and Sons, 2010.

Course Code	Course Name	L	T	P	C
VCE313	STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING	3	0	0	3

Category: Professional Elective

a. Preamble

- To introduce dynamic loading and the dynamic performance of the structures during earthquake.
- To familiarize the performance of structures under earthquake loading.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Explain the various principles of vibration analysis, and mathematical model of structures under free and forced vibration.	K2
CO2	Outline Two degree of freedom system for free and forced vibration under normal modes of vibration.	K2
CO3	Illustrate the elements of Seismology.	K2
CO4	Develop the response of structures subjected to earthquake.	K3

CO5	Make use of codal procedures for the design of Earth quake resistant structures.	K3

c. Course Syllabus **Total : 45 Periods**

THEORY OF VIBRATIONS **9**

Difference between static loading and dynamic loading – Degree of freedom – idealisation of structure as single degree of freedom system – Formulation of Equations of motion of SDOF system - D‟Alemberts principles – effect of damping – free and forced vibration of damped and undamped structures

MULTIPLE DEGREE OF FREEDOM SYSTEM **9**

Two degree of freedom system – modes of vibrations – formulation of equations of motion of multi degree of freedom (MDOF) system - Eigen values and Eigen vectors – Response to free and forced vibrations - damped and undamped MDOF system – Modal superposition methods.

ELEMENTS OF SEISMOLOGY **9**

Elements of Engineering Seismology - Causes of Earthquake – Plate Tectonic theory – Elastic rebound Theory – Characteristic of earthquake – Estimation of earthquake parameters - Magnitude and intensity of earthquakes.

RESPONSE OF STRUCTURES TO EARTHQUAKE **9**

Effect of earthquake on different type of structures – Behaviour of Reinforced Cement Concrete, Masonry and Steel Structure under earthquake loading –Evaluation of earthquake forces as per IS:1893 – 2002 - Response Spectra – Lessons learnt from past earthquakes.

INTRODUCTION TO SEISMIC DESIGN METHODOLOGY **9**

Causes of damage – Planning considerations / Architectural concepts as per IS:4326 – 1993 – Guidelines for Earthquake resistant design – Earthquake resistant design for masonry and

Reinforced Cement Concrete buildings (Procedure only) –Design and detailing as per IS:13920 – 1993.

d. **Activities**

Students will able to understand the dynamic loading and design procedures of the structures subjected to seismic loading as per code provisions.

e. Learning Resources

Text Books

1. Chopra, A.K., *Dynamics of Structures – Theory and Applications to Earthquake Engineering*, 4 th Edition, Pearson Education, 2011.
2. Agarwal. P and Shrikhande. M., *Earthquake Resistant Design of Structures*, Prentice Hall of India Pvt. Ltd. 2007
3. Biggs, J.M., *Introduction to Structural Dynamics*, McGraw Hill Book Co., New York, 1964.

Reference Books

1. Dowrick, D.J., *Earthquake Resistant Design*, John Wiley & Sons, London, 2009.
2. Paz, M. and Leigh.W. *Structural Dynamics – Theory & Computation*, 4th Edition, CBS Publishers & Distributors, Shahdara, Delhi, 2006.

Course Code	Course Name	L	T	P	C
VCE314	FORENSIC AND RETROFITTING TECHNIQUES ENGINEERING	3	0	0	3

Category: Professional Elective

a. Preamble

- To acquire the knowledge on quality of concrete, durability aspects, causes of deterioration, assessment of distressed structures, repairing of structures and demolition procedures.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Summarize the significance of maintenance and repair strategies of building.	K2
CO2	Interpret the quality of concrete construction and also the effects of environmental conditions on it.	K2
CO3	Outline the concepts of special concrete.	K2
CO4	Explain the suitable techniques for repair and protection methods.	K2
CO5	Apply the suitable repairs and retrofitting techniques for different structural failure with case studies.	K3

c. Course Syllabus **Total : 45 Periods**

MAINTENANCE AND REPAIR STRATEGIES **9**

Maintenance, Repair and Rehabilitation - Facets of Maintenance - Importance of Maintenance - Various aspects of Inspection - Assessment procedure for evaluating a damaged structure - Causes of deterioration.

STRENGTH AND DURABILITY OF CONCRETE **9**

Quality assurance for concrete – Strength, Durability, of concrete - Cracks, different types, causes – Effects due to climate, temperature, Sustained elevated, Corrosion - Effects of cover thickness.

SPECIAL CONCRETES **9**

Polymer concrete, Sulphur infiltrated concrete, Fibre reinforced concrete, High strength concrete, High performance concrete, Vacuum concrete, Self compacting concrete, Geopolymer concrete, Reactive powder concrete, Concrete made with industrial wastes.

TECHNIQUES FOR REPAIR AND PROTECTION METHODS **9**

Non-destructive Testing Techniques, Load Test for Stability-Epoxy injection, Shoring, Underpinning, Corrosion protection techniques–Corrosion inhibitors, Corrosion resistant steels, Coatings to reinforcement, cathodic protection.

REPAIR, REHABILITATION AND RETROFITTING OF STRUCTURES **9**

Strengthening of Structural elements, Repair of structures distressed due to corrosion, fire, leakage, earthquake-Transportation of Structures from one place to other –Structural Health Monitoring- demolition techniques-Engineered demolition methods, Case studies.

d. Activities

Students shall be exposed to the repair and retrofitting techniques in nearby construction sites.

e. Learning Resources

Text Books

1. Guha, P.K, *Maintenance and Repairs of Buildings* , New Central Book Agency (P) Ltd, Calcutta, 2011.
2. Dodge woodson, *Concrete structures - protection, Repair and Rehabilitation*, Butterworth- Heinmann, imprint of Elsevier, 2009.
3. Shetty.M.S. Jain A K., *Concrete Technology - Theory and Practice*, S.Chand and Company, Eighth Edition, 2019.
4. Francis Cherunilam and Odeyar D Heggade, *Housing in India*, Himalaya Publishing House, Bombay, 1997.

Reference Books

1. Macdonald, S, *Concrete - Building Pathology*, Blackwell Science Limited, Oxford, 2008.
2. Chudley, R, *The Maintenance and Adaptation of Buildings*, Longman Group Ltd, New York, 2002.
3. P.C.Varghese, *Maintenance Repair and Rehabilitation & Minor works of building*, Prentice Hall India Pvt Ltd, 2014.
4. R. Dodge Woodson, *Concrete Structures, Protection, Repair and Rehabilitation*, Butterworth-Heinemann, Elsevier, New Delhi, 2012.

Course Code	Course Name	L	T	P	C
VCE315	PREFABRICATED STRUCTURES	3	0	0	3

Category: Professional Elective

a. Preamble

- To make the students to learn about modular construction, industrialized construction and design of prefabricated elements and construction methods.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Outline design principles, layout of factory and stages of loading in precast construction.	K2
CO2	Explain the types of floor systems, stairs and roofs used in precast construction.	K2
CO3	Summarize the design principles of precast concrete systems.	K2
CO4	Infer the types of walls used in precast construction, sealants, design of joints.	K2
CO5	Outline the importance of progressive collapse and abnormal loading.	K2

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION **9**

Need for prefabrication – Principles of prefabrication – Modular coordination – Standardization – Materials – Systems – Production – Transportation – Erection.

PREFABRICATED COMPONENTS **9**

Behaviour and types of structural components – Large panel systems – roof and floor slabs – Walls panels - Beams - Columns - Shear walls

DESIGN PRINCIPLES **9**

Design philosophy- Design of cross section based on efficiency of material used – Issues in design of joint flexibility – Allowance for joint deformation - Demountable precast concrete systems.

JOINTS AND CONNECTIONS IN STRUCTURAL MEMBERS **9**

Types of Joints – based on action of forces - compression joints - shear joints - tension joints - based on function - construction, contraction, expansion. Design of expansion joints - Dimensions and detailing - Types of sealants - Types of structural connections - Beam to Column - Column to Column - Beam to Beam - Column to foundation.

DESIGN FOR ABNORMAL LOADS **9**

Progressive collapse – Codal provisions – Equivalent design loads for considering abnormal effects such as earthquakes, cyclones, etc., - Importance of avoidance of progressive collapse - Case studies

d. Activities

Students shall be exposed to different precast structures through industrial visits.

e. Learning Resources

Text Books

1. Bruggeling A.S. G and Huyghe G.F., 1991, *Prefabrication with Concrete*, A.A. Balkema Publishers, USA. .
2. Lewitt,M., 1982, *Precast Concrete- Materials, Manufacture, Properties And Usage*, Applied Science Publishers , London And New Jersey.
3 Bachmann, H. and Steinle, A., 2011, *Precast Concrete Structures*, Ernst & Sohn, Berlin.

Reference Books

1. Koncz T., 1976, *Manual of precast concrete construction*, Vol. I, II and III, Bauverlag, GMBH.
2. Handbook on Precast Concrete Buildings, 2016, Indian Concrete Institute.
3 Structural design manual, 2009, Precast concrete connection details, Society for the studies in the use of precast concrete, Netherland Betor Verlag
4. IS:11447-1985, *Indian standard code of practice for construction with large panel prefabricates.*
5. IS 15916 : 2010, *building design and erection using prefabricated concrete.*
6. IS 10297 : 1982, Reviewed In : 2018, *Code of practice for design and construction of floors and roofs using precast reinforced/prestressed concrete ribbed or cored slab units.*
7. IS 10505 : 1983, Reviewed In : 2018, *Code of practice for construction of floors and roofs using precast concrete waffle units.*

Course Code	Course Name	L	T	P	C
VCE316	PIPELINE ENGINEERING AND SAFETY MANAGEMENT	3	0	0	3

Category: Professional Elective

a. Preamble

- To make the students learn about the pipeline's lifecycle: design, construction, installation, asset management, maintenance, protective measures and safety management in industries.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the basic principles in pipeline engineering.	K2
CO2	Explain the concepts related to materials selection, quality management, design and construction of pipelines	K2
CO3	Outline various protection measures available for pipeline operations and maintenance.	K2
CO4	Understand the concepts of safety management and accident prevention in industries.	K2
CO5	Summarize the concepts of air, pipe routing, storage tanks and pumps.	K2

c. Course Syllabus **Total : 45 Periods**

BASIC PRINCIPLES OF PIPELINE ENGINEERING **9**

Elements of pipeline design: Types of piping systems; transmission lines, In-plant piping systems, Distribution mains, Service lines. Types of water distribution networks; serial networks, branched networks and looped networks. Basic hydraulic principles; continuity and Energy principle. Pipeline route selection, survey and geotechnical guidelines.

MATERIAL SELECTION AND CONSTRUCTION **9**

Materials selection and quality management: Materials designation standards-Quality management- -types of pipelines-laying method-materials. Pipe wall thickness verification. Pipeline stability. Pipeline construction- Pipe supporting structures.

PIPELINE PROTECTION MEASURES **9**

Pipeline protection, Instrumentation, pigging & Operations -Pipeline coating – Cathodic protection Cathodic protection calculations for land pipelines – Internal corrosion – Flow meters and their calibration – Sensors – Pigs-Pipeline Operations and maintenance.

CONCEPTS OF SAFETY MANAGEMENT AND ACCIDENT PREVENTION **9**

Evolution of modern safety concept-safety management functions– safety organization, safety department- staff functions for safety-budgeting for safety- pipe line fire safety - safety policy–accident causes-unsafe act and condition-principles of accident prevention–accident investigation and analysis.

MECHANICAL, ELECTRICAL AND PLUMPING **9**

Mechanical – Air water system, all water system – Heat load formula, ventilation requirements – Concept of fresh air – Piping and wiring routing – Wiring connections – cable routing – Transformer and its applications – Plumbing codes and standards – water supply system – Water distribution pipe routing – storage tank types – Pump classifications.

d. Activities

Students shall be exposed to industrial visit to get practical exposure about challenges in construction and maintenance process.

e. Learning Resources

Text Books

1. Henry Liu, *Pipeline Engineering*, Lewis Publishers (CRC Press), 2003.
2. George A. Antaki , *Piping and Pipeline Engineering: Design, Construction, Maintenance Integrity and Repair*, CRC Press, 2003.
3. P.R. Bhave, R. Gupta, *Analysis of Water Distribution Networks*, Narosa Publishing House Pvt. Ltd.
4. C.Ray Asfahl, David W. Rieske, *Industrial Safety and Health Management*, Prentice Hall, 7th Edition, 2018.

Reference Books

1. E. Shashi Menon , *Piping Calculation Manual*, McGraw-Hill, 2004.
2. E. W. McAllister, *Pipeline Rules of Thumb Handbook*, 7th Edition, 2009.
3. E. Shashi Menon, Mareel Dekker, *Liquid Pipeline Hydraulics*, Inc., 2004.
4. John V.Grimaldi and Rollin H.Simonds, *Safety Management*, Richard D. Irwin publisher,1994.
5. R.K.Mishra, *Safety Management*, AITBS Publishers, 2012.

