Malnad College of Engineering,

Hassan

[An Autonomous Institution Affiliated to VTU Belagavi]

Autonomous Programme

Bachelor of Engineering in

Civil Engineering

Scheme & Syllabus

VII & VIII Semester

(2021-22 Admitted Batch)

Academic Year: 2024-25

Department of Civil Engineering

Vision of the Department

The Department of Civil Engineering will be a centre of excellence in industry-oriented teaching, training, research, professional ethics, social responsibility, and continuing education for practicing engineers through sponsored research and consultancy services.

Mission of the Department

1. To improvise the curriculum to include contents pertaining to situational experience of variety of sites and develop a sense of social responsibility and to enhance research orientation of students through internship programs.
2. To enhance sponsored research and consultancy works to achieve effective industry-institute-interaction and conduct Continuing Education Programme for practicing engineers.
3. To inculcate professional ethics through quality and modern construction practices.
4. To switch over to modern methods of material testing, Engineering analysis and design.

Program Educational Objectives (PEOs)

PEO1: The graduate will be successful professionally and contribute to core civil engineering construction projects, infrastructure projects, alternative construction technology projects, green buildings towards environmental sustainability for academic domain as well as for research and pursue higher studies.

PEO2: The graduate will be professionally sound in broad area of knowledge of various dimensions of civil engineering and allied fields.

PEO3: The graduate will be a team leader/effective team member with ethical values, versatile, quick learner will adapt to

given professional context with lifelong learning capability.

Program Outcomes (POs)

Engineering Graduates will be able to:

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem Analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct Investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and
environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering
practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in
multidisciplinary settings.

10. **Communication**: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance**: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Program Specific Objectives (PSOs)

PSO1: The Graduates will be demonstrate ability to design a civil engineering system, components or process to meet desired
project needs.

PSO2: Graduates will be familiar with civil engineering professional software tools and demonstrate their ability in applying them for the solution of design situations.

SEVENTH SEMESTER						
Sl. No.	**Course Category and Course Code**		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
1.	PCC	21CV701	Specifications & Quantity Surveying	2-2-0	3	4
2.	PCC	21CV702	Prestressed Concrete Structures	2-2-0	3	4
3.	PCC	21CV703	Design of RC Structures- II	2-2-0	3	4
4.	PCC	21CV704	Technical Seminar	0-0-4	2	-
5.	PEC	21CV74X	Professional Elective – III	3-0-0	3	3
6.	PEC	21CV75X	Professional Elective – IV	3-0-0	3	3
7.	OEC	21OECV76X	Open Elective –II	3-0-0	3	3
8.	PI	21PROJ1	Main Project Work Phase-1	0-0-4	2	4
9.	AEC	21RMIP	Research Methodology & Intellectual Property rights (Mandatory non-credit)	2-2-0	AUD IT	4
				Total	**22**	**29**
	AEC: Ability Enhancement Course; OEC: Open Elective					

SEVENTH SEMESTER: PROFESSIONAL ELECTIVES-III						
Sl. No.	**Course Category and Course Code**		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
1.	PEC	21CV741	Railway, Harbour & Airport Engineering	3-0-0	3	3
2.	PEC	21CV742	Structural Dynamics	3-0-0	3	3
3.	PEC	21CV743	Advanced Foundation Design	3-0-0	3	3
4.	PEC	21CV744	Rural Water Supply & Sanitation	3-0-0	3	3
5.	PEC	21CV745	Advanced Design of RC Structures	3-0-0	3	3
6.	PEC	21CV746	Composite & Smart Materials	3-0-0	3	3
7.	PEC	21CV747	Remote Sensing & GIS	3-0-0	3	3
8.	PEC	21CV748	Design and Drawing of Irrigation Structures	3-0-0	3	3
9.	PEC	21CV749	Building Information Modelling	1-0-2	3	5
10.	PEC	21CV750	Water Resources Management	3-0-0	3	3
	PCC: Professional Core Course; IPCC: Professional Core Course Theory Integrated with Practical of the same course PCCL: Professional Core Course Laboratory **AEC: Ability Enhancement Course; UHV: Universal Human Value Courses**					

SEVENTH SEMESTER: PROFESSIONAL ELECTIVES-IV						
Sl. No.	**Course Category and Course Code**		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
1.	PEC	21CV751	Finite Element Analysis	3-0-0	3	3
2.	PEC	21CV752	Atmospheric Environmental Engg.	3-0-0	3	3
4.	PEC	21CV753	Urban and Rural Planning	3-0-0	3	3
5.	PEC	21CV754	Earthquake Resistant Design of Structures	3-0-0	3	3
6.	PEC	21CV755	Pavement Materials & Design	3-0-0	3	3
7.	PEC	21CV756	Reinforced Earth Structures	3-0-0	3	3
8.	PEC	21CV757	Rock Mechanics	3-0-0	3	3
9.	PEC	21CV758	Operation and Maintenance of Environmental Facilities	3-0-0	3	3
	PCC: Professional Core Course; IPCC: Professional Core Course Theory Integrated with Practical of the same course PCCL: Professional Core Course Laboratory **AEC: Ability Enhancement Course; UHV: Universal Human Value Courses**					

SEVENTH SEMESTER: OPEN ELECTIVES-II						
Sl. No.	**Course Category and Course Code**		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
1.	OEC	21OECV761	Engineering Seismology	3-0-0	3	3
2.	OEC	21OECV762	Water Supply and Sanitation	3-0-0	3	3
3.	OEC	21OECV763	Composite and Smart Materials	3-0-0	3	3
4.	OEC	21OECV764	Urban Design and Regeneration	3-0-0	3	3
5.	OEC	21OECV765	Hazardous Waste Management	3-0-0	3	3
6.	OEC	21OECV766	Water Resources Management	3-0-0	3	3
7.	OEC	21OECV767	Green Buildings	3-0-0	3	3
8.	OEC	21OECV768	Sustainable Development Goals	3-0-0	3	3
9.	OEC	21OECV769	Remote Sensing and GIS	3-0-0	3	3
10.	OEC	21OECV770	Engineering Optimization	3-0-0	3	3

	PCC: Professional Core Course; IPCC: Professional Core Course Theory Integrated with Practical of the same course PCCL: Professional Core Course Laboratory **AEC: Ability Enhancement Course; UHV: Universal Human Value Courses**

EIGHTH SEMESTER						
Sl. No.	**Course Category and Course Code**		**Course Title**	**L-T-P**	**Credits**	**Contact Hours**
1.	PI	21PROJ2	Main Project Work Phase 2	0-0-8	4	8
2.	PI	21INT3	Research/Industry Internship - III	0-0-12	12	24
				Total	**16**	**32**