Course Code	Course Name	L	T	P	C
VCE317	SPECIAL CONCRETE DEVELOPMENT AND APPLICATION	3	0	0	3

Category: Professional Elective

a. Preamble

- To investigate the characteristics of concrete-making materials, experiments, mix design, specialty concretes, and different concrete-making techniques.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Outline the fundamentals and mix proportioning of normal concrete.	K2
CO2	Outline the requirements during extreme weather concreting.	K2
CO3	Demonstrate under water concreting.	K2
CO4	Compare different types of special concrete.	K2
CO5	Summarize fiber usage in concrete and special concreting techniques.	K2

c. Course Syllabus **Total : 45 Periods**

REVIEW OF NORMAL CONCRETE **9**

Concrete – A Composite material – fresh and hardened properties of concrete – fundamentals of proportioning concrete mixes – pores and porosity in concrete – Admixtures.

EXTREME WEATHER CONCRETING **9**

Curing of Concrete – types of curing – Batching mixing placing testing in cold weather and hot weather concreting.

RHEOLOGY AND UNDER WATER CONCRETING **9**

Rheology of concrete – Heat of hydration of cement and thermal stresses – Under water concreting – Antiwashout concreting.

SPECIAL CONCRETE **9**

Batching and Mixing – Types of mixers – Shotcrete – dry mix and wet mix – High strength concrete – SCC.

FRC AND SPECIAL TOPICS **9**

Fibre Reinforced concrete – Polymers in concrete - polymerization – compaction of concrete – effects on fresh and hardened concrete – effect of over compaction – Types of compaction - precast concrete – Quality cover concrete – Use of CPF liners – Permanent formwork.

d. Activities

Students shall be exposed to the different field test for selection of required type of concrete making materials.

e. Learning Resources

Text Books

1. Shetty, M.S., *Concrete Technology (Theory and Practice), 7th Edition*, S. Chand & Company Ltd., New Delhi, 2013.
2. Neville, A.M., *Properties of concrete, 5 th Edition*, Pitman Publishers, New Delhi, India 1996.

Reference Books

1. Mehta, P.K., and Monteiro P.J.M., *Concrete – Microstructure, Properties and Materials, 3rd Edition*, McGraw Hill Education (India) Private Limited, New Delhi, Prentice-Hall, Inc., 2006.
2. Sidney, M., Young, J.F., and Darwin, D., *Concrete, 2nd Edition*, Prentice-Hall, Pearson Education, Inc., New Jersey, 2003.

VERTICAL 2: Environmental and Water Resources Engineering

Course Code	Course Name	L	T	P	C
VCE321	AIR POLLUTION AND CONTROL ENGINEERING	3	0	0	3

Category: Professional Elective

a. Preamble

- This course imparts knowledge on the principle and design of control of Indoor/ particulate/ gaseous air pollutant and its emerging trends.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Classify the air pollutants, their effects and to know about the ambient air quality and emission standards.	K2
CO2	Characterize the plume behaviour and dispersions.	K2
CO3	Select the methods of air pollution control for particulate contaminants.	K2
CO4	Select the methods of air pollution control for gaseous pollutants.	K2
CO5	Assess the indoor air quality and to know about the noise pollution, source, effect, control and preventive measures.	K2

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION **9**

Structure and composition of Atmosphere – Definition, Scope and Scales of Air Pollution – Sources and classification of air pollutants and their effect on human health, vegetation, animals, property, aesthetic value and visibility- Ambient Air Quality and Emission standards –Ambient and stack sampling and Analysis of Particulate and Gaseous Pollutants.

METEOROLOGY **9**

Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Atmospheric Diffusion Theories – Dispersion models, Plume rise.

CONTROL OF PARTICULATE CONTAMINANTS **9**

Factors affecting Selection of Control Equipment – Gas Particle Interaction – Working principle, Design and performance equations of Gravity Separators, Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators – Operational Considerations.

CONTROL OF GASEOUS CONTAMINANTS **9**

Factors affecting Selection of Control Equipment – Working principle, Design and performance equations of absorption, Adsorption, condensation, Incineration, Bio scrubbers, Bio filters – Process control and Monitoring - Operational Considerations.

INDOOR AIR QUALITY MANAGEMENT **9**

Sources, types and control of indoor air pollutants, sick building syndrome and Building related illness- Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive measures.

d. Activities

Students shall be exposed to different case studies pertaining to effect of meteorological factors on dispersion of pollutants.

e. Learning Resources

Text Books

1. Lawrence K. Wang, Norman C. Pareira, Yung Tse Hung, *Air Pollution Control Engineering*, Tokyo, springer science & science media LLC. 2004
2. Noel de Nevers, *Air Pollution Control Engineering*, Waveland press,Inc. 2017.
3. Anjaneyulu. Y, *Air Pollution and Control Technologies*, Allied Publishers (P) Ltd., India, 2002.

Reference Books

1. David H.F. Liu, Bela G. Liptak, *Air Pollution*, Lweis Publishers, 2000.
2. Arthur C. Stern, *Air Pollution (Vol.I – Vol.VIII)*, Academic Press, 2006.
3. Wayne T.Davis, *Air Pollution Engineering Manual*, John Wiley & Sons, Inc. 2000.
4. M.N Rao and HVN Rao, *Air Pollution*, Tata Mcgraw Hill Publishing Company limited, 2007.
5. C.S.Rao, *Environmental Pollution Control Engineering*, New Age International (P) Limited Publishers, 2006.

Course Code	Course Name	L	T	P	C
VCE322	CLIMATOLOGY FOR BUILT ENVIRONMENT	3	0	0	3

Category: Professional Elective

a. Preamble

- To equip the students with the basic understanding of climatic types in India, and the impact on requirements of building design and site planning.
- To introduce the students to the basic science of building design and site planning for thermal comfort, daylighting and natural ventilation; familiarize them with the data, methods, principles, standards and tools for planning and designing for climatic comfort.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Outline about building climatology.	K2
CO2	Interpret the tropical climates and design considerations.	K2
CO3	Examine the thermal comfort of a space.	K2
CO4	Summarize the heat exchange process in buildings and the thermophysical properties of building materials.	K2
CO5	Understand the concepts of solar orientation.	K2

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO BUILDING CLIMATOLOGY **9**

Climate and built form interaction. Global Climatic factors, elements of climate, graphic representation of climatic data, Mahoneys Tables, macro and micro climate; challenge of rapid, extreme environmental change.

TROPICAL CLIMATES **9**

Definition, classification of tropical climates, characteristics of different climatic zones, Design considerations for warm-humid, hot-dry, composite and upland climates.

THERMAL COMFORT **9**

Thermal comfort factors, Physiological aspects, Body heat balance, comfort range, comfort charts.

HEAT FLOW THROUGH BUILDINGS **9**

Basic principles of heat transfer through buildings, performance of different materials, Periodic heat flow.

SUN AND THE DESIGN PROCESS **9**

Solar geometry, Solar charts, Sun angles and shadow angles, orientation for sun, sun control, design of shading devices, building form and heat gain, basic principles of daylighting, sunlight and glare.

d. Activities

Students shall be exposed to the different climatology conditions for various places drive in the college premises.

e. Learning Resources

Text Books

1. Koenigsberger, O.H. and Others. *Manual of Tropical Housing and Building*. Orient Longman, Chennai, 2003.
2. Kukreja, C.P. *Tropical Architecture*. Tata McGraw-Hill Pub. Co. Ltd., New Delhi, 1978.

Reference Books

1. Markus, T.A. and Morris. E.N. Buildings, *Climate and Energy*. Pitman Pub. Ltd., London, 1980.

Course Code	Course Name	L	T	P	C
VCE323	GROUND IMPROVEMENT TECHNIQUES	3	0	0	3

Category: Professional Elective

a. Preamble

- Students will learn about a number of problems with soil deposits and how to assess them.
- Students will learn many strategies for enhancing the qualities of challenging soils as well as the design procedures necessary to put diverse ground development techniques into practice.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the concepts of hydraulic modifications for ground improvement.	K2
CO2	Summarize the techniques and methods of mechanical modification of soil.	K2
CO3	Outline the ground's properties through physical alterations utilizing several techniques.	K2
CO4	Relate soil properties through various reinforcing methods and design.	K2
CO5	Identify the chemical procedures to enhance soil properties.	K3

c. Course Syllabus **Total : 45 Periods**

HYDRAULIC MODIFICATIONS **9**

Scope and necessity of ground improvement in Geotechnical engineering basic concepts. Drainage – Ground Water lowering by well points, deep wells, vacuum and electro-osmotic methods. Stabilization by thermal and freezing techniques - Applications.

MECHANICAL MODIFICATIONS **9**

Insitu compaction of granular and cohesive soils, Shallow and Deep compaction methods – Sand piles – Concept, design, factors influencing compaction. Blasting and dynamic consolidation design and relative merits of various methods – Soil liquefaction mitigation methods.

PHYSICAL MODIFICATION **9**

Preloading with sand drains, fabric drains, wick drains – theories of sand drain - Stone column with and without encased, lime stone – functions – methods of installation – design, estimation of load carrying capacity and settlement. Root piles and soil nailing – methods of installation – Design and Applications.

MODIFICATION BY INCLUSIONS **9**

Reinforcement – Principles and basic mechanism of reinforced earth, simple design: Synthetic and natural fiber based Geotextiles and their applications. Filtration, drainage, separation, erosion control.

CHEMICAL MODIFICATION **9**

Grouting – Types of grout – Suspension and solution grouts – Basic requirements of grout. Grouting equipment – injection methods – jet grouting – grout monitoring – Electro – Chemical stabilization – Stabilization with cement, lime - Stabilization of expansive clays – case studies.

d. Activities

Students shall be exposed to the different materials to stabilize the soil inside the college premises.

e. Learning Resources

Text Books

1. Pappala, A.J., Huang,J., Han, J., and Hoyos, L.R., *Ground Improvement and Geosynthetics*; Geotechnical special publication No.207, Geo Institute, ASCE, 2010
2. Day, R.W., *Foundation Engineering Handbook, McGraw* – Hill Companies, Inc. 2006.

Reference Books

1. Rowe, R.K., *Geotechnical and Geo-environmental Engineering Handbook*, Kluwer Academic Publishers, 2001.
2. Das, B.M., *Principles of Foundation Engineering*, Fourth Edition, PWS Publishing, 1999.

Course Code	Course Name	L	T	P	C
VCE324	HYDROLOGY AND WATER RESOURCES ENGINEERING	3	0	0	3

Category: Professional Elective

a. Preamble

- This course imparts the concept of hydrological aspects of water availability and requirements and should be able to quantify, control and regulate the water resources.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the key drivers on water resources, hydrological processes.	K2
CO2	Outline the integrated behaviour in catchments.	K2
CO3	Apply a range of hydrological models to surface water and groundwater problems.	K3
CO4	Develop spatial analysis of rainfall data and design water storage reservoirs.	K3
CO5	Understand the concept and methods of ground water management.	K2

c. Course Syllabus **Total : 45 Periods**

PRECIPITATION AND ABSTRACTIONS **9**

Hydrological cycle- Meteorological measurements – Requirements, types and forms of precipitation - Rain gauges-Spatial analysis of rainfall data using Thiessen and Isohyetal methods-Interception - Evaporation. Horton‟s equation, pan evaporation measurements and evaporation suppression - Infiltration-Horton‟s equation - double ring infiltrometer, infiltration indices.

RUNOFF **9**

Watershed, catchment and basin - Catchment characteristics - factors affecting runoff - Run off estimation using empirical - Strange‟s table and SCS methods – Stage discharge relationships- flow measurements- Hydrograph – Unit Hydrograph – IUH

FLOOD AND DROUGHT **9**

Natural Disasters-Flood Estimation- Frequency analysis- Flood control- Definitions of droughts-Meteorological, hydrological and agricultural droughts- IMD method-NDVI analysis- Drought Prone Area Programme (DPAP)

RESERVOIRS **9**

Classification of reservoirs, General principles of design, site selection, spillways, elevation – area - capacity - storage estimation, sedimentation - life of reservoirs – rule curve.

GROUNDWATER AND MANAGEMENT **9**

Origin- Classification and types - properties of aquifers- governing equations – steady and unsteady flow - artificial recharge - RWH in rural and urban areas

d. Activities

Students shall be exposed to the different realtime storage and diversion structures through Industrial visit.

e. Learning Resources

Text Books

1. Subramanya .K. *Engineering Hydrology*- Tata McGraw Hill, 2010
2. Jayarami Reddy .P. *Hydrology*, Tata McGraw Hill, 2008.
3. Linsley, R.K. and Franzini, J.B. *Water Resources Engineering*, McGraw Hill International Book Company, 1995.

Reference Books

1. David Keith Todd. *Groundwater Hydrology*, John Wiley & Sons, Inc. 2007.
2. Ven Te Chow, Maidment, D.R. and Mays, L.W. *Applied Hydrology*, McGraw Hill International Book Company, 1998.
3. Raghunath .H.M., *Hydrology*, Wiley Eastern Ltd., 1998.

Course Code	Course Name	L	T	P	C
VCE325	COMPUTATIONAL FLUID DYNAMICS	3	0	0	3

Category: Professional Elective

a. Preamble

- This course introduces the fundamentals of CFD, Finite difference and finite volume methods for steady, transient and convection diffusion, Flow field analysis and turbulence modeling.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the fundamentals of CFD, and develop case specific governing equations.	K2
CO2	Explain finite difference and finite volume based analysis for steady and transient diffusion problems.	K2
CO3	Outline various mathematical schemes under finite volume method for convention diffusion.	K2
CO4	Solve complex problems in the field of fluid flow and heat transfer with the support of high speed computers.	K3
CO5	Apply the various discretization methods, solution procedure and the concept of turbulence modeling.	K3

c. Course Syllabus **Total: 45 Periods**

GOVERNING EQUATIONS AND BOUNDARY CONDITIONS **9**

Basics of computational fluid dynamics – Governing equations– Continuity, Momentum and Energy equations – Chemical species transport –Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

FINITE DIFFERENCE AND FINITE VOLUME METHODS FOR DIFFUSION **9**

Derivation of finite difference equations– General Methods for first and second order accuracy – Finite volume formulation for steady and transient diffusion problems –Example problems– Use of Finite Difference and Finite Volume methods.

FINITE VOLUME METHOD FOR CONVECTION DIFFUSION **9**

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes, properties of discretization schemes, Hybrid, Power-law, QUICK Schemes, Conservativeness, Boundedness, Transportiveness.

FLOW FIELD ANALYSIS **9**

Stream function and vorticity, Representation of the pressure gradient term, Staggered grid – Momentum equations, Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms.

TURBULENCE MODELS AND MESH GENERATION **9**

Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models, Mesh Generation and refinement Techniques-software tools.

d. Activities

Students shall be exposed to write the flow equation for the real time fluids.

e. Learning Resources

Text Books

1. Versteeg, H.K., and Malalasekera, W., *An Introduction to Computational Fluid Dynamics*: The finite volume Method, Pearson Education, 2014.
2. Ghoshdastidar, P.S., *Computer Simulation of flow and heat transfer*, Tata McGraw Hill, 1998.

Reference Books

1. John. F. Wendt, *Computational Fluid Dynamics – An Introduction*, Springer, 2013.
2. K.Muralidhar&T.Sundararajan, *Computational Fluid Flow and Heat Transfer*, Narora Publishing House, 1994.

Course Code	Course Name	L	T	P	C
VCE326	ENVIRONMENTAL IMPACT ASSESSMENT	3	0	0	3

Category: Professional Elective

a. Preamble

- This course imparts the knowledge and skills to identify, assess and mitigate the environmental and social impacts of developmental projects.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the application of sustainable development principles in EIA process, EIA notification and legal framework.	K2
CO2	Outline the methods and procedures to assess and predict Environmental impact.	K2
CO3	Summarize and prepare an EIA report with environmental management plan.	K2
CO4	Outline the assessment of socio economic impact.	K2
CO5	Identify the impact of infrastructure projects with the help of case studies.	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION **9**

Impacts of Development on Environment – Rio Principles of Sustainable Development- Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework.

ENVIRONMENTAL ASSESSMENT **9**

Screening and Scoping in EIA – Drafting of Terms of Reference, Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise, flora and fauna - Matrices – Networks – Checklist Methods - Mathematical models for Impact prediction.

ENVIRONMENTAL MANAGEMENT PLAN **9**

Plan for mitigation of adverse impact on water, air and land, water, energy, flora and fauna – Environmental Monitoring Plan – EIA Report Preparation – Public Hearing- Environmental Clearance.

SOCIO ECONOMIC ASSESSMENT **9**

Baseline monitoring of Socio economic environment – Identification of Project Affected Personal – Rehabilitation and Resettlement Plan- Economic valuation of Environmental impacts – Cost benefit Analysis.

CASE STUDIES **9**

EIA case studies pertaining to Infrastructure Projects – Roads and Bridges – Mass Rapid Transport Systems - Airports - Dams and Irrigation projects - Power plants, Multi-storey Buildings – Water Supply and Drainage Projects.

d. Activities

Students shall be exposed to the different EIA case studies pertaining to Infrastructure Projects.

e. Learning Resources

Text Books

1. Canter, R.L, *Environmental impact Assessment*, McGraw Hill Inc, New Delhi, 1995.
2. Lohani, B., Evans.J.W., Ludwig. H, Everitt R.R , Richard A. Carpenter, and Tu .S.L., *Environmental Impact Assessment for Developing Countries in Asia*, Volume 1 – Overview, Asian Development Bank,1997.
3. Peter Morris, Riki Therivel, *Methods of Environmental Impact Assessment*, Routledge Publishers, 2009.

Reference Books

1. Becker H. A., Frank Vanclay, *The International handbook of social impact assessment*, Edward Elgar Publishing,2003
2. Barry Sadler and Mary McCabe, *Environmental Impact Assessment Training Resource Manual*, United Nations Environment Programme,2002.
3. Judith Petts, *Handbook of Environmental Impact Assessment Vol. I and II*, Blackwell Science New York, 1998.
4. *Ministry of Environment and Forests EIA Notification and Sectoral Guides*, Government of India, New Delhi, 2010.

Course Code	Course Name	L	T	P	C
VCE327	**MUNICIPAL SOLID WASTE MANAGEMENT**	**3**	**0**	**0**	**3**

Category: Professional Elective

a. Preamble

- The students will understand the problems created due to various types of solid and hazardous wastes to environment and health.
- The knowledge of legal, institutional and financial aspects of management of solid and hazardous wastes would be understood by the student.
- The students will also be able to apply appropriate engineering, financial and technical options for waste management.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Outline the types of solid and hazardous waste constituents based on the source generation.	K2
CO2	Outline the characterization, sampling and source reduction methods of waste.	K2
CO3	Organize the solid waste collection and transport system.	K3
CO4	Summarize various steps involved in the solid waste processing technologies.	K2
CO5	Identify various waste disposal methods for the real time applications.	K3

c. Course Syllabus **Total : 45 Periods**

SOURCES, CLASSIFICATION AND REGULATORY FRAMEWORK 9

Types and Sources of solid and hazardous wastes - Need for solid and hazardous waste management – Salient features of Indian legislations on management and handling of municipal solid wastes, hazardous wastes, biomedical wastes, nuclear wastes - lead acid batteries, electronic wastes, plastics and fly ash – Elements of integrated waste management and roles of stakeholders - Financing and Public Private Participation for waste management Integrated solid waste management.

WASTE CHARACTERIZATION AND SOURCE REDUCTION 9

Waste generation rates and variation - Composition, physical, chemical and biological properties of solid wastes – Hazardous Characteristics – TCLP tests – waste sampling and

characterization plan - Source reduction of wastes –Waste exchange - Extended producer responsibility - Recycling and reuse.

STORAGE, COLLECTION AND TRANSPORT OF WASTES 9

Handling and segregation of wastes at source – storage and collection of municipal solid wastes – Analysis of Collection systems - Need for transfer and transport – Transfer stations Optimizing waste allocation– compatibility, storage, labeling and handling of hazardous wastes – hazardous waste manifests and transport.

WASTE PROCESSING TECHNOLOGIES 9

Objectives of waste processing – material separation and processing technologies – biological and chemical conversion technologies – methods and controls of Composting thermal conversion technologies and energy recovery – incineration – solidification and stabilization of hazardous wastes- treatment of biomedical wastes - Health considerations in the context of operation of facilities.

WASTE DISPOSAL 9

Waste disposal options – Disposal in landfills - Landfill Classification, types and methods – site selection - design and operation of sanitary landfills, secure landfills and landfill bioreactors – leachate and landfill gas management – landfill closure and environmental monitoring – Rehabilitation of open dumps-remediation of contaminated sites – case studies.

d. Activities

Students shall be exposed to the various field exposure related to Solid and Hazardous waste treatment and disposal methods

e. Learning Resources

Reference Books

1. Hilary Theisen and Samuel A, Vigil, George Tchobanoglous, *Integrated Solid Waste Management*, McGraw- Hill, New York, 1993
2. CPHEEO, *Manual on Municipal Solid waste management*, Central Public Health and Environmental Engineering Organization, Government of India, New Delhi, 2000
3. Michael D. LaGrega, Philip L Buckingham, Jeffrey C. E *Vans and Environmental"*
4. *"Resources Management, Hazardous waste Management*, Mc-Graw Hill International edition, New York, 2001.

5. Vesilind P.A., Worrell W and Reinhart, *Solid waste Engineering*, Thomson Learning Inc., Singapore, 2002.
6. Charles A. Wentz, *Hazardous Waste Management*, Second Edition, Pub: McGraw Hill International Edition, New York, 1995.

VERTICAL 3 : Geoinformatics and Transportation Engineering

Course Code	Course Name	L	T	P	C
VCE331	AIRPORT AND HARBOUR ENGINEERING	3	0	0	3

Category: Professional Elective

a. Preamble

- This course introduces the basic concepts of planning and designing of Airport and Harbour.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Outline the planning and site selection of Airport.	K2
CO2	Develop the design elements of runway, taxiway, terminal building.	K3
CO3	Illustrate the concepts of Air traffic control and Visual aids.	K2
CO4	Understand the various features in Harbour planning.	K2
CO5	Understand coastal structure and protection works.	K2

c. Course Syllabus **Total: 45 Periods**

AIRPORT PLANNING **9**

History and development of air transport, air crafts and its characteristics, airport classifications as per ICAO, Airport master plan, Airport layout, airport size and site selection, Airport Zones and Zoning laws.

AIRPORT DESIGN **9**

Runway – Wind rose and orientation of Runway, Basic Runway length, and corrections to Runway length, Taxiway – Geometric elements, layout, exit taxiway, location and geometrics, holding apron, turnaround facility, Terminal building – functions, space requirements, location planning concepts, vehicular parking area.

AIR TRAFFIC CONTROL AND VISUAL AIDS **9**

Air traffic control-objectives, control system, control network-Visual aids-landing information system, Airport markings and lighting, Airport grading-importance - operations, Airport drainage aims, functions, basic requirements.

HARBOUR PLANNING **9**

History of water transportation, Classification of harbours, natural and artificial, Harbour components, ship characteristics, characteristics of good harbour and principles of harbour planning, size of harbour, site selection criteria and layout of harbours, Surveys to be carried out for harbor planning.

HARBOUR STRUCTURES **9**

General design aspects, Breakwaters – Function, types general design principles, wharves, quays, jetties, piers, pier heads, dolphin, fenders, mooring accessories, navigational aids – function, types, suitability, Wet docks-purpose, design consideration, Repair docks - graving docks, floating docks. Costal protection – Purpose and devices, Dredging – Purpose, methods.

d. Activities

Students shall be arranged to visit the Harbour structures

e. Learning Resources

Text Books

1. Khanna.S.K. Arora.M.G and Jain.S.S, *Airport Planning and Design*, Nemachand and Bros, Roorkee, 2017.
2. S. P. Bindra, *A Course in Docks and Harbour Engineering*, Dhanpat Rai & Sons, NewDelhi, 2012.

Reference Books

1. Ashford N. and Wright P.H., *Airport Engineering*, John Wiley and Sons, Inc., New York, 2016.
2. R. Srinivasan and S. C. Rangwala, *Harbour, Dock and Tunnel Engineering*, Charotar Pub.House, Anand, 2013.

Course Code	Course Name	L	T	P	C
VCE332	TOTAL STATION, GPS AND DRONE SURVEYING	3	0	0	3

Category: Professional Elective

a. Preamble

- The students will understand the working of Total Station and GPS.
- The students will understand the fundamentals of Drone survey.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the fundamentals of Total station.	K2
CO2	Outline electro optical and micro wave system and its usage in Totalstation.	K2
CO3	Understand the concepts of GPS satellite system.	K2
CO4	Construct GPS data processing with software applications.	K3
CO5	Explain the fundamentals of Drone surveying.	K2

c. Course Syllabus **Total : 45 Periods**

FUNDAMENTALS OF TOTAL STATION AND CORRECTIONS 9

Methods of Measuring Distance, Basic Principles of Total Station, Historical Development, Classifications, applications and comparison with conventional surveying. Refractive index (RI) - factors affecting RI-Computation of RI for light,near infrared waves and microwaves at standard and ambient conditions- Reference refractive index- Real time application of first velocity correction - Mean refractive index- Second velocity correction -Total atmospheric correction- Use of temperature and pressure transducers.

ELECTRO OPTICAL AND MICRO WAVE SYSTEM 9

Electro-optical system: Measuring principle, Working principle, Sources of Error, Infrared and Laser Total Station instruments. Microwave system: Measuring principle, working principle, Sources of Error, Microwave Total Station instruments. Comparison between Electro-optical and Microwave system. Care and maintenance of Total Station instruments – Traversing and Trilateration-COGO functions, offsets and stake out-land survey applications.

GPS SATELLITE SYSTEM **9**

Basic concepts of GPS - Historical perspective and development - applications - Geoid and Ellipsoid- satellite orbital motion - Keplerian motion — Kepler‘s Law - Perturbing forces - Geodetic satellite - Doppler effect - Positioning concept –GNSS, IRNSS and GAGAN - Different segments - space, control and user segments - satellite configuration — GPS signal structure - Orbit determination and representation - Anti Spoofing and Selective Availability - Task of control Segment-GPS Receiver.

GPS DATA PROCESSING **9**

GPS observables - code and carrier phase observation - linear combination and derived observables - concept of parameter estimation — downloading the data RINEX Format — Differential data processing – software modules -solutions of cycle slips, ambiguities, Concepts of rapid, static methods with GPS - semi Kinematic and pure Kinematic methods -satellite geometry& accuracy measures - applications- long baseline processing- use of different softwares.