Malnad College of Engineering, Hassan
Department of Civil Engineering

Scheme of Evaluation for Theory Courses

	Portions for CIE	Mode of Evaluation	Weightage in Marks
CIE-1	Syllabus to be decided by the Course Coordinators such that all the COs shall be covered.	Descriptive Test	10
CIE-2		Descriptive Test	10
CIE-3		Descriptive Test	10
Activity	Minimum of Two Activities to be conducted	Assignment/Case Study/Practical/ Working Model/Quiz	20
		Total	**50**

Examination		Max. Marks	Minimum Marks to be scored	Minimum Average Marks to qualify
CIE	Tests	30	12 (>=40%)	40 (.=40%)
	Activities	20	08 (>=40%)	
SEE		50	17.50 (>=35%)	

Scheme of Evaluation for Laboratory Courses

Evaluation Type	Evaluation Modules	Marks
Continuous Internal Evaluation (CIE.) in every Laboratory session by the Course Coordinator	Conduction of Experiments	10
	Observation and Tabulation of Results	10
	Record Writing	20
	Viva-Voce/Quiz	10
Continuous Internal Evaluation (CIE)		**50**
Semester End Examination (SEE)		**50**

Note: The marks distribution to be made based on the rubrics for a particular laboratory course.

Course Title	SPECIFICATIONS & QUANTITY SURVEYING		
Course Code	21CV701	**(L-T-P) C**	(2-2-0) 3
Exam	3 Hrs.	**Hours/Week**	4
CIE + SEE	50 + 50 Marks	**Total Hours**	50

Course Objective: To equip students with the knowledge and skills to prepare, interpret, and apply construction specifications, ensuring that projects are executed according to design intent and quality standards.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Comprehend the importance of estimation an specifications with different types of contracts and check measurement and bill Preparations for a given project.	PO1, PO2, PO6, PO7	
CO2	Determine the quantities of various items identified in a project for given specifications	PO2, PO6, PO7	
CO3	Apply long wall and short wall method and centerline method for calculating quantities	PO1, PO2, PO6	
CO4	Conduct rate analysis for standard items with given specifications	PO1, PO6, PO7	

Course Contents:

MODULE – 1	13 Hrs.

Introduction:- Different type of estimates — Study of various drawings attached with estimates- important terms, units of measurement — abstract — approximate methods of estimating cost of buildings.

Estimating - Methods of taking out quantities and cost — center line method— long and short wall method or crossing method — Preparation of detailed and abstract estimates for the following Civil Engineering works: Buildings framed structures with flat or sloped RCC slabs and Masonry structures

Self-study component: Students shall visit a building under construction and observe how the center line is marked and find the total length of the centre line. They shall also identify the long walls, short walls and intersection points of the walls. They shall observe the progressive construction of masonry and RC components, prepare a report and submit.

MODULE – 2	13 Hrs.

Estimating; Building components: Beams - Columns, Column Footings, stair cases and retaining walls. Estimating - Steel trusses, A.C. Sheet and G.I. Sheet roofs, RCC slab culverts, pipe culverts, metal led roads, C.C. track way, premix carpeting, stabilized soil roads, manholes and septic tanks

Self-study component: Students shall visit a building under construction and observe how Building components: Beams - Columns, Column Footings, stair cases barbending schedules are made and prepare a report and submit.

MODULE -3	12 Hrs.

Rate Analysis - Definition and purpose — Working out quantities and rates as per CPWD standards for the following standard items of work: earthwork indifferent types of soils— cement concrete of different mixes, brick and stone masonry, flooring — plastering— RCC works, painting, white washing and distempering.

Computation of Earthwork in cuttings and embankments for Roads and canals Methods of computation of earthwork — cross-sections — mid section formula — trapezoidal or average end

area or mean sectional area formula — prismoidal formula- for different terrain

Self-study component: Students shall visit a highway under construction and observe how cuttings and embankments for Roads and canals are made and prepare a report and submit.students need to collect local / state govt SR

MODULE -4	**12 Hrs.**

Specifications: Definition of specifications — objective of writing specifications — essentials of specifications — general and detailed specifications of various items of work in buildings. Contracts -

Types of contract — essentials of contract agreement-legal aspects- penal provisions on breach of contract — Definition of the terms — Tender — earnest money deposit— security deposit — tender forms—documents and types— Comparative statements — acceptance of contract documents and issue of work orders- Duties and liabilities- termination of contract—completion certificate- quality control—rights of contractor—refund of deposit Administrative approval— Technical sanction— Nominal muster roll— measurement books — procedure for recording and checking measurements preparation of bills.

Self-study component: Self-study component: Students shall visit a building under construction. They will go through the estimates in detail by including the measurement of actual at site along with working drawings, contract details, specifications, rate of various components like materials, Labor, machinery, prepare a report and submit. Ready software packages may be used to prepare for the estimates.

Practical Component:

Preparation of spread sheet of various quantity estimation

Text Books:

1. Datta, B. N. "Estimating and Costing in Civil Engineering" UBS Publications 7thReprint - twenty sixth revised ed.2009
2. Chakraborti, N. "Estimating, Costing, Specification and Valuation", published by the author, ninth edition.1987

Reference Books:

1. Bhasin, P. L. "Quantity Surveying" S. Chand & Co., New Delhi.2006
2. Kohli, D. D. and Kohli, R. C. A text book on "Estimating, Costing and Accounts" - S. Chand Co.,New Delhi. 2008.
3. PWD SR (HassanCircle)
4. National Building Code (NBC), Bureau of Indian Standards.

MOOC Course:

1. https://onlinecourses.swayam2.ac.in/nou20_cs11/preview

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2				2								
CO2		3				2	2							
CO3	3	2				2								
CO4	3					2	2							

Course Title	PRESTRESSED CONCRETE STRUCTURES		
Course Code	21CV702	**(L-T-P) C**	(2-2-0) 3
Exam	3 Hrs.	**Hours/Week**	04
CIE + SEE	50 + 50 Marks	**Total Hours**	50

Course Objective: To learn broader understandings on various aspects of Prestressed concrete structures

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Apply your knowledge to distinguish between pre-tensioning and post-tensioning systems in pre-stressed concrete by describing their properties and applications.	PO1	
CO2	Analyze the variation of stresses and the factors contributing to the loss of prestress in pre-tensioned and post-tensioned members.	PO2	
CO3	Design pre-stressed concrete beams considering permissible stresses, anchorage zones, and end blocks as per IS codal provisions.	PO3	
CO4	Compare and prepare a report on the process involved in Pre tensioned and Post tensioned concrete with the conventional Reinforced concrete..	PO8, PO9, PO12	

Course Contents:

MODULE – 1	13 Hrs.
Introduction & fundamentals – Definition of pre-stressing & pre-stressed concrete, comparison & advantages over RCC, High Strength materials - necessity, properties, Difference between pre tensioning and post tensioning systems**. Analysis of prestress -** Resultant stress concept, pressure line concept, load balancing concept. ***Self-study component: Students shall visit nearby factory producing pre tensioned electric poles and observe the method of pre tensioning materials used and testing of products.***	
MODULE – 2	**13 Hrs.**
Variation of stresses - Variation of stress in steel in bonded and unbonded beams, Cracking moment. Losses of Prestress – Types of losses in pre-tensioning and post-tensioning. Determination of losses due to various causes. ***Self-study component: Students shall visit nearby factory producing pre tensioned members and calculate the losses of Prestress in members.***	
MODULE -3	**12 Hrs.**
Deflection of Pre-stressed Members – Short term and long-term deflections, deflections at transfer & working load stage, codal provisions. Flexural Strength and Shear Capacity - IS recommendations, ultimate flexural strength, ultimate shear resistance, shear reinforcement as per IS codal provisions. ***Self-study component: Students shall visit a construction site comprising post tensioning of beams and slabs and collect the details***	
MODULE -4	**12 Hrs.**
Design of PSC Beams - Permissible stresses, design of symmetrical and unsymmetrical sections. Anchorage Zone and End Blocks – Transmission of prestress in pre-tensioning systems, transmission length, anchorage stresses in post tensioning systems, end blocks, design of end blocks by IS Method ***Self-study component: Students shall visit a construction site comprising post tensioning of***	

beams and slabs and collect the details of Anchorage zone, end blocks.

Text Books:

1. Sinha, N. C. & Roy, S. K. "Fundamentals of Prestressed Concrete", S. Chand. Co New Delhi, 1997 [Ch.1,2]
2. Krishnaraju N. "Prestressed Concrete" Tata McGraw Hill, New Delhi.2007 [Ch.1 to 14) Ninth reprint 2010.

Reference Books:

1. Dayaratnam.P, 1996, "Prestressed Concrete Structures"oxford – IBH publishers -, ISBN-13: 9788120400450.
2. LiN .T.Y, Margy Burns,1981, 'Design of Prestressed Concrete Structures. John Willey & Sons-ISBN 0-471-01898-8.
3. Rajagopalan. N, 2005, "Design of Prestressed Concrete Structure", BIS New Delhi, ISBN-13: 9781842652121.
4. Muthu K U., Ibrahim Azmi, Janardhana Maganti Vijayanand M (2016),Prestressed Concrete, ISBN-13: 9788120351691.
5. IS 1343-2000, "Prestressed concrete structure-Code of practice", BIS New Delhi.

MOOC Course:

1. Prestressed Concrete Structures

https://archive.nptel.ac.in/courses/105/106/105106118/

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3													
CO2		3												
CO3			3											
CO4								2	2			3		

Course Title	DESIGN OF RC STRUCTURES -II		
Course Code	21CV703	**(L-T-P) C**	(2-2-0) 3
Exam	3 Hrs.	**Hours/Week**	4
CIE + SEE	50 + 50 Marks	**Total Hours**	50

Course Objective: To equip students with the skills to design more complex reinforced concrete elements, such as flat slabs, deep beams, shear walls, and foundations, ensuring structural stability and safety.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Design of Ground Water tanks as per relevant IS code.	PO1,PO3, PO8	PSO1
CO2	Illustrate bar bending details and determine total quantity of steel for RC Retaining walls as per relevant IS code	PO1,PO3, PO8	PSO1
CO3	Evaluate various types of combined footings	PO1,PO3, PO8	PSO1
CO4	Design of Concrete slabs by strip method and design of circular slabs	PO1,PO3, PO8	PSO1

Course Contents:

MODULE – 1	13 Hrs.

Design of RC Water tanks – Introduction – Classification-Basis of design- Permissible stresses in concrete and steel – Joints in tanks - **Design of Circular water tanks** resting on ground with fixed base and without top cover. **Design of Rectangular water tanks** resting on ground with fixed base and without top cover -shall be designed as per relevant IS guidelines.

MODULE – 2	12 Hrs.
Design of RC Retaining walls- Introduction – Classification -Stability and safety considerations -Design loads -**Design of cantilever retaining wall** – Wall proportion – Stability of retaining wall – Pressure distribution- Design of Toe and Heel slabs – Design of Stem. **Design of Counterfort retaining wall -** Wall proportion – Stability of retaining wall – Pressure distribution- Design of Toe and Heel slabs – Design of Stem – Design of Counterfort , by the limit state design method.	
MODULE -3	**13 Hrs.**
Design of RC Combined footings - Introduction – Rectangular footing,Trapezoidal footing - Design loads – Code requirements for concrete reinforcements – Load on foundation –Design of rectangular combined footing (slab and beam type), Design of trapezoidal combined footing (slab and beam type) by the limit state design method.	
MODULE -4	**12 Hrs.**
Hillerborg's Strip method of design of concrete slabs- Introduction –Different edge conditions – Simply supported, slab with free edge, fixed along edges, continuous at adjacent sides and unsupported on the other two sides. **Design of circular slabs –** Slab freely supported at edges, slab fixed at edges.	
Self-study component: Students shall visit different types of RC structures within the campus and out-side the campus and identify detailing in terms of bar bending for water tanks, retaining walls and combined footings.	
Text Books: 1. Ramamrutham.S "Design of Reinforced Concrete Structures" Dhanpath Rai & Sons 2015 2. Dr. B. C. Pumnia, RCC Designs, 11th edition, Lakshmi Publications, New Delhi - 2022	
Reference Books: 1. P C Vargheese, Advanced Reinforced Concrete Design, PHI Learning Private Limited -2014 2. S Unnikrishna Pillai, Devdas Menon, Reinforced Concrete Design, 4th Edition, TMH, 2021 3.N Subramanian, Design of RC Structures, Oxford IBH	

4. IS 456 – 2000, SP – 24-1983, SP – 16-1984, SP -34 -1989, IS 3370 (part 4) 1967 BIS Publications.

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	1		3					2					3	
CO2	1		3					2					3	
CO3	1		3					2					3	
CO4	2		3					2					3	

Course Title	TECHNICAL SEMINAR		
Course Code	21CV704	(L-T-P) C	(0-0-2) 2
Exam	-	Hours/Week	-
CIE + SEE	100 marks	Total Hours	-

Course Objective: To upgrade technical presentation and communication skills through literature survey, review and documentation.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Carry out the required literature survey on any topic of research and developments in Civil Engineering	PO2, PO4	
CO2	Prepare a technical report based on the literature survey on given topic of the domain of Civil Engineering	PO2, PO10	
CO3	Acquire presentation skill on the chosen technical topic	PO9, PO10	

SCHEME FOR SEMINAR EVALUATION:

Sl. No.	Criteria	Maximum Marks
1	Organization and style	15
2	Content and knowledge	20
3	Understanding and relevance	20
4	Presentation	10
5	Format and flow of communication	15
6	Report organization and presentation	20
	Total	**100**

Course Articulation Matrix

Course Outcomes	Program Outcomes[POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO1		3		3										
CO2		3								3				
CO3									3	3				

Course Title	RAILWAY, HARBOUR & AIRPORT ENGINEERING		
Course Code	21CV741	(L-T-P) C	(3-0-0) 3
Exam	3 Hrs.	Hours/Week	3
CIE + SEE	50 + 50 Marks	Total Hours	40

Course Objective: To learn broader understandings on various aspects of railway, harbor & airport engineering.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Illustrate the role of railways, comparing with other modes and highlight the initiatives by Indian Railways towards development	PO1,PO2, PO3	
CO2	Explain the various key elements of a construction of track, maintenance & geometric design.	PO1,PO2, PO4	
CO3	Illustrate the various components of harbour, wave action and elements of harbour structures and concepts of airport planning	PO1,PO2	
CO4	Explain the concepts of airport orientation, geometric design of runway and taxiway	PO1,PO2, PO3	

Course Contents:

MODULE – 1	10 Hrs.