INTRODUCTION ON DRONE SURVEY **9**

Introduction to Drones, History of Drone/UAS/UAVs, payload, battery life, Specs for good results, Regulations of DGCA and Drone license, Pre and Post Flight planning- Flight execution and photography, data collection- Image Format, GSD, Scale and Resolution.

d. Activities

Students shall be exposed to concepts and applications of Total station, GPS and Drone survey by theory and practice.

e. Learning Resources

Text Books

1. Rueger, J.M. *Electronic Distance Measurement*, Springer-Verlag, Berlin, 4th Edition,1996.
2. Lillesand and Kiefer, *Remote Sensing and Image Interpretation*, 5th Edition, published by John Wiley and Sons, 2008.

   Satheesh Gopi, rasathishkumar, N.madhu, *Advanced Surveying , Total Station GPS and Remote Sensing*, Pearson education , 2nd Edition,2017.

Reference Books

1. Laurila, S.H. *Electronic Surveying in Practice*, John Wiley and Sons Inc, 1983.
2. David P Paine, *Aerial Photography and Image Interpretation*, 2nd Edition, published by Wiley, Higher Education, 2006.

Course Code	Course Name	L	T	P	C
VCE333	INTELLIGENT TRANSPORT SYSTEMS	3	0	0	3

Category: Professional Elective

a. Preamble

- To impart knowledge on fundamentals of intelligent transport systems, concepts of ATIS and its operations, basics of predictive route guidance system, concepts of APTS and its operations, have an overview of ITS implementation in developing countries.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the fundamentals of ITS and its benefits.	K2
CO2	Outline the data collection techniques using sensors.	K2
CO3	Explain the various Traffic Management systems of ITS.	K2
CO4	Explain the various Traffic Planning systems of ITS.	K2
CO5	Apply knowledge of ITS in Logistics.	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO ITS **9**

Fundamentals of ITS: Definition of ITS, Challenges in ITS Development-Purpose of ITS Deployment - Benefits of ITS- Overview of application of ITS in Transportation Planning

DATA COLLECTION THROUGH ITS **9**

Sensors & its application in traffic data collection - Elements of Vehicle Location and Route Navigation and Guidance concepts; ITS Data collection techniques – vehicle Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), GIS, RFID, video data collection, Internet of Things (IOT).

ITS IN TRAFFIC MANAGEMENT **9**

ITS User Needs and Services and Functional areas –Introduction, Advanced Traffic Management systems (ATMS), Advanced Traveler Information systems (ATIS), Advanced Vehicle Control systems (AVCS), Advanced Public Transportation systems (APTS),

Advanced Rural Transportation systems (ARTS)- Autonomous Vehicles- Autonomous Intersections.

ITS IN TRANSPORTATION PLANNING **9**

ITS and safety, ITS and security- Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing.; Transportation network operations – public transportation applications- Weight –in Motion.

ITS APPLICATION IN LOGISTICS **9**

Commercial vehicle operations and intermodal freight-Fleet Management- IT application in freight logistics-E commerce – case studies.

d. Activities

Case studies on Impact on route guidance on ITS , APTS, ITS on Environment.

e. Learning Resources

Text Books

1. R. Srinivasa Kumar, *Intelligent Transportation Systems*, Universities Press P Ltd, Telangana, 2022.

Reference Books

1. *Intelligent Transport Systems*, Intelligent Transportation Primer, Washington, US,2001.
2. Henry F.Korth, and Abraham Siberschatz, *Data Base System Concepts*, McGraw Hill,1992.
3. TurbanE.,*Decision Support and Export Systems Management Support Systems*, Maxwell Macmillan,1998.
4. Sitausu S. Mittra, *Decision Support Systems–Tools and Techniques*, John Wiley, New York,1986.

Course Code	Course Name	L	T	P	C
VCE334	REMOTE SENSING AND GIS TECHNIQUES	3	0	0	3

Category: Professional Elective

a. Preamble

- This course introduces the students to the basic concepts and principles of various components of remote sensing and its application in Civil Engineering.
- It will also provide an exposure to GIS and its practical applications in civil engineering.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the interaction of electromagnetic radiation with atmosphere and earth material.	K2
CO2	Infer knowledge about satellite orbits and remote sensors.	K2
CO3	Outline the concepts of interpretation of satellite imagery and civil engineering applications.	K2
CO4	Understand the fundamentals of maps, their characteristics and GIS, its Components.	K2
CO5	Apply various analysis tools for modeling applications.	K3

c. Course Syllabus **Total : 45 Periods**

EMR AND ITS INTERACTION WITH ATMOSPHERE & EARTH MATERIAL **9**

Definition of remote sensing and its components – Electromagnetic spectrum – wavelength regions important to remote sensing – Wave theory, Particle theory, Stefan- Boltzman and Wein‟s Displacement Law – Atmospheric scattering, absorption – Atmospheric windows – spectral signature concepts – typical spectral reflective characteristics of water, vegetation and soil.

PLATFORMS AND SENSORS **9**

Types of platforms – orbit types, Sun-synchronous and Geosynchronous – Passive and Active sensors – resolution concept – Pay load description of important Earth Resources and Meteorological satellites – Airborne and spaceborne TIR and microwave sensors.

IMAGE INTERPRETATION, ANALYSIS AND APPLICATION **9**

Types of Data Products – types of image interpretation – basic elements of image interpretation - visual interpretation keys – Digital Image Processing – Pre-processing – image enhancement techniques – multispectral image classification – Supervised and unsupervised. Civil Engineering applications: highway and railway alignments, site selection for dams, town and regional planning.

GEOGRAPHIC INFORMATION SYSTEM **9**

Introduction – Maps – Definitions – Map projections – types of map projections – map analysis – GIS definition – basic components of GIS – standard GIS softwares – Application of QGIS – Data type – Spatial and non-spatial (attribute) data – measurement scales – Data Base Management Systems (DBMS).

DATA ENTRY, STORAGE AND ANALYSIS **9**

Data models – vector and raster data – data compression – data input by digitization and scanning – attribute data analysis – integrated data analysis – Modeling in GIS Highway alignment studies – Land Information System - Remote sensing tools – Applications – Demo on remote sensing tool.

d. Activities

Students shall be exposed to 3D image processing using satellite images.

e. Learning Resources

Text Books

1. Anji Reddy. M., *Textbook of remote sensing and geographical information systems*, S. Publications, Hyderabad, 2001.
2. Lillesand, T.M., Kiefer, R.W. and JW, C., *Remote Sensing and Image Interpretation*, New York: JohnWiley and Sons, 2004.

Reference Books

1. Lo CP and AKW Yeung., *Concepts and Techniques of Geographic Information Systems*, Prentice-Hall of India Pvt. Ltd., New Delhi, 2002.
2. Burrough, P.A., McDonnell, R., McDonnell, R.A. and Lloyd, C.D., *Principles of geographical information systems*. Oxford university press, 2015.
3. Ian, H., *An introduction to geographical information systems*, Pearson Education India, 2010.

Course Code	Course Name	L	T	P	C
VCE335	SMART CITIES	3	0	0	3

Category: Professional Elective

a. Preamble

- To help the leaners to understand the concepts of smart city and to introduce the students about application of technologies in smart cities.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the basics of Urbanization and the role of smart cities.	K2
CO2	Outline the concepts of smart physical infrastructure.	K2
CO3	Understand the role of smart planning for sustainable development.	K2
CO4	Apply the knowledge of Technologies in Smart City.	K3
CO5	Make use of case studies for the management of smart city projects.	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION **9**

Urbanisation, need of focused development, role of Authorities, Smart city, Opportunity and Challenges- Smart infrastructures for city- Smart Cities Mission.

SMART PHYSICAL INFRASTRUCTURE **9**

Infrastructure development in Smart Cities - Physical Infrastructure, Land Use - Compact/mixed-use development, Transit oriented development (TOD); Smart City Management-Transportation Unified governance structure (UMTA). Smart public transportation, Smart parking, Intelligent traffic management, Detour management; Low emission vehicles, Electric Mobility - Environmental projects etc.,

SUSTAINABILITY AND SMART PLANNING **9**

Relationship Between Sustainability and Smart planning - Place making project guidelines-Surveillance, Smart Street Lighting, Intelligent Emergency Services,

Intelligent Disaster Forecasting and Management, GIS-based Spatial Decision Support Systems, Smart Communication Services.

APPLICATION OF TECHNOLOGIES IN SMART CITIES **9**

Role of Technologies in Smart Cities - Integrated Command and Control Center (ICCC), Data Analytics, Data driven strategies implementation in smart cities.

SMART CITIES PROJECT MANAGEMENT **9**

Need for project management, Philosophy and concepts; Project phasing and stages; Project organizational structuring: Planning and Scheduling: Project cost analysis; Procurement and Contracting: PPP: Project Monitoring and Evaluation: Risk Management; Case studies.

d. Activities

Students shall be exposed to the Industrial Visit related to Smart cities project.

e. Learning Resources

Reference Books

1. P Sharma , *Sustainable Smart cities in India, Challenges and Future Perspectives*, Springer Link, 2017
2. Sameer Sharma, *Smart Cities Unbounded- Ideas and Practice of Smart Cities in India*, Bloomsbury India, 2018.
3. Binti Singh, ManojParmar, *Smart City in India Urban Laboratory, Paradigm or Trajectory,* Routledge India,2019
4. https://smartcities.gov.in/guidelines#block-habikon-content
5. https://smartnet.niua.org/learn/library

Course Code	Course Name	L	T	P	C
VCE336	SATELLITE IMAGE PROCESSING	3	0	0	3

Category: Professional Elective

a. Preamble

- To make the students understand the concepts, principles and processing of Satellite data.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand about Remote sensing and Image processing systems.	K2
CO2	Explain the source of error in satellite image and also to remove the error from satellite image.	K2
CO3	Interpret appropriate image Enhancement techniques based on image characteristics.	K2
CO4	Outline the satellite image using various methods and also evaluate the accuracy of classification.	K2
CO5	Apply the advanced image classification methods and conduct lifelong research in the field of image processing.	K3

c. Course Syllabus **Total : 45 Periods**

FUNDAMENTALS OF IMAGE PROCESSING **9**

Information Systems - Encoding and decoding - acquisition, storage and retrieval –data products - satellite data formats - Digital Image Processing Systems - Hardware and software design consideration Scanner, digitizer - photo write systems.

SENSORS MODEL AND PRE PROCESSING **9**

Image Fundamentals – Sensor models – spectral response – Spatial response – IFOV,GIFOV& GSI – Simplified Sensor Models – Sampling & quantization concepts – Image Representation& geometry and Radiometry – Colour concepts – Sources of Image degradation and Correction procedures- Atmospheric, Radiometric, Geometric Corrections- Image Geometry Restoration- Interpolation methods and resampling techniques.

IMAGE ENHANCEMENT **9**

Image Characteristics - Histograms - Scattergrams – Univariate and multi variate statistics-enhancement in spatial domain – global, local & colour Transformations – PC analysis, edge detections, merging - filters - convolution – LPF, HPF , HBF, directional box, cascade – Morphological and adaptive filters – Zero crossing filters – scale space transforms – power spectrum – texture analysis – frequency transformations - Fourier, wavelet and curvelet transformations.

IMAGE CLASSIFICATION **9**

Spectral discrimination - pattern recognition concepts - Baye‘s approach - Signature and training sets – Separability test –Supervised Classification – Minimum distance to mean, Parallelepiped, MLC – Unsupervised classifiers – ISODATA,K-means-Support Vector Machine – Segmentation (Spatial, Spectral) – Tree classifiers - Accuracy assessment – Error matrix – Kappa statistics – ERGAS, RMS.

ADVANCED CLASSIFIERS **9**

Fuzzy set classification – sub- pixel classifier – hybrid classifiers, Texture based classification – Object based classifiers – Artificial Neural nets – Hebbian leaning – Expert system, types and examples – Knowledge systems.

d. Activities

Students shall be exposed to concepts, principles, processing of Satellite data.

e. Learning Resources

Text Books

1. John, R. Jensen, *Introductory Digital Image Processing*, Prentice Hall, New Jersey, 4th Edition, 2015.
2. Robert, A. Schowengergt, *Techniques for Image Processing and classification in Remote Sensing*, Academic Press, 2012.

Reference Books

1. Robert, G. Reeves,- *Manual of Remote Sensing* Vol. I & II - American Society of Photogrammetry, Falls, Church, USA, 1983.
2. Richards, *Remote sensing digital Image Analysis - An Introduction* 5th Edition ,2012, Springer -Verlag 1993.
3. Rafael C Gonzalez,Richard Eugene Woods, *Digital Image Processing*, Pearson/ Prentice Hall,2008
4. Annadurai *Fundamentals of Digital Image Processing* Pearson Education, 2006.

5. William K. Pratt, *Digital Image Processing: PIKS Scientific Inside* by 4th Edition, Wiley Interscience, 2007.

Course Code	Course Name	L	T	P	C
VCE337	TRAFFIC ENGINEERING AND MANAGEMENT	3	0	0	3

Category: Professional Elective

a. Preamble

- To give an overview of various surveys to be conducted in Traffic engineering, Traffic Regulation, management and Traffic safety to the students.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the knowledge of science and engineering fundamentals in conducting traffic surveys.	K2
CO2	Outline the principles of traffic flow characteristics and their relationships	K2
CO3	Understand various traffic management measures in addressing the demand Pricing and ITS applications	K2
CO4	Develop various types of control and regulatory measures to meet an efficient traffic network.	K3
CO5	Explain various type of facilities and plan for Non Motorised Transport	K2

c. Course Syllabus **Total : 45 Periods**

TRAFFIC SURVEYS AND ANALYSES **9**

Traffic characteristics: Human, vehicular, and Pavement Characteristics, Problems-presentation of traffic volume data, Annual Average Daily Traffic, Average Daily Traffic, Design hourly traffic volume; Speed- spot speed, presentation of spot speed data, speed and delay studies, methods of conducting spot-speed studies and Speed and Delay studies; Problems Origin and Destination – methods of conducting the survey and presentation of data; parking surveys, presentation of data and analyses, determination of parking demand; Accident studies and analyses; Different problems.

TRAFFIC FLOW AND ROADWAY CAPACITY **9**

Traffic Flow Characteristics – Basic traffic manoeuvres, Traffic stream flow characteristics, Speed - Flow- Density Relations; Passenger Car Units – Mixed traffic flow and related issues

– Concept of PCU value- Factors affecting PCU values- Recommended PCU values for different conditions; Capacity and Level of Service – Factors affecting practical capacity – Design Service Volumes.

COST – EFFECTIVE TRAFFIC MANAGEMENT TECHNIQUES **9**

Traffic System Management: Regulatory Techniques- one way street, Reversible Street, Reversible lane, Turning moment restrictions, closing streets; Traffic Control Devices – Traffic Signs – Road Markings, Traffic Signals, Miscellaneous traffic control devices; Traffic Segregation – Vehicle 150 segregation, Pedestrian segregation, Traffic signals design; Bus Priority Techniques – Priority manoeuvres – With-flow bus lane and contra-flow bus lane; Self- Enforcing Techniques- Demand Management Techniques (TDM) Road pricing, parking control, Tolls, Staggering of office/educational institution hours.

DESIGN OF ROAD INTERSECTIONS **9**

Importance and Classification; Intersections at-grade – uncontrolled, channelised; Rotary intersections (problems)- Signalised intersections (problems)- Grade Separated Intersections – merits and demerits, types, pattern of intersections with different types of interchanges- Capacity, Concept diagrams.

DESIGN OF PARKING AND PEDESTRIAN FACILITIES AND CYCLE TRACKS **9**

Parking: Need for parking studies and its ill effects- Parking Standards for different land uses, different types of parking - Conceptual plans for different types of parking; Pedestrians: Importance, Barriers, Behaviour, Pedestrian facilities – Principles of planning, Level of Service (LoS), Design standards.; Cycle Tracks: Principles of design, Design criteria, Design standards for Rural Expressways- Introduction to ITS.

d. Activities

Models on road safety.

e. Learning Resources

Text Books

1. Dr. L.R.Kadiyali, *Traffic Engineering and Transport Planning*, Khanna Publishers, Delhi, 8th Edition, 2014.
2. Srinivasa Kumar, *Introduction to Traffic Engineering*, Universities Press, 2018.

Reference Books

1. Khanna S. K, and others, *Highway Engineering*, Nam Chand & Bros, Roorkee, 2014, Pages 177 – 308.
2. Indian Roads Congress (IRC) Specifications: Guidelines and special publications on *Traffic Planning and Management*.
3. R.J.Satter, N.B.Houncel, *Highway Traffic Analysis and Design*, Bloomsbury Academic, 1996.

VERTICAL 4 : Computer Applications in Structures

Course Code	Course Name	L	T	P	C
VCE341	BUILDING INFORMATION MODELING TECHNIQUES	2	0	2	3

Category: Professional Elective (Theory cum Lab)

a. Preamble

- To explore computer modelling techniques using BIM Software.
- Presenting the Building Model, Creating and Printing Drawing Sheets, Working with Title Blocks, Managing Revisions, Creating Renderings, Using Walkthroughs, Using Sun and Shadow Settings Building Information Modelling, background and history, need for BIM Revit Architecture Basics, Exploring the User Interface, Working with Revit Elements and Families.

b. Course Outcome (Theory)

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the fundamentals of BIM in construction design process.	K2
CO2	Outline the challenges in BIM implementation.	K2
CO3	Relate the automation techniques in construction	K2
CO4	Develop fundamental building components using Revit.	K3
CO5	Develop 3D models and rendering using Revit.	K3

Course Outcome (Lab)

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

CO. No.	Course Outcome	Knowledge Level
CO1	Develop a Residential Building Plan using Revit	K3
CO2	Construct Interior Design using Revit	K3
CO3	Construct Exterior design and landscaping of Residential building using Revit	K3
CO4	Make use of Revit tool for Rendering and Walkthrough of Residential building	K3
CO5	Demonstrate various add-ons for rendering.	K2

c. Course Syllabus **Total : 60 Periods**

INTRODUCTION TO BIM FOR CONSTRUCTION **6**

Fundamentals of BIM – terminology, CAD & BIM, BIM-based construction process – 4D, 5D, nD BIM.

CHALLENGES IN BIM IMPLEMENTATION **6**

BIM-based operation issues – facility management, Drivers and barriers in BIM adoption, BIM global practices.

CONSTRUCTION AUTOMATION **6**

Automation in design and construction, virtual experiments – augmented reality, virtual reality, use of sensors in construction.

FUNDAMENTAL DESIGNING USING BIM SOFTWARE REVIT **6**

Experimental procedure for- Creating a Basic Floor Plan, Creating and Modifying Levels, Adding and Modifying Walls, placing and customizing Doors, Windows and Building Components, Controlling Object Visibility, solar study.

RENDERING USING BIM SOFTWARE REVIT **6**

Experimental procedure for- Dimensioning, Creating and Modifying Floors, Adding and Modifying Ceilings, Adding and Modifying Roofs, Creating Curtain Walls, Adding Stairs and Railings, Creating and Modifying Schedules, Creating Schedules, Creating and Modifying 3D Views, Rendering.

PRACTICAL EXERCISES **30 Periods**

LIST OF EXPERIMENTS

1. Preparation of Residential Building Plan using Revit
2. Interior Design using Revit
3. Exterior design and landscaping of Residential building using Revit
4. Rendering and Walkthrough of Residential building using Revit
5. Introduction to various add-ons for rendering.

d. Activities

Students shall be given project using Building Information Modeling software.

e. Learning Resources

Text Books

1. Daniotti, Bruno, Gianinetto, Marco, Della Torre, Stefano (Eds.), *Digital Transformation of the Design*, Construction and Management Processes of the Built Environment, Research for Development, Springer Open,2020.
2. Dominik Holzer, *The BIM Manager's Handbook: Guidance for Professionals in Architecture, Engineering, and Construction*, Wiley, 2016.
3. Erica Epstein, *Implementing Successful Building Information Modeling*, Artech House, 2012.

Course Code	Course Name	L	T	P	C
VCE342	COMPUTER AIDED STRUCTURAL ANALYSIS	2	0	2	3

Category: Professional Elective (Theory cum Lab)

a. Preamble

- To analyse structures using STAAD.Pro and its applications in beams, frames and plane trusses.

b. Course Outcome (Theory)

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

CO. No.	Course Outcome	Knowledge Level
CO1	Develop the pin-jointed plane and space frames.	K3
CO2	Outline the concepts of plastic analysis.	K2
CO3	Utilize plastic analysis concepts in beams and frames.	K3
CO4	Apply the concept of matrix stiffness method and analyze continuous beams, pin jointed trusses and rigid plane frames.	K3
CO5	Apply matrix flexibility method in indeterminate pin jointed plane frames continuous beams and rigid frames.	K3

Course Outcome (Lab)

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

CO. No.	Course Outcome	Knowledge Level
CO1	Outline the fundamentals of STAAD.Pro	K2
CO2	Develop axial force diagram for plane truss.	K3
CO3	Make use of STAAD.Pro to analyze and design simple beam.	K3
CO4	Make use of STAAD.Pro to analyze and design continuous beam.	K3
CO5	Construct portal frame using STAAD.Pro.	K3

c. Course Syllabus **Total : 60 Periods**

ANALYSIS OF TRUSSES **6**

Determinate and indeterminate trusses - analysis of determinate trusses - method of joints - method of sections - Deflections of pin-jointed plane frames.

INTRODUCTION TO PLASTIC ANALYSIS **6**

Plastic theory - Statically indeterminate structures – Plastic moment of resistance – Plastic modulus – Shape factor – Load factor.

PLASTIC ANALYSIS OF INDETERMINATE BEAMS AND FRAMES **6**

Plastic hinge and mechanism – collapse load - Static and kinematic methods – Upper and lower bound theorems - Plastic analysis of indeterminate beams and frames.

STIFFNESS METHOD **6**

Restrained structure – Formation of stiffness matrices - equilibrium condition -Analysis of Continuous Beams, Pin-jointed plane frames and rigid frames by direct stiffness method.

FLEXIBILITY METHOD **6**

Primary structures - Compatibility conditions – Formation flexibility matrices - Analysis of indeterminate pin- jointed plane frames, continuous beams and rigid jointed plane frames by direct flexibility approach.

PRACTICAL EXERCISES **30 Periods**

LIST OF EXPERIMENTS

1. Introduction to STAAD.Pro software
2. Analysis and design of plane truss and generate the axial force diagram using STAAD.Pro.
3. Analysis and design of simple beam using STAAD.Pro
4. Analysis and design of continuous beam using STAAD.Pro
5. Analysis and design of portal frame using STAAD.Pro

d. Activities

Students shall be exposed to analyse various structures for different loading conditions.

e. Learning Resources

Text Books

1. Punmia. B.C, Ashok Kumar Jain &Arun Kumar Jain, *Theory of structures*,Laxmi Publications, New Delhi,2012.

2. Bhavikatti,S.S, *StructuralAnalysis,Vol.1,&2,*Vikas Publishing House Pvt.Ltd.,New Delhi-4, 2014.

Reference Books

1. Bhavikatti, S.S, *Matrix Method of Structural Analysis*, I. K. International Publishing House Pvt.Ltd.,New Delhi-4,2014.
2. Vazrani.V.NAndRatwani, M.M, *Analysis of Structures*, Khanna Publishers,2015.

Course Code	Course Name	L	T	P	C
VCE343	ENERGY EFFICIENT BUILDINGS	3	0	0	3

Category: Professional Elective

a. Preamble

- To impart knowledge about sustainable construction and to understand the concepts of sustainable materials, energy calculations, green buildings and environmental effects.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the various sustainable materials used in construction.	K2
CO2	Explain the method of estimating the amount of energy required for building.	K2
CO3	Outline the features of LEED, TERI and GRIHA ratings of buildings.	K2
CO4	Explain the core concepts of lean construction tools and techniques and their importance in achieving better productivity.	K2
CO5	Apply lean tools & techniques to achieve sustainability in construction projects.	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION & MATERIALS USED IN SUSTAINABLE CONSTRUCTION **9**

Introduction and definition of Sustainability - Carbon cycle - role of construction material: concrete and steel, etc. - CO_2 contribution from cement and other construction materials and carbon foot print - Recycled and manufactured aggregate - Role of QC and durability - Life cycle and sustainability.

ENERGY CALCULATIONS **9**

Components of embodied energy - calculation of embodied energy for construction materials - Energy concept and primary energy - Embodied energy via-a-vis operational energy in conditioned building - Life Cycle energy use.

GREEN BUILDINGS **9**

Control of energy use in building – National Building Code (NBC), ECBC code, codes in neighbouring tropical countries - OTTV concepts and calculations – Features of LEED and TERI – Griha ratings - Role of insulation and thermal properties of construction materials - influence of moisture content and modeling -Performance ratings of green buildings - Zero energy building'

CORE CONCEPTS IN LEAN **9**

Introduction to the Course; Lean Overview; Need for Productivity Measurement and improvement; Productivity Measurement System (PMS).

LEAN CONSTRUCTION TOOLS AND TECHNIQUES **9**

Sampling/ Work Sampling; Survey/ Foreman delay survey; Value Stream/ Process Mapping– 5S ,Collaborative Planning System (CPS)/ Last Planner™ System (LPS) – Big Room Approach, IT/BIM and Lean, How to Start Practicing Lean Tools in Project Site.

d. Activities

Students shall be exposed to case studies about Green Buildings

e. Learning Resources

Reference Books

1. Charles J Kibert, *Sustainable Construction : Green Building Design & Delivery,* 4th Edition , Wiley Publishers 2016
2. Steve Goodhew, *Sustainable Construction Process*, Wiley Blackwell,UK, 2016
3. Craig A. Langston & Grace K.C. Ding, *Sustainable Practices in the Built Environment,* Butterworth Heinemann Publishers, 2011.
4. Ballard, G., Tommelein, I., Koskela, L. and Howell, G., *Lean construction tools and techniques*, 2002.
5. Salem, O., Solomon, J., Genaidy, A. and Luegring, M., *Site implementation and Assessment of Lean Construction Techniques*, Lean Construction Journal, 2005.