Introduction: Role of railways in transportation, Historical developments of railways in India, Selection of routes - preliminary and locations surveys.

Permanent way: Rail – functions and types, Sleeper – functions and requirements, Ballast – functions, requirements and types. Gauges, cross section of permanent way, coning of wheel, creep of rail, rail damage – defects, rail joints, calculation of quantity of materials needed for laying of tracks.

Self-study component: Students shall visit nearby Railway and Metro stations and observe the components of railway track, rail joints, sleepers and other details, prepare a report and submit.

MODULE – 2	10 Hrs.

Construction and Maintenance: Construction – earth work – formation and consolidation, plate laying, laying of ballast. Maintenance – necessity, advantages, Station and Yards: Railway station – site selection, requirements, classification.

Geometric Design of Track: gradient – necessity, ruling gradient, pusher gradient, momentum gradient, gradients in station yards. superelevation– cant deficiency and negative cant – numerical, Curves – necessity, types.

Self-study component: Students shall visit nearby Railway station and discuss with the railway staff regarding track maintenance, ruling gradient, speed of train, prepare a report and submit.

MODULE -3	10 Hrs.

Harbour Engineering: Water transportation – inland and ocean. Harbour – components, classification, requirements and site selection. Wave – origin, wave action and coastal protection works.

Airport Planning: Air transportation – role, advantages and limitations. Airport – components, site selection, classification and regional planning. Aircraft characteristics

Self-study component: Students shall collect the material from the internet on typical details

of a Harbour and Airport and identify various components and other relevant details, prepare a report and submit.

MODULE -4	10 Hrs.

Runway Design: Analysis of wind data by wind rose diagram to find out the best direction of runway. Basic patterns of runway, basic runway length – correction to runway length by ICAO and FAA specifications. Runway geometric design.

Taxiway Design: Factors affecting layout of taxiway, Geometric design of Taxiway, turning radius of taxiways as per ICAO. Design of exit taxiway. Instrumental landing system.

Self-study component: Students shall collect the material from internet on typical details of Airport markings, prepare a report and submit.

Text Books:

1. S C Saxena and Arora "Railway Engineering" Dhanpath Rai and Sons, New Delhi-2015. ISBN: 978 – 9383182923
2. M M Agarwal, "Indian Railway Track" Oxford Publications, Bombay – 2018. ISBN-13: 978- 0-19-568779-8.

Reference Books:

1. Rangawala, "Principles of Railway Engineering" Charotar Publishing House, New Delhi–2017.ISBN:8192869253.
2. Sathish Chandra,"Railway Engineering"Oxford University Press,New Delhi–2013.ISBN-10:0-19-568779-5.
3. Amith Gupta,"Railway Engineering" Standard Publishers Distributors, New Delhi–.2015.ISBN:81–8014–011–3.

MOOC Course:

1. Urban Transportation Systems Planning,

https://onlinecourses.nptel.ac.in/noc24_ce37/preview

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1											
CO2	3	2	1											
CO3	3	2												
CO4	3	2	1											

Course Title	STRUCTURAL DYNAMICS		
Course Code	21CV742	(L-T-P) C	(3-0-0) 3
Exam	3 Hrs.	Hours/Week	3
CIE + SEE	50 + 50 Marks	Total Hours	40

Course Objective: The objective of this course is to equip students with the skills to analyze and understand vibrations in SDOF and MDOF systems under various conditions.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Comprehend principles of vibration and elementary components of a vibratory system, analyze undamped and damped free vibration of a single degree of freedom system	PO1, PO2, PO3	
CO2	Analyze undamped and damped forced vibration of a single degree of freedom system	PO2,PO3, PO4	
CO3	Comprehend the response of SDOF to general system of loading	PO2,PO3, PO4	
CO4	Analyze MDOF systems	PO2,PO3, PO4	

Course Contents:

MODULE – 1	10 Hrs.
Introduction; Laws of motion, D' Alembert's Principle, Stiffness of springs in series and parallel, Mass moment of inertia, Simple harmonic motion, Definition of vibration – Parts of a vibrating system –Degrees of freedom – Types of vibration. Free vibration; Undamped and damped free vibration of a single degree of freedom system–Logarithmic decrement. ***Self-study component: Students shall collect material from the internet on fundamentals of dynamics and free vibration, prepare a report and submit.***	
MODULE – 2	**10 Hrs.**
Forced Vibration; Undamped and damped forced vibration of a single degree of freedom system – Steady state response, Dynamic magnification factor, response to harmonic loading. **Forced vibration (cont'd)**; Rotational and reciprocating unbalance, Force transmissibility, Force transferred to the foundation. ***Self-study component: Students shall collect material from the internet on forced vibration and its effect on machine foundation. prepare a report and submit***	
MODULE -3	**10 Hrs.**
SDOF subjected to base excitation; Harmonic base excitation, Vibration isolation, Vibration measuring instruments. **Response of SDOF for general System of loading (undamped);** Duhamel' Integral – dynamic load factor for step, rectangular, ramp and triangular input. ***Self-study component: Students shall collect material from the internet on fundamentals of vibration isolation, vibration measuring instruments and response of a SDOF system. prepare a report and submit.***	
MODULE -4	**10Hrs.**
MDOF Systems: Free vibration – natural frequencies – Orthogonality principle. Eigen values and Eigen vectors, Shear buildings modeled as MDOF systems. **MDOF Systems (Cont'd);** Forced undamped and damped vibration of shear buildings – Modal superposition method – Response to harmonic excitation only. ***Self-study component: Students shall observe the demonstration of vibration of MDOF***	

system, and collect material from the internet on fundamentals of MDOF systems subjected to both forced undamped and damped vibrations. prepare a report and submit.