Course Code	Course Name	L	T	P	C
VCE344	DIGITALIZED CONSTRUCTION TECHNIQUES	2	0	2	3

Category: Professional Elective (Theory cum Lab)

a. Preamble

- To explore computer modelling, construction project management techniques using REVIT and MS Project.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the basic concepts and Applications of BIM.	K2
CO2	Summarize the various tools in BIM implementation.	K2
CO3	Develop fundamental building components using Revit.	K3
CO4	Outline construction management concepts using MS Project.	K2
CO5	Make use of automation techniques in construction.	K3

Course Outcome (Lab)

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

CO. No.	Course Outcome	Knowledge Level
CO1	Develop an Office Building Plan using Revit.	K3
CO2	Develop Interior Design of Office Building using Revit	K3
CO3	Construct Exterior design and landscaping of Office building using Revit	K3
CO4	Outline the fundamentals of MS Project.	K2
CO5	Make use of MS project for construction project management.	K3

c. Course Syllabus **Total : 60 Periods**

INTRODUCTION TO BIM FOR CONSTRUCTION **6**

Basics of BIM – Terminology, BIM-Based Construction Process –BIM Global Practices - Facility Management – Operational problems in BIM.

FUNDAMENTAL DESIGNING USING REVIT ARCHITECTURE 6

Experimental procedure for setting units, Creating new levels, preparation of Basic Floor Plan, Adding and Modifying Walls, Additional Building Component, Creating new construction materials, wallpaper, paint and marking dimension.

DEVELOPING AND RENDERING MODEL USING REVIT ARCHITECTURE 6

Experimental procedure for Developing the Building Model - Creating and Modifying Floors, Creating different types of Curtain Walls, Adding Stairs and Railings, Creating Schedules, Creating and Modifying 3D Views, Rendering.

DIGITAL KNOWLEDGE IN CONSTRUCTION MANAGEMENT 6

Introduction to MS Project- Preparation of calendar, defining activities, presidence relationship among the activities, Introduction to critical path method, Schedule the Construction Project Using MS Project.

CONSTRUCTION AUTOMATION 6

Automation in Design and Construction, Importance of Virtual Experiments – Augmented Reality, Virtual Reality, Use of Sensors in Construction.

PRACTICAL EXERCISES 30 Periods

LIST OF EXPERIMENTS

To implement the digital knowledge in construction (use relevant softwares)

1. Interior Design of Residential Building using Revit
2. Interior Design of office Building using Revit
3. Exterior design and landscaping of Residential building using Revit
4. Introduction and understanding of MS Project for a construction project
5. Using MS project, schedule the construction project planning

d. Activities

Development of BIM Management for a small firm construction industry using software

e. Learning Resources

Text Books

1. Daniotti, Bruno, Gianinetto, Marco, Della Torre, Stefano (Eds.), *Digital Transformation of the Design, Construction and Management Processes of the Built Environment*, Research for Development, Springer Open,2020.
2. Dominik Holzer, *The BIM Manager's Handbook: Guidance for Professionals in Architecture, Engineering, and Construction*, Wiley, 2016.
3. Erica Epstein, *Implementing Successful Building Information Modeling*, Artech House, 2012.

Course Code	Course Name	L	T	P	C
VCE345	INTRODUCTION TO FINITE ELEMENT METHOD	3	0	0	3

Category: Professional Elective

a. Preamble

- To make the students understand the finite element analysis techniques.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the basics of finite element formulation.	K2
CO2	Illustrate the stiffness matrix for beam, truss and framed structures.	K2
CO3	Apply finite element formulations to solve one-dimensional problems..	K3
CO4	Apply finite element method to solve two dimensional problems.	K3
CO5	Apply finite element method to analyze plate bending problems	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION **9**

Determinate and indeterminate trusses - analysis of determinate trusses - method of joints - method of sections - Deflections of pin-jointed plane frames - lack of fit - change in temperature method of tension coefficient - Application to space trusses.

STIFFNESS MATRIX FORMULATION **9**

Introduction to Discrete and Continua elements – Discrete Elements - Direct stiffness method - Special characteristics of stiffness matrix - Assemblage of elements – Boundary condition & reaction - 2D – truss element - 2D - beam element - Analysis of framed Structures - Basic steps in finite element analysis - Differential equilibrium equations - strain

displacement relation - linear constitutive relation - Numerical methods in finite element analysis- Gauss elimination method.

ONE DIMENSIONAL PROBLEMS **9**

One Dimensional Second Order Equations – Discretization – Element types- Linear and Higher order Elements – Continua Elements - Displacement models - convergence requirements. Natural coordinate systems - Shape function. Interpolation function. Linear and quadratic elements - Lagrange & Serendipity elements. Strain displacement matrix - element stiffness matrix and nodal load vector. Natural frequencies of longitudinal vibration and mode shapes.

TWO DIMENSIONAL PROBLEMS **9**

Two dimensional isoparametric elements - Four noded quadrilateral elements - triangular elements. Computation of stiffness matrix for isoparametric elements - Numerical integration (Gauss quadrature) Convergence criteria for isoparametric elements.

ANALYSIS OF PLATES **9**

Introduction to Plate Bending Problems - displacement functions – Analysis of Thin Plate - Analysis of Thick Plate - Analysis of Skew Plate, Finite Element Analysis of Shell, plane stress and plane strain analysis, Example problem using any general-purpose finite element software

d. Activities

Students develop a thorough understanding of the finite element analysis techniques with an ability to effectively use the tools of the analysis for solving practical problems arising in Civil Engineering.

e. Learning Resources

Text Books

1. Rao, S.S., *The Finite Element Method in Engineering*, 6th Edition, Butterworth Heinemann, 2018.
2. Reddy,J.N. *Introduction to the Finite Element Method*, 4thEdition, Tata McGrawHill,2018.

Reference Books

1. Krishnamoorthy, C. S, *Finite Element Analysis - Theory and Programming*, McGraw - Hill, 1995.
2. Chennakesava R. Alavala *Finite Element Methods: Basic Concepts and Applications*, Prentice Hall Inc., 2010.

Course Code	Course Name	L	T	P	C
VCE346	SENSOR APPLICATIONS IN STRUCTURAL HEALTH MONITORING	3	0	0	3

Category: Professional Elective

a. Preamble

- This course introduces the students to make familiar with various structural health monitoring tools and techniques.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the need, advantages and challenges of SHM.	K2
CO2	Explain various types of sensors and instrumentation techniques.	K2
CO3	Outline the knowledge of static and dynamic measurement techniques.	K2
CO4	Compare the various damage detection techniques.	K2
CO5	Apply the various data processing methods in different structures and case studies.	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO STRUCTURAL HEALTH MONITORING **9**

Need for SHM, Structural Health Monitoring versus Non-Destructive Evaluation, Methods of SHM Local & Global Techniques for SHM, Short & Long-Term Monitoring, Active & Passive Monitoring, Remote Structural Health Monitoring- Advantages, Challenges in SHM.

SENSORS AND INSTRUMENTATION FOR SHM **9**

Sensors for measurements: Electrical Resistance Strain Gages, Vibrating Wire Strain Gauges, Fiber Optic Sensors, Temperature Sensors, Accelerometers, Displacement Transducers, Load Cells, Humidity Sensors, Crack Propagation Measuring Sensors, Corrosion Monitoring Sensors, Pressure Sensors, Data Acquisition – Data Transmission - Data Processing – Storage of processed data - Knowledgeable information processing.

STATIC AND DYNAMIC MEASUREMENT TECHNIQUES FOR SHM **9**

Static measurement - Load test, Concrete core trepanning, Flat jack techniques, Static response measurement, Dynamic measurement -Vibration based testing- Ambient Excitation methods, Measured forced Vibration-Impact excitation, step relaxation test, shaker excitation method.

DAMAGE DETECTION **9**

Damage Diagnostic methods based on vibrational response- Method based on modal frequency/shape/damping, Curvature and flexibility method, Modal strain energy method, Sensitivity method, Baseline-free method, Cross-correlation method, Damage Diagnostic methods based on wave propagation Methods-Bulk waves/Lamb waves, Reflection and transmission, Wave tuning/mode selectivity, Migration imaging, Phased array imaging, Focusing array/SAFT imaging.

DATA PROCESSING AND CASE STUDIES **9**

Advanced signal processing methods -Wavelet, Hilbert-Huang transform, Neural networks, Support Vector Machine Principal component analysis, Outlier analysis. Applications of SHM on bridges and buildings, case studies of SHM in Civil/ Structural engineering.

d. Activities

Students shall be exposed to various instrumentation, measuring and damage detection techniques in Structural Health Monitoring.

e. Learning Resources

Text Books

1. Ansari, F Karbhari, *Structural health monitoring of civil infrastructure systems*, V.M,Woodhead Publishing, 2009
2. Daniel Balageas, Peter Fritzen, Alfredo Guemes, *Structural Health Monitoring*, John Wiley & Sons, 2006.
3. Douglas E Adams, *Health Monitoring of Structural Materials and Components Methods with Applications*, Wiley Publishers, 2007

Reference Books

1. Hua-Peng Chen, *Structural Health Monitoring of Large Civil Engineering Structures*, Wiley Publishers, 2018
2. J. P. Ou, H. Li and Z. D, *Duan Structural Health Monitoring and Intelligent Infrastructure*, Vol1, Taylor and Francis Group, London, UK, 2006.

3. Victor Giurglutiu, *Structural Health Monitoring with Wafer Active Sensors*, Academic Press Inc, 2007.

Course Code	Course Name	L	T	P	C
VCE347	CONSTRUCTION MANAGEMENT WITH BIM APPLICATIONS	3	0	0	3

Category: Professional Elective

a. Preamble

- To make the students to learn about planning of construction projects, scheduling procedures and techniques, cost and quality control projects and use of project information as decision making tool.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Outline the concept of construction planning and scheduling.	K2
CO2	Apply the knowledge of scheduling activities of the project using different network diagrams such as CPM, PERT etc.,	K3
CO3	Infer quality and safety concerns in construction.	K2
CO4	Understand the concept of BIM in construction.	K2
CO5	Outline the use of modern digital technologies in construction.	K2

c. Course Syllabus **Total : 45 Periods**

CONSTRUCTION PLANNING **9**

Basic concepts in the development of construction plans- Choice of Technology and Construction method - Defining Work Tasks - Work breakdown structure – Definition Precedence relationships among activities - Estimating Activity Durations - Estimating Resource Requirements for work activities - Coding systems.

SCHEDULING PROCEDURES AND TECHNIQUES **9**

Relevance of construction schedules-Bar charts - The critical path method - Calculations for critical path scheduling - Activity float and schedules - Presenting project schedules - Critical path scheduling for Activity -on-node and with leads, Calculations for scheduling with leads, - Scheduling with uncertain durations- Crashing procedure and time/cost tradeoffs procedure.

QUALITY CONTROL AND SAFETY DURING CONSTRUCTION **9**

Quality and safety Concerns in Construction - Organizing for Quality and Safety - Work and Material Specifications - Total Quality control - Quality control during construction – Safety during construction.

INTRODUCTION TO BIM AND CHALLENGES IN BIM IMPLEMENTATION **9**

Fundamentals of BIM – terminology, BIM-based construction process –4D, 5D, BIM-based operation issues – facility management, BIM global practices.

MODERN DIGITAL TECHNOLOGIES IN CONSTRUCTION **9**

Robots in construction, autonomous robots, and 3D printing technology in construction. Drones for Construction monitoring, Internet of Things, Smart Manufacturing.

d. Activities

Students shall be exposed to the different software applications in the college premises.

e. Learning Resources

Text Books

1. Chris Hendrickson and Tung Au ― *Project Management for Construction Fundamentals Concepts for Owners*, Engineers, Architects and Builders, Prentice Hall, Pitsburgh, 2000.
2. Chitkara, K.K. ―*Construction Project Management Planning, Scheduling and Control*, Tata McGraw Hill Publishing Co., New Delhi, 2009.
3. Daniotti, Bruno, Gianinetto, Marco, Della Torre, Stefano (Eds.), *Digital Transformation of the Design, Construction and Management Processes of the Built Environment*, Research for Development, Springer Open,2020.

Reference Books

1. Srinath,L.S. ― *Pert and CPM Principles and Applications,* Affiliated East West Press, 2001.
2. Moder.J., Phillips. C. and Davis E ―*Project Management with CPM,* PERT and Precedence Diagramming, Van Nostrand Reinhold Co., 3rd Edition, 1985
3. Dominik Holzer, *The BIM Manager's Handbook: Guidance for Professionals in Architecture, Engineering, and Construction*, Wiley, 2016.

OPEN ELECTIVES I (Offered to AI&DS, BT,CSE, ECE, EEE, IT, MECH, MTR)

Course Code	Course Name	L	T	P	C
OCE781	BIOMASS CONSERVATION AND BIOREFINERY	3	0	0	3

Category: Open Elective

a. Preamble

This course enable students to develop necessary skills to design appropriate biomass based fractionation technique as per the need.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the availability of biomass and overview about biorefinery.	K2
CO2	Outline the biomass pretreatment and conversion processes	K2
CO3	Understand the concept of fermentation and production technologies for biodiesel, biooil and biochar production	K2
CO4	Explain the concept of production and utilization of hydrogen, methane and methanol	K2
CO5	Identify the conversion processes, techno- economic evaluation, life-cycle assessment of integrated biorefinery.	K3

c. Course Syllabus **Total : 45 Periods**

BIOMASS AND BIOREFINERY **9**

Availability and abundance, photosynthesis, composition and energy potential, virgin biomass production and selection, waste biomass (municipal, industrial, agricultural and forestry) availability, abundance and potential, biomass as energy resources: dedicated energy crops, oil crops and their biorefinery potential, microalgae as feedstock for biofuels and biochemical, enhancing biomass properties for biofuels, challenges in conversion. Basic concept, types of

biorefineries, biorefinery feedstocks and properties, economics Barriers in lignocellulosic biomass conversion.