Text Books:

1. Mukhopadhya, M. "Vibrations, Dynamics and Structural Systems" Oxford IBH Publications, 2000 (Ch. 1, 2, &8)
2. Mario Paz, "Structural Dynamics" CBS Publishers, 2004 (Ch. 3, 4, 5, 6 &7)

Reference Books:

1. Clough & Penzien. "Dynamics of Structures" McGraw Hill Publishers2004
2. Anil K. Chopra, "Dynamics of Structures" PHI Publishers2006

MOOC Course:

1. https://archive.nptel.ac.in/courses/105/106/105106151/

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	3	3											
CO2		3	3	2										
CO3		3	3	2										
CO4		2	3	2										

Course Title	ADVANCED FOUNDATION DESIGN		
Course Code	21CV743	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs.	**Hours/Week**	3
CIE + SEE	50 + 50 Marks	**Total Hours**	40

Course Objective: To learn and explore various foundation types and understand their suitability for diverse soil conditions, loading conditions, and learn the basics of machine foundation.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Apply foundation design principles to real-world scenarios, selecting suitable foundation types based on site conditions and structural needs.	PO1	
CO2	Analyze foundation systems considering soil properties, loads, and construction methods to determine optimal solutions for projects.	PO2	
CO3	Design diverse foundations (e.g., footings, piles, caissons, machine foundations) considering factors like bearing capacity, settlement, and soil dynamics for structural safety and stability.	PO3	
CO4	Develop practical knowledge and observational skills in foundation engineering to critically assess real-world construction practices and apply theoretical concepts effectively.	PO9,PO11 PO12	

Course Contents:

MODULE – 1	10 Hrs.
Shallow Foundations- Presumptive bearing capacity according to BIS – Factors affecting bearing capacity and settlement – Factors influencing selection of depth of foundation – Problems on settlement-Principles of design of footings _ Design of Isolated footing – Combined footing – Strap footing – Strip footing and raft (proportioning only).Foundations on Expansive Soils-identification of expansive soils – foundation treatment for structures on expansive soils. ***Self-study component:Students shall visit construction sites and observe the type of foundation adopted for a given design situations***	
MODULE – 2	**10 Hrs.**
Deep Foundations - *Pile groups – Number of piles and spacing – group capacity of piles – group efficiency of piles – settlement of piles – negative skin friction and under reamed piles. Drilled Piers: Introduction – Construction – Advantages and disadvantages of drilled piers* ***Self-study component:Students shall visit construction sites and observe pile driving, pile testing and drilled piers***	
MODULE -3	**10 Hrs.**
Caissons and well foundation- Caissons - Introduction – Types of Caissons – Design aspects of caissons – Construction of open, pneumatic and floating caissons – their advantages and disadvantages – Well Foundation: Shapes of wells – components of well foundation and their design aspects – forces acting on a well foundation – Sinking of wells– causes and remedies of tilts and shifts ***Self-study component:Students shall visit a bridge construction site and observe the components of caissons and well foundation.***	
MODULE -4	**10 Hrs.**
Machine Foundations – Dynamic Soil Properties, Machine Foundations - Introduction – Types of machine foundations –Basic definitions – Degrees of Freedom of a block foundation – general criteria for design of machine Foundation - free and forced vibrations – vibration analysis of a machine Foundation – Determination of natural frequency –vibration isolation and control.	

Self-study component:Students shall visit a construction site and observe the behaviour of a typical expansive soil and the measures taken to treat the same - collect the material from the internet on behavior and performance of machine foundation.

Text Books:

1. Arora,K.R. "Soil Mechanics and Foundation Engineering" Standard Publishers Distributors, Delhi, Fifth edition 2001(Ch.1,2,3,4,5,6,8)
2. GopalRanjan & Rao.A.S.R "Basic and Applied Soil Mechanics" New Age International Publishers, 2nd edition 2006(Ch.1,2,3,6,7,8)

Reference Books:

1. Punmia,B.C., Ashok Kumar Jain, Arun Kumar Jain "Soil Mechanics and Foundations" Laxmi Publications (P) ltd, 16th edition Oct. 2008(Ch.1,2,3,6,8)
2. Venkataramaiah,C "Geotechnical Engineering" New Age International Publishers,3rd edition2006 (ch.1,2,3,5,6,8)
3. Srinivasulu,P and Vaidyanathan,C.V. (2017). Handbook on machine foundations. Tata McGrawHill

MOOC Course:

1. https://onlinecourses.nptel.ac.in/noc24_ce95/preview

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3													
CO2		3												
CO3			3											
CO4									2		2	2		

Course Title	RURAL WATER SUPPLY & SANITATION		
Course Code	21CV744	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs	**Hours / Week**	3
CIE + SEE	50 + 50 Marks	**Total hours**	40

Course Objective: To provide knowledge on technical aspects of drinking water supply and scope of sanitation in rural areas

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

COs	Course Outcomes	Mapping to POs	Mapping to PSOs
CO1	Discuss the importance of village community and need for protected water supply	PO1, PO6, PO7	
CO2	Describe the need and methods of water treatment and rural sanitation	PO1, PO6, PO7	
CO3	Assess different methods of rain water harvesting and refuse disposal	PO1, PO6, PO7	
CO4	Discuss various methods of controlling communicable diseases and milk sanitation	PO1, PO6, PO7	

Course Contents:

MODULE –1	10 Hrs.

Introduction: Importance of Village community in India, Need for protected water supply, Traditional sources of water in rural areas, Investigation and selection of water sources

Rural Water Supply: Waterborne diseases, protection of well waters, drinking water quality standards, Water lifting arrangements, Water supply system

MODULE –2	10 Hrs.

Water Treatment Methods: Disinfection, Deflouridation, Hardness and iron removal, water quality surveillance, ground water contamination and control

Improved methods and compact systems of treatment: Brief Details of multi-bottom settlers (MBS), diatomaceous earth filter, cloth filter, slow sand filter, chlorine diffusion cartridges. Water supply during fair, festival and emergencies.

Rain Water Harvesting: need, advantages, components of roof top rain water harvesting system, methods of rainwater harvesting, maintenance tip for rainwater harvesting structure

MODULE –3	**10 Hrs.**

Rural Sanitation: Disposal of night soil, requirement of privy, types of privies, disposal by trenching and composting, Imhoff tank, septic tank, soak pit, Sullage and storm water disposal

Refuse Collection & Disposal: Types and characteristics of refuse, refuse collection – planning and collection system. Refuse disposal – dumping, hog feeding, methods of composting, methods of sanitary land filling. Dung disposal and biogas plant for dung disposal

MODULE – 4	**10 hrs.**

Communicable Diseases and Insect Control: Terminology, classification, modes of communication, general methods of control. House fly and mosquito - life cycle, disease transmission and control measures

Milk Sanitation: Essential of milk sanitation, Essential tests for milk quality, methods of pasteurization, cattle borne disease and planning for a cow shed

Self-study: Students shall visit nearby village and study different sanitation methods adopted and shall submit a report of their observations under self-study components.

Text Books:

1. Salveto "Environmental Sanitation" Mc Graw Hill, II Edition, 1970 Steel.E.W.
2. "Water Supply and Sewerage." Mc Graw Hill, V Edition, 1985

Reference Books:

1. Gourishekar Gosh "Water Supply in Rural India : Policy and Programme" APH Publishing Corporation- 2006
2. Allan Greenwell "Rural Water Supply" Bibliolife publishers

MOOC/NPTEL Courses:

1. Urban Utilities Planning: Water Supply, Sanitation and Drainage By Prof. Debapratim Pandit,IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc24_ar18/preview
2. Wastewater Treatment and Recycling by Prof. Manoj Kumar Tiwari, IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc24_ce105/preview

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3						2							
CO2						2	3							
CO3	2						3							
CO4	3						2							

Course Title	ADVANCED DESIGN OF RC STRUCTURES		
Course Code	21CV745	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs.	**Hours/Week**	3
CIE + SEE	50 + 50 Marks	**Total Hours**	40

Course Objective: The students should be able to design the components of various structures covering material aspects of concrete, analysis and design of advance reinforce concrete structures by limit state and working stress method.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Analysis and Design of overhead RC tank, silos, and bunkers	PO3	
CO2	Analysis and Design of the slabs by equilibrium & virtual work methods through yield line analysis approach.	PO3	
CO3	Design of Grid floors by approximate methods and Flat slab by Direct design method.	PO3	
CO4	Prepare a comprehensive report on Design of Silos, Bunkers, Grid floors and Flat slabs using advanced software tools	PO3, PO5, PO9	PSO2

Course Contents:

MODULE – 1	10 Hrs.
Overhead RC circular tank: Design of various components of overhead RC circular tank with flat base slab by working stress method. ***Self-study component: Students shall visit construction sites of RC overhead tank and observe various components and their details.***	
MODULE – 2	**10 Hrs.**
Bins: Introduction, Classification, Design of various components of silos and bunkers using Janssen's Theory. ***Self-study component: Students shall visit construction sites of Bins and observe various components and their details.***	
MODULE -3	**10 Hrs.**
Yield line analysis: Introduction, Assumptions, Characteristic features of yield lines, analysis and design of square and rectangular slabs with different support conditions by equilibrium method and virtual work method (Including derivations). ***Self-study component: Students shall test in the laboratory a slab panel with different boundary condition and observe the yield line pattern at failure.***	
MODULE -4	**10 Hrs.**
Grid floors: Introduction, Classification, Proportioning, Design of Grid Floors by approximate methods. **Flat Slabs:** Introduction, Classification, Proportioning, Design of flat slabs by Direct Design Method (with and without drops). ***Self-study component: Students shall visit a construction site with grid slab and flat slab***	

structural systems. Observe various components and their details.

Text Books:

1) Bhavikatti S. S. "Advance RCC Design", 3 rd Edition, New Age International Private Limited, 2008.
2) Krishnam Raju, N. "Design of Reinforced Concrete Structures", 2 nd Edition, CBS Publishers and Distributors, New Delhi, 2007.

Reference Books:

1) Varghese P.C. "Advanced Reinforced Concrete Design", 2 nd Edition, Prentice - Hall of India,, 2008.
2) Indian Standarad Code 456 2000, "Code of Practice for plan & reinforced centre", British Standard Code-2000.
3) Special Publications -16, "Design Aids for Reinforced Concrete", to Is: 456.
4) Purushothaman,P., "Reinforced Concrete Structural Elements", 3 rd Edition, Tata Mc Graw- Hill Publishing Co, 2004.
5) Pillai and Devadas Menon, "Reinforced Concrete Design", 2 nd Edition, Tata McGraw Hill Publishing Co. Ltd., 2003.

MOOC Course:

1) Advanced Reinforced Concrete Design - Course (nptel.ac.in)
2) Design Of Reinforced Concrete Structures - Course (nptel.ac.in)

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1			3											
CO2			3											
CO3			3											
CO4			3		2									2

Course Title	COMPOSITES AND SMART MATERIALS		
Course Code	21CV746	(L-T-P) C	(3-0-0) 3
Exam	3 Hrs.	Hours/Week	3
CIE + SEE	50 + 50 Marks	Total Hours	40

Course Objective: The course aims to analyze the environmental impact on materials, study various composite characteristics and to study various types of smart materials used in engineering application.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Comprehend the fundamental properties, manufacturing processes, and applications across various industries for different types of composites	PO2, PO3	
CO2	Perceive different classes of ceramic and polymeric smart materials; development of actuators and sensors and their integration into a smart structure	PO2, PO3	
CO3	Apply the principles to various fields like automobile, space, medical, automotive, building construction, etc	PO2, PO3	
CO4	Design of embedded & surface mounted, piezoelectric devices	PO1, PO2, PO3	

Course Contents:

MODULE – 1	10Hrs.

Introduction to Composite materials: Classifications and applications of fibers, volume fraction and load distribution among constituents, minimum & critical volume fraction, compliance & stiffness matrices.

Self-study component: Student shall gain knowledge about the innovative composite materials and their applications in civil engineering domain.

MODULE – 2	**10 Hrs.**

Anisotropic elasticity - Unidirectional and anisotropic lamina, thermo- mechanical properties, micromechanical analysis, classical composite lamination theory**.** Cross and angle–ply laminates, symmetric, antisymmetric and general asymmetric laminates, mechanical coupling and laminate stacking.

Self-study component: Student shall explore appropriate websites to observe the behaviour of composite material subject to varying temperature.

MODULE -3	**10 Hrs.**

Analysis of simple laminated structural elements - Ply-stress and strain, lamina failure theories - first fly failure, environmental effects and manufacturing of composites.

Self-study component: Student shall learn different types of composite materials and their application in aircraft design.

MODULE -4	**10 Hrs.**

Smart materials - Introduction, Types of smart structures, actuators & sensors, embedded & surface mounted, piezoelectric coefficients, phase transition, piezoelectric constitutive relation.

Self-study component: Student shall learn about self-healing materials used in aircraft industry etc.

Text Books:

1. Robart M Jones, "Mechanic of Composite Materials", McGraw Hill Publishing Co, ISBN 10: 0891164901 ISBN, 13: 9780891164906, Wonder book seller , Frederick, USA.
2. Bhagwan D Aggarwal and Lawrence J Broutman, "Analysis and Performance of Fiber Composites", ISBN: 978-1-119-38997-2, John Willy and Sons, NewYork.

Reference Books:

1. Crawley, E and de Luis, J., "Use of piezoelectric actuators as elements of intelligent structures", AIAA Journal, Vol. 25 No 10, Oct 1987, PP 1373-1385.

2. Crawley, E and Anderson, E., "Detailed models of Piezoceramic actuation of beams", Proc. of the 30th AIAA /ASME/ASCE/AHS/ASC- Structural dynamics and material conference, AIAA Washington DC, April 1989.
3. Lecture notes on "Smart Structures", by Inderjith Chopra, Department of Aerospace Engg., University of Maryland.