BIOMASS PRETREATMENT AND CONVERSION PROCESSES 9

Pretreatment technologies such as acid, alkali, autohydrolysis, hybrid methods, role of pretreatment in the biorefinery concept. physical, thermal and microbial conversion processes - Types, fundamentals, equipments and applications; thermal conversion products, commercial success stories.

BIODIESEL BIOOIL AND BIOCHAR 9

Factors affecting biooil, biochar production, fuel properties, bio oil upgradation Corn ethanol, lignocellulosic ethanol, microorganisms for fermentation, current industrial ethanol production technology, cellulases and their role in hydrolysis, concepts of SSF and CBP, advanced fermentation technologies, ABE fermentation pathway and kinetics, product recovery technologies

HYDROGEN, METHANE AND METHANOL 9

Biohydrogen generation, metabolic basics, feedstocks, dark fermentation by strict anaerobes, facultative anaerobes, thermophilic microorganisms, integration of biohydrogen with fuel cell; fundamentals of biogas technology, fermenter designs, biogas purification, methanol production and utilization

INTEGRATED BIOREFINERY 9

Concept, corn/soybean/sugarcane biorefinery, lignocellulosic biorefinery, aquaculture and algal biorefinery, waste biorefinery, hybrid chemical and biological conversion processes, techno- economic evaluation, life-cycle assessment.

d. Activities

Students will be taken to distillary industry to understand about utilization of biomass,fermentation process, production of biodiesel.

e. Learning Resources

Text Books

1. Donald L. Klass, *Biomass for Renewable Energy, Fuels, and Chemicals*, Academic Press, Elsevier, 2006.
2. Prabir Basu, *Biomass Gasification, Pyrolysis and Torrefaction*, Academic Press, Elsevier, 2013.
3. A.A. Vertes, N. Qureshi, H.P. Blaschek, H. Yukawa (Eds.), *Biomass to Biofuels: Strategies for Global Industries*, Wiley, 2010.

Reference Books

1. S. Yang, H.A. El-Enshasy, N. Thongchul (Eds.), *Bioprocessing Technologies in Biorefinery for Sustainable Production of Fuels, Chemicals and Polymers*, Wiley, 2013.
2. Shang-Tian Yang (Ed.), *Bioprocessing for Value Added Products from Renewable Resources*, Elsevier, 2007.

Course Code	Course Name	L	T	P	C
OCE782	FUNDAMENTALS OF FIRE SAFETY ENGINEERING	3	0	0	3

Category: Open Elective

a. Preamble

This course introduces the basic concepts,

- Thorough understanding of the principles underlying fire and explosion.
- The origins and consequences of fire and explosion
- The numerous preventive measures including fire and explosion prevention systems.
- The prevention of fire in buildings
- The various fire prevention methods that should be used in a building.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Summarize the fundamental principles of fire science	K2
CO2	Outline how different types of firefighting apparatus operate.	K2
CO3	Understand the various causes and effects of fire	K2
CO4	Utilize the fire protection techniques effectively in the building	K3
CO5	Make use of the techniques for the prevention of explosion.	K2

c. Course Syllabus **Total : 45 Periods**

FUNDAMENTALS OF FIRE	**9**

Combustion process & concepts, combustion in solids, liquid, gases- smouldering fires- Spontaneous combustion - rapid fire progress phenomena- Properties influencing fire hazard – properties of solid, liquid and gaseous fuels - classification of fires.	
FIRE CONTROL	**9**
Fire extinguishers – Location and operation of extinguishers - Extinguishing methods- extinguishing agents: water, foam, chemical powder, CO_2, sand, steam, saw dust – Fire detectors – Fire tender - Automatic fire extinguishing system - Fixed firefighting installations - Risk analysis: risk assessment, consequence analysis, risk reduction – Fire drill – Emergency procedures.	
PRODUCTS AND EFFECTS OF COMBUSTION	**9**
Heat: Conduction, convection, radiation- effects of heat- effects of flames – different fire gases and their effects – effects of smoke on humans– Smoke movement control and venting	
BUILDING FIRE SAFETY	**9**
Objectives of fire safe building design, Fire load, fire resistant material and fire testing – concept of egress design - exits – width calculations -– fire safety requirements for high rise buildings – Behavior of materials & structures in fire – Concrete and steel. Flame spread in high rise building – Statutory requirements.	
FUNDAMENTALS OF EXPLOSION	**9**
Introduction – Explosion fundamentals – Types – - Effects of explosion – Negative pressure wave – Fragmentation – Physical, Boiling Liquid Expanding Vapour Explosion, Chemical explosion – Vapour cloud explosion – Dust explosion – Explosion prevention – Explosion mitigation, case studies.	
d. Activities	
Students shall be exposed to fire safety equimpments in the college premises.	
e. Learning Resources	
	Text Books

	1.	Purandare D.D., Abhay D. Purandare, *Hand Book on Industrial Fire Safety*, P & A Publications, 1st Edition, 2006.
	2.	Jain V.K., *Fire Safety in Building*, Taylor & Francis, 2nd edition, 2016.
	Reference Books	
	1.	Gupta, R.S., *Hand Book of Fire Technology,* Orient Longman, Bombay, 2010
	2.	*Accident Prevention manual for industrial operations,* N.S.C., Chicago, 1988.
	3.	Dinko Tuhtar, *Fire and explosion protection – A system approach*, Ellis Horwood Ltd, 1989
	4.	*Fire fighters hazardous materials Reference Book Fire Prevention in Factories*, Nostrand Rein Hold, New York, 1991.
	5.	*Fire Prevention Hand Book*, NFPA, 20th edition, 2008.
	6.	*Fire Prevention and fire fighting*, International Maritime Organisation, London, 2000.

Course Code	Course Name	L	T	P	C
OCE783	SUSTAINABLE CONSTRUCTION	3	0	0	3

Category: Open Elective

a. Preamble

This course introduces the students familiar with various structural health monitoring tools and techniques.

b. Course Outcome

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

CO No.	Course Outcome	Knowledge Level
CO1	Understand the need, advantages and challenges of SHM.	K2
CO2	Outline the different types of sensors and instrumentation techniques.	K2
CO3	Summarize knowledge of the static and dynamic measurement techniques.	K2
CO4	Compare the various damage detection techniques.	K2
CO5	Make use of data processing methods through case studies.	K3

c. Course Syllabus **Total : 45 Periods**

INTRODUCTION TO SUSTAINABILITY **9**

Sustainability principles, concept of zero waste, 3 R's principles, sustainability concept in construction industry, need, objectives, achieving sustainability at various stages of construction, resource economics, waste minimization techniques, Governmental and citizen's role, demolition and Deconstruction techniques.

ENERGY CONCEPTS FOR SUSTAINABILITY **9**

Concept of Embodied energy, importance of embodied energy, constituents of embodied energy, Operational energy, Life cycle energy, case study of a typical building, typical embodied energy values of few materials of construction.

SUSTAINABLE BUILDINGS **9**

Zero carbon buildings, energy efficiency, energy monitoring, energy modeling, carbon reduction in buildings, renewable energy sources, concept of net zero energy building.

SUSTAINABLE MATERIALS AND RESOURCES **9**

Concept of recyclability, use of marginal materials in construction of civil engineering structures, use of processed demolished materials and construction waste, use of recycled materials: aluminum, steel, wood, flyash, GGBS, gypsum, manufactured sand.

ASSESSMENT OF SUSTAINABILITY **9**

Introduction and brief description of existing rating systems for sustainable building design and construction (both new and for renovations), LEED rating system, GRIHA rating system for green buildings.

d. Activities

Students shall be exposed to Testing of marginal materials, material characterization, and evaluation of mortar/concrete/masonry units made with marginal materials.

e. Learning Resources

Text Books

1. Charles Kibert, *Sustainable construction- Green Building Design and Delivery*, Wiley Publishers, 2012
2. Meg Calkins , *Materials for sustainable sites*, John Wiley and Sons, 2007
3. V M Tam, Chi Ming Tam, *Reuse of Construction and Demolition Waste in Housing Development*, Nova Science Publishers, 2008

Reference Books

1. Richard Ian Stessel, *Recycling and Resource Recovery Engineering*, Springer Verlag Berlin Heidelberg, 1996.
2. Greg Winkler, *Recycling Construction and Demolition waste: A LEED-Based Toolkit*, McGraw Hill Professional

Course Code	Course Name	L	T	P	C
MCE102	ENVIRONMENTAL QUALITY MONITORING AND ANALYSIS	3	0	0	3

Category: Open Elective (Minor Degree)

a. Preamble

- To understand and study the complexity of the environment in relation to pollutants generated due to industrial activity.
- To analyze the quality of the environmental parameters and monitor the same for the purpose of environmental risk assessment.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand basic concepts of environmental standards and monitoring.	K2
CO2	Outline the ambient air quality and water quality standards.	K2
CO3	Demonstrate the various instrumental methods and their principles for environmental monitoring.	K3
CO4	Understand the significance of environmental standards in monitoring quality and sustainability of the environment.	K2
CO5	Develop data acquisition and management system.	K2

c. Course Syllabus **Total : 45 Periods**

ENVIRONMENTAL MONITORING AND STANDARDS **9**

Introduction- Environmental Standards- Classification of Environmental Standards- Global Environmental Standards- Environmental Standards in India- Ambient air quality standards- water quality standard- Environmental Monitoring-Need for environmental monitoring- Concepts of environmental monitoring- Techniques of Environmental Monitoring.

MONITORING OF ENVIRONMENTAL PARAMETERS **9**

Current Environmental Issues- Global Environmental monitoring programme-International conventions- Application of Environmental Monitoring- Atmospheric Monitoring -

screening parameters – Significance of environmental sampling- sampling methods – water sampling - sampling of ambient air-sampling of flue gas.

ANALYTICAL METHODS FOR ENVIRONMENTAL MONITORING 9

Classification of Instrumental Method- Analysis of Organic Pollutants by Spectrophotometric methods -Determination of nitrogen, phosphorus and, chemical oxygen demand (COD) in sewage; Biochemical oxygen demand (BOD)- Sampling techniques for air pollution measurements; analysis of particulates and air pollutants like oxides of nitrogen, oxides of sulfur, carbon monoxide, hydrocarbon; Introduction to advanced instruments for environmental analysis.

ENVIRONMENTAL MONITORING PROGRAMME (EMP) & RISKASSESSMENT 9

Water quality monitoring programme- national water quality monitoring- Parameters for National Water Quality Monitoring- monitoring protocol; Process of risk assessment- hazard identification-exposure assessment- dose-response assessment; risk characterization.

AUTOMATED DATA ACQUISITION AND PROCESSING 9

Data Acquisition for Process Monitoring and Control - The Data Acquisition System - Online Data Acquisition, Monitoring, and Control - Implementation of a Data Management System - Review of Observational Networks -Sensors and transducers- classification of transducers- data acquisition system- types of data acquisition systems- data management and quality control; regulatory overview.

d. Activities

Students shall be exposed to the energy efficient techniques and practices for susitainable environment through field visit.

e. Learning Resources

Text Books

1. *Environmental monitoring Handbook*, Frank R. Burden, © 2002 by The McGraw-Hill Companies, Inc.
2. *Handbook of environmental analysis: chemical pollutants in the air, water, soil, and soild wastes / Pradyot Patnaik*, © 1997 by CRC Press, Inc

Reference Books

1. *Environmental monitoring / edited by G. Bruce Wiersma*, © 2004 by CRC Press LLC.

2. H. H. Willard, L. L. Merit, J. A. Dean and F. A. Settle, *Instrumental Methods of Analysis*, CBP Publishers and Distributors, New Delhi, 1988.
3. Heaslip, G. (1975) *Environmental Data Handling*. John Wiley & Sons. New York.

Course Code	Course Name	L	T	P	C
MCE103	SUSTAINABLE INFRASTRUCTURE DEVELOPMENT	3	0	0	3

Category: Open Elective (Minor Degree)

a. Preamble

- To impart knowledge about sustainable Infrastructure development goals, practices and to understand the concepts of sustainable planning, design, construction, maintenance and decommissioning of infrastructure projects.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the environment sustainability goals at global and Indian scenario.	K2
CO2	Understand risks in development of projects and suggest mitigation measures.	K2
CO3	Apply lean techniques, LBMS and new construction techniques to achieve sustainability in infrastructure construction projects.	K3
CO4	Explain Life Cycle Analysis and life cycle cost of construction materials.	K2
CO5	Explain the new technologies for maintenance of infrastructure projects.	K2

c. Course Syllabus **Total : 45 Periods**

SUSTAINABLE DEVELOPMENT GOALS **9**

Definitions, principles and history of Sustainable Development - Sustainable development goals (SDG): global and Indian – Infrastructure Demand and Supply - Environment and Development linkages - societal and cultural demands – Sustainability indicators - Performance indicators of sustainability and Assessment mechanism - Policy frameworks

and practices: global and Indian – Infrastructure Project finance – Infrastructure project life cycle - Constraints and barriers for sustainable development - future directions.