MOOC Course:

1. https://archive.nptel.ac.in/courses/105/108/105108124/
2. https://nptel.ac.in/courses/112104173

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1		3	2											
CO2		3	2											
CO3		2	1											
CO4	3	2	1											

Course Title	REMOTE SENSING AND GIS		
Course Code	21CV747	(L-T-P) C	(3-0-0) 3
Exam	3 Hrs.	Hours/Week	3
CIE + SEE	50 + 50 Marks	Total Hours	40

Course Objective: To develop knowledge on RS & GIS technologies to collect , analyze and interpret spatial data for solving real life problems.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Comprehending remote sensing entails understanding of Energy interactions.	PO1,PO2	
CO2	Applying remote sensing in data collection and analysis through different types of sensors & platforms	PO1,PO2	
CO3	Comprehend GIS : Managing , Analyzing ,Visualizing spatial data solutions.	PO1,PO2	
CO4	Develop a comprehensive report on different types of currently working satellites and their uses.	PO1,PO9 ,PO10	

Course Contents:

MODULE – 1	10 Hrs.

Introduction: Basics of Remote Sensing, Active and Passive Remote sensing (RS), Scope of remote sensing; Electromagnetic radiation and electromagnetic spectrum: Visible, Infra-Red (IR), Near IR, Middle IR, Thermal IR, and Microwave. Black body radiation and radiation laws; Interaction of EMR with atmosphere and Earth's surface features; Types of Remote Sensing and Sensors Characteristics Platform and Orbits: Ground Based, Air Borne, Space borne. Orbits: Geo-Stationary satellite, Polar Orbiting satellite. Types & characteristics of sensors, Sensor resolution, Concept of Swath and Nadir, Image referencing system, Remote sensing data

products: IRS, LANDSAT, SPOT, IKONOS, Quick Bird

Self - study component: Students shall collect the information on space research organizational structure ,Types of Indian satellites, and data products

MODULE – 2	**10Hrs.**

Thermal Remote Sensing; Thermal properties of materials:

Emissivity of materials; thermal inertia of Earth surface features; Thermal data sets: LANDSAT and ASTER; Concept and Principles of microwave remote sensing; Microwave data sets SLAR. LIDAR and SAR;

Application of Thermal and Microwave data; Digital Image processing: Introduction to Image, Digital image Types of Data Products, Types of image interpretation, Basic elements of image interpretation, Visual interpretation keys, Digital Image Processing, Preprocessing, image enhancement techniques, multispectral image classification, Supervised and unsupervised.

Self-study component: Students shall collect the information on commercial and open-source Remote Sensing data for use in GIS. Download free DEM and LULC data.

MODULE -3	**10 Hrs.**

Introduction to GIS: Fundamentals of Geographic Information System: Basic Concepts: definition of GIS, Components of GIS, Variables - points, lines, polygon, Functionality of GIS, Recent trends and applications of GIS; GIS Softwares, Open-source GIS;

GIS Data base: Geographic data: Spatial and non-spatial; Data models: Raster and vector; DatabaseManagement System (DBMS): Geo-database. Data Structures: Relational, hierarchical and network; Data input and scale: Nature and Source of data, Digitization of maps and imageries, Attribute data generation; Data Editing: Coordinate systems, Coordinate transformation .Reprojection.

Self-study component: Students shall collect the information on different commercial and open-source GISsoftware

MODULE -4	10 Hrs.

Spatial analysis: Spatial overlay operations, network analysis and proximity analysis; 3D models; TIN, Types of DEM. Application of DEM, Raster to Vector vice versa conversion. Water shed delineation using topographic sheets. Estimation of reservoir capacity.

Introduction to Global Positioning System (GPS): GPS satellites constellations; GPS segments: Space, Control, User; GPS antennas, signals, and codes; GPS receivers; Modes of measurements and post processing of data; Accuracy of GPS measurements; Application of GPS.

Self-study component: Students shall collect the information on different GPS system in world and their working.

Text Books:

1. Lillesand, Kiefer, Chipman, "Remote Sensing and Image Interpretation", Wiley2011.
2. Basudeb Bhatta "Remote sensing and GIS" Oxford university Press, New Delhi, India,2021
3. Narayan Panigrahi, "Geographical Information Science", and ISBN 10: 8173716285 / ISBN 13: 9788173716287, University Press2008.
4. Kang – T surg Chang, "Introduction to Geographic Information System". Tata McGraw Hill Education Private Limited2015.

Reference Books:

1.Anji Reddy M., "Remote sensing and Geographical information system", B. S. Publications2008.

2.S Kumar,"Basics of remote sensing & GIS", Laxmi publications 2005

3. John R. Jensen, "Remote sensing of the environment", an earth resources perspective–2nd edition– by Pearson Education2007

4. Chor Pang Lo and Albert K.W Yeung, "Concepts &Techniques of GIS", PHI,2006

MOOC Course:

1. https://onlinecourses.nptel.ac.in/noc22_ce84/preview
2. https://www.iirs.gov.in/pgdiploma
3. https://archive.nptel.ac.in/courses/105/103/105103193/

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2												
CO2	3	2												
CO3	3	2												
CO4	3								2	2				

Course Title	DESIGN AND DRAWING OF IRRIGATION STRUCTURES		
Course Code	21CV748	(L-T-P) C	(3-0-0) 3
Exam	3 Hrs.	Hours/Week	3
CIE + SEE	50 + 50 Marks	Total Hours	40

Course Objective: The objective of this course is to equip students with the knowledge and skills to design and draw various irrigation structures, ensuring effective water management and distribution.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Gain fundamental knowledge of irrigation structures such as overflow gravity dams, different types of earthen dams & canal sections	PO1, PO2, PO3	
CO2	Design head and cross regulators for given details	PO2, PO4, PO5	
CO3	Design canals drop for given details	PO2, PO3, PO5	
CO4	Design direct sluice for a canal and tank sluice for given details	PO3, PO4, PO6	

Course Contents:

MODULE – 1	20 Hrs.

Preparation of Drawings for given design details of: Overflow Section of Gravity Dams. Sections of earth dams of Homogeneous fill, zonal embankment, and Diaphragm types with drainage plans. Sections of Canals of different conditions, in cutting, in banking and partly in cutting & partly in banking.

Self-study component: Students shall visit nearby gravity dam, canals in cutting and embankment, submit a report.

MODULE – 2	20 Hrs.

Designs and Drawings for: Surplus Weir with stepped type of aprons, Tank Sluice, Direct Sluice, Head Regulator, Cross regulator, and Canal Drop(Notch type).

Self-study component: Students shall visit nearby tank weir, sluice, canal sluice, canal drop and canal regulator, observe the components, submit a report.

Text Books:

1. Murthy, C. S. "Design of Minor Irrigation and Canal Structures" Wiley Eastern Ltd, New Delhi (Part A) 2000 Edition (Ch. Part A, PartB).
2. Leliavsky, S."Design Textbook in Civil Engineering 'Oxford and IBH Publishing co., Pvt.Ltd, New Delhi (Part B) 1996 Edition.