SUSTAINABLE INFRASTRUCTURE PLANNING 9

Overview of Infrastructure projects: Housing sector, Power sector, Water supply, road, rail and port transportation sector, rural and urban infrastructure. Environmental Impact Assessment (EIA), Land acquisition -Legal aspects, Resettlement &Rehabilitation and Development - Cost effectiveness Analysis - Risk Management Framework for Infrastructure Projects, Economic, demand, political, socio-environmental and cultural risks. Shaping the Planning Phase of Infrastructure Projects to mitigate risks, Designing Sustainable Contracts, Negotiating with multiple Stakeholders on Infrastructure Projects. Use of ICT tools in planning – Integrated planning - Clash detection in construction - BIM (Building Information Modelling).

SUSTAINABLE CONSTRUCTION PRACTICES AND TECHNIQUES 9

Sustainability through lean construction approach - Enabling lean through information technology – Lean in planning and design - IPD (Integrated Project Delivery) - Location Based Management System - Geospatial Technologies for machine control, site management, precision control and real time progress monitoring - Role of logistics in achieving sustainable construction – Data management for integrated supply chains in construction - Resource efficiency benefits of effective logistics - Sustainability in geotechnical practice – Design considerations, Design Parameters and Procedures – Quality control and Assurance - Use of sustainable construction techniques: Precast concrete technology, Pre-engineered buildings

SUSTAINABLE CONSTRUCTION MATERIALS 9

Construction materials: Concrete, steel, glass, aluminium, timber and FRP - No/Low cement concrete - Recycled and manufactured aggregate - Role of QC and durability - Sustainable consumption – Eco-efficiency - green consumerism - product stewardship and green engineering - Extended producer responsibility – Design for Environment Strategies, Practices, Guidelines, Methods, And Tools. Eco-design strategies –Design for Disassembly - Dematerialization, rematerialization, transmaterialization – Green procurement and green distribution - Analysis framework for reuse and recycling – Typical constraints on reuse and recycling - Communication of Life Cycle Information - Indian Eco mark scheme - Environmental product declarations – Environmental marketing- Life cycle Analysis (LCA), Life cycle costing (LCC) - Combining LCA and LCC – Case studies.

SUSTAINABLE MAINTENANCE OF INFRASTRUCTURE PROJECTS 9

Case Studies - Sustainable projects in developed countries and developing nations - An Integrated Framework for Successful Infrastructure Planning and Management - Information Technology and Systems for Successful Infrastructure Management, - Structural Health Monitoring for Infrastructure projects - Innovative Design and Maintenance of Infrastructure Facilities - Capacity Building and Improving the Governments Role in Infrastructure Implementation, Infrastructure Management Systems and Future Directions. – Use of Emerging Technologies – IoT, Big Data Analytics and Cloud Computing, Artificial Intelligences, Machine and Deep Learning, Fifth Generation (5G) Network services for maintenance .

d. Activities

Students shall be exposed to the different sustainable techniques through field visit.

e. Learning Resources

Reference Books

1. Charles J Kibert, *Sustainable Construction: Green Building Design & Delivery*, 4th Edition, Wiley Publishers 2016.
2. Steve Goodhew, *Sustainable Construction Process*, Wiley Blackwell,UK, 2016.
3. Craig A. Langston & Grace K.C. Ding, *Sustainable Practices in the Built Environment*, Butterworth Heinemann Publishers, 2011.
4. William P Spence, *Construction Materials, Methods & Techniques (3e)*, Yesdee Publication Pvt. Ltd, 2016.
5. New Building Materials and Construction World magazine
6. Kerry Turner. R, *Sustainable Environmental Management*, Principles and Practice Publisher:Belhaven Press,ISBN:1852930039.
7. Munier N, *Introduction to Sustainability*, Springer2005
8. Sharma, *Sustainable Smart Cities In India: Challenges And Future Perspectives*, SPRINGER, 2022.
9. Ralph Horne, Tim Grant, KarliVerghese, *Life Cycle Assessment: Principles, Practice and Prospects*, Csiro Publishing,2009
10. European Commission - Joint Research Centre - Institute for Environment and Sustainability*: International Reference Life Cycle Data System (ILCD) Handbook - General guide for Life Cycle Assessment - Detailed guidance*. Luxembourg. European Union;2010

11. Hudson, Haas, Uddin, *Infrastructure management: integrating design, construction, maintenance, rehabilitation, and renovation*, McGraw Hill, (1997).
12. GregerLundesjö, *Supply Chain Management and Logistics in Construction: Delivering Tomorrow's Built Environment*, Kogan Page Publishers, 2015.

Course Code	Course Name	L	T	P	C
MCE104	**GREEN TECHNOLOGY**	**3**	**0**	**0**	**3**

Category: Open Elective (Minor Degree)

a. Preamble

- To acquire knowledge on green systems and the environment, energy technology and efficiency, and sustainability.
- To provide green engineering solutions to energy demand, reduced energy footprint.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the principles of green engineering and technology.	K2
CO2	Outline different types of pollution and methods of waste minimization.	K2
CO3	Interpret the processes and products to make them green and safe.	K2
CO4	Apply realtime analysis for safe product and process design.	K3
CO5	Understand the concepts on green nanotechnology.	K2

c. Course Syllabus **Total : 45 Periods**

PRINCIPLES OF GREEN CHEMISTRY **9**

Historical Perspectives and Basic Concepts. The twelve Principles of Green Chemistry and green engineering. Green chemistry metrics- atom economy, E factor, reaction mass efficiency, and other green chemistry metrics, application of green metrics analysis to synthetic plans.

POLLUTION TYPES **9**

Pollution – types, causes, effects, and abatement. Waste – sources of waste, different types of waste, chemical, physical and biochemical methods of waste minimization and recycling.

GREEN REAGENTS AND GREEN SYNTHESIS **9**

Environmentally benign processes- alternate solvents- supercritical solvents, ionic liquids, water as a reaction medium, energy-efficient design of processes- photo, electro and sono chemical methods, microwave-assisted reactions

DESIGNING GREEN PROCESSES **9**

Safe design, process intensification, in process monitoring. Safe product and process design – Design for degradation, Real-time Analysis for pollution prevention, inherently safer chemistry for accident prevention.

GREEN NANOTECHNOLOGY **9**

Nanomaterials for water treatment, nanotechnology for renewable energy, nanotechnology for environmental remediation and waste management, nanotechnology products as potential substitutes for harmful chemicals, environmental concerns with nanotechnology.

d. Activities

Students shall be exposed to different types of pollutants and waste management using case studies.

e. Learning Resources

Text Books

1. Samir B. Billatos, Nadia A. Basaly, Taylor & Francis, *Green technology and design for the environment*, Washington, DC, ©1997
2. M. Lancaster, *Green Chemistry – An introductory text* - RSC, 2016.
3. Alexi Lapkin and david Constable (Eds) ,*Green chemistry metrics* - Wiley publications,2008

Reference Books

1. Stanley E Manahan, Taylor and Francis, *Environmental chemistry*, 2017

Course Code	Course Name	L	T	P	C
MCE105	SUSTAINABLE AGRICULTURE AND ENVIRONMENTAL MANAGEMENT	3	0	0	3

Category: Open Elective (Minor Degree)

a. Preamble

- To educate the students about the issues of sustainability in agroecosystems, introduce the concepts and principles of agroecology as applied to the design and management of sustainable agricultural systems for a changing world.

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the concepts, principles and advantages of sustainable agriculture.	K2
CO2	Outline the sustainable ways in managing soil health, nutrients, pests and diseases.	K2
CO3	Summarize the ways to optimize the use of water in agriculture to promote an ecological use of resources	K2
CO4	Interpret energy and waste management plans for promoting sustainable agriculture in non-sustainable farming areas	K2
CO5	Develop an ecosystem for its level of sustainability and prescribe ways of converting to a sustainable system.	K3

c. Course Syllabus **Total : 45 Periods**

AGROECOLOGY, AGROECOSYSTEM AND SUSTAINABLE AGRICULTURE CONCEPTS **9**

Ecosystem definition - Biotic *Vs*. abiotic factors in an ecosystem - Ecosystem processes - Ecological services and agriculture - Problems associated with industrial agriculture/food

systems - Defining sustainability - Characteristics of sustainable agriculture - Difference between regenerative and sustainable agriculture systems

SOIL HEALTH, NUTRIENT AND PEST MANAGEMENT **9**

Soil health definition - Factors to consider (physical, chemical and biological) - Composition of healthy soils - Soil erosion and possible control measures - Techniques to build healthy soil - Management practices for improving soil nutrient - Ecologically sustainable strategies for pest and disease control

WATER MANAGEMENT **9**

Soil water storage and availability - Plant yield response to water - Reducing evaporation in agriculture - Earthworks and tanks for rainwater harvesting - Options for improving the productivity of water - Localized irrigation - Irrigation scheduling - Fertigation - Advanced irrigation systems and agricultural practices for sustainable water use

ENERGY AND WASTE MANAGEMENT **9**

Types and sources of agricultural wastes - Composition of agricultural wastes - Sustainable technologies for the management of agricultural wastes - Useful and high value materials produced using different processes from agricultural wastes - Renewable energy for sustainable agriculture

EVALUATING SUSTAINABILITY IN AGROECOSYSTEMS **9**

Indicators of sustainability in agriculture - On-farm evaluation of agroecosystem sustainability - Alternative agriculture approaches/ farming techniques for sustainable food production - Goals and components of a community food system - Case studies

d. Activities

Students shall be exposed to the organic farming techniques for sustainable food production through field visit.

e. Learning Resources

Reference Books

1. Oberc, B.P. & Arroyo Schnell, A., *Approaches to Sustainable Agriculture – Exploring the Pathways Towards the Future of Farming*, IUCN, Belgium, 2020
2. Singh, J. & Yadav, A.N., *Natural bioactive products in sustainable agriculture*, Springer, 2020
3. Nandwani, D., *Organic Farming for Sustainable Agriculture*, Springer, 201
4. Villalobos, F.J. & Fereres, E., *Principles of Agronomy for Sustainable Agriculture*, Springer, 2016

5. Balkrishna, A., *Sustainable Agriculture for Food Security: A Global Perspective*, CRC Press, 2021
6. Bundschuh, J. & Chen, G., *Sustainable Energy Solutions in Agriculture*, CRC Press, 2014

Course Code	Course Name	L	T	P	C
MCE106	ENERGY EFFICIENCY FOR SUSTAINABLE DEVELOPMENT	3	0	0	3

Category: Open Elective (Minor Degree)

a. Preamble

- To understand the types of energy sources, energy efficiency and environmental implications of energy utilisation.
- To create awareness on energy audit and its impacts.
- To acquaint the techniques adopted for performance evaluation of thermal utilities
- To familiarise on the procedures adopted for performance evaluation of electrical utilities.
- To learn the concept of sustainable development and the implication of energy usage

b. Course Outcome

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

CO. No.	Course Outcome	Knowledge Level
CO1	Understand the prevailing energy scenario	K2
CO2	Outline energy audits and its relevance	K2
CO3	Apply the concept of energy audit on thermal utilities	K3
CO4	Interpret relevant techniques for energy improvement in electrical utilities	K2
CO5	Understand Sustainable development and its impact on human resource development	K2

c. Course Syllabus **Total : 45 Periods**

ENERGY AND ENVIRONMENT **9**

Primary energy sources - Coal, Oil, Gas – India Vs World with respect to energy production and consumption, Climate Change, Global Warming, Ozone Depletion, UNFCCC, COP

ENERGY AUDITING **9**

Need and types of energy audit. Energy management (audit) approach-understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments

ENERGY EFFICIENCY IN THERMAL UTILITIES **9**

Energy conservation avenues in steam generation and utilisation, furnaces, Thermic Fluid Heaters. Insulation and Refractories - Commercial waste heat recovery devices: recuperator, regenerator, heat pipe, heat exchangers (Plate, Shell & Tube), heat pumps, and thermocompression

ENERGY CONSERVTION IN ELECTRICAL UTILITIES **9**

Demand side management - Power factor improvement – Energy efficient transformers - Energy conservation avenues in Motors, HVAC, fans, blowers, pumps, air compressors, illumination systems and cooling towers

SUSTAINABLE DEVELOPMENT **9**

Sustainable Development: Concepts and Stakeholders, Sustainable Development Goal (SDG). Globalization and Economic growth. Economic development: Economic inequalities, Income and growth. Social development: Poverty, conceptual issues and measures, impact of poverty

d. Activities

Students shall be exposed to the energy efficient techniques and practices through field visit.

e. Learning Resources

Reference Books

1. *Energy Manager Training Manual (4Volumes) available at http://www.em-ea.org/gbook1.asp, a website administered by Bureau of Energy Efficiency (BEE),* a statutory body under Ministry of Power, Government of India.2004
2. Eastop.T.D& Croft D.R, *Energy Efficiency for Engineers and Technologists*, Logman Scientific & Technical, ISBN-0-582-03184, 1990
3. W.R. Murphy and G. McKay, *Energy Management.*, Butterworths, London 1987

4. Pratap Bhattacharyya, *Climate Change and Greenhouse Gas Emission*, New India Publishing Agency- Nipa,2020
5. Matthew John Franchetti , Defne Apul, *Carbon Footprint Analysis: Concepts, Methods, Implementation, and Case Studies*, CRC Press,2012

   Robert A. Ristinen, Jack J. Kraushaar, Jeffrey T. Brack, *Energy and the Environment*, 4th Edition,Wiley,2022
6. M.H. Fulekar,Bhawana Pathak, R K Kale, *Environment and Sustainable Development*, Springer,2016