Reference Books:

1. Sehgal, P. P. "Design of Irrigation Structures" Khanna Publishers, NewDelhi.1998
2. Varshney, S.C. Gupta &. "Irrigation Engineering & Hydraulic Structures" R. L Nem Chand & BrosRoorkee,1999

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	2	3	3											
CO2		3		2	2									
CO3		3	3		2									
CO4			3	2		2								

Course Title	BUILDING INFORMATION MODELLING		
Course Code	21CV749	**(L-T-P) C**	(1-0-2) 3
Exam	3 Hrs.	**Hours/Week**	3
CIE + SEE	50 + 50 Marks	**Total Hours**	40 (12 L + 28P)

Course Objective: This course aims to make the students creative by imparting the ability to produce drawings of building projects.

1. It will help navigate user interface, architectural objects such as door, walls, roofs, windows, and stairs.
2. It will cover the basics of Architectural Design This course will assist in the creation of schematic design through construction documentation.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Prepare Drawings a given building by measure drawing on site	PO3, PO5, PO8, PO10	
CO2	Develop 3D model for any building with all the building elements as per the given requirements	PO1, PO5, PO9	
CO3	Calculate area requirements for various functions of a building	PO1, PO5, PO9	
CO4	Present effectively the Design Features of the proposed project	PO1, PO5, PO9	

Course Contents:

MODULE – 1	20 Hrs.
The concepts of Building Information Modelling and introduction to the tools for parametric building design and documentation .The benefits, use and fundamental features of Building Information Modelling. Use of parametric 3D design tools to create 3D modelling of design projects.	
MODULE – 2	**20 Hrs.**
List of Exercises: Documentation of a Public Building as group work.(3-4 students) Drawing of Plan and 3D Modelling including electrical, plumbing and sanitary services using BIM software for a given set of requirements and given site: 1. Single story residential building. 2. Two Storey residential building 3. Hostel building. 4. Hospital building. 5. Commercial building. ***Self-study component: Each student shall visit, study and photograph architecturally well designed public buildings and prepare a report on the same. The students shall visit- ongoing project sites and study for real time experience of BIM.***	
Text Books: 1. Linkan Sagar, Sristry Rawal REVIT 2019 Architecture step by step. BPB Publications 2019 2. S.P Arora, S.P.Bindra The Text book of Building Construction, Dhanpat Rai Publications	
Reference Books: 1. Shah. M. H. and Kale. C.M. "Building Drawing" Tata Mc Graw Hill Publishing Co, New Delhi 2. Linkan Sagar, Sristry Rawal REVIT 2019 Architecture Training Guide, BPB Publications 2019 3. REVIT ARCHITECTURE lab manual.	

MOOC Course:

1. https://youtu.be/Mux0p1dNBvw?si=Twr1TEwS9dlY6Z6s
2. https://youtu.be/uEdh-AR8g_c?si=NqDFU0h8-fQQaKbV

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1			1		3	2		1		2				
CO2	1				3				2					
CO3	1				3				2					
CO4	1								2					

LAB RUBRICS: 21CV749 BUILDING INFORMATION MODELLING

	3	2	1	0/0.5
Drawing Accuracy. /03	All drawing elements are accurate and precise. No errors are present.(3)	All necessary drawing elements are evident. Three minor errors are present.(2)	Attempt was made to accurately create the drawing (1)	No attempt was made to accurately create the drawing (0)
Modern Tool Usage /03	The student has effectively used the software to do the given drawing. (3)	The student has the basic knowledge of most of the tools of the software to do the given drawing (2)	The student has the basic knowledge of some of the tools of the software to do the given drawing (1)	The student clearly failed to use the basic tools of the software to do the given drawing (0)
Completeness /02	All the three views are drawn completely (3)	Dimensions of few objects were missing(2)	Incomplete views (1)	No real attempt was made to draw the model (0.5)
Dimensions /02	Dimensions of all of the objects were shown(2)	Dimensions of few of the objects missing (2)	Dimensions of many of the objects missing (1)	Dimensions not shown (0.5)

Course Title	WATER RESOURCES MANAGEMENT		
Course Code	21CV750	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs.	**Hours/Week**	3
CIE + SEE	50 + 50 Marks	**Total Hours**	40

Course Objective: To develop an understanding of the availability and occurrence of freshwater, its uses, and problems related to water resources management

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Apply your understanding of the Scope and Economics of Water Resources Engineering in assessing its importance	PO1	PSO1
CO2	Apply Principles of Engineering Economy and Optimization in Water Resources Management	PO1	PSO1
CO3	Analyze Integrated Water Resource Management (IWRM) Strategies for Sustainable Development	PO2	PSO1
CO4	Cultivate Environmental Sustainability and Lifelong Learning in Water Resources Engineering through Project-Based Initiatives	PO7, PO12	PSO1

Course Contents:

MODULE – 1	10 Hrs.

Introduction: Applications of water resources engineering, Economics in Water resource planning, social aspects, planning of water resources surveys, Water resources of the world, Water resources in India, Water demand for various purposes, Integrated Water Resources, Rejuvenation and conservation of water resources.

Water Law: Riparian right, Appropriative rights, Permit system, Water codes. Groundwater laws, Interstate problems,international problems

Self-study component: Students shall collect the information from internet on water resource Planning, interstate river disputes, international problems. submit a report.

MODULE – 2	10 Hrs.

Floods: Importance of flood studies, Definition of flood, causes of floods Factors affecting flood flow. Estimating the magnitude and frequency of floods, Empirical formulae, Rational method, Envelope curve, Unit hydrograph method and probability methods, Design floods, Standard project flood & probable maximum flood.

Engineering Economy in Water Resources Projects: Introduction, Steps involved in economy study, Economics of combined flood projects and multipurpose projects. Principle of Optimization in planning, Capital Budgeting.

Self-study component:Students shall collect information from the internet on causes of flood-estimation of design flood-economics of multipurpose projects-capital budgeting, submit a report.

MODULE -3	10 Hrs.

Planning for Water Resources Development: Definition of Planning, Levels and Phases of planning, Objectives of Project Planning. Formulation Project evaluation, Environmental aspects in planning, System analysis, Pit falls in Planning;

Multi-purpose Projects: Functional requirements, Compatibility of multipurpose uses, Cost Allocation to various uses in multipurpose projects planning, Components of a multipurpose river basin development, Operation of multipurpose reservoirs, Watershed management, small dam’s v/s big dams, Economic height of a dam.

Self-study component: Students shall collect the information from the internet on objectives of planning- cost allocation in multipurpose projects-watershed management-visit small dams, submit a report.

MODULE -4	**10 Hrs.**

Integrated Water Resource Development: Main Objectives, Secondary objectives like reclamation of waterlogged areas. Control of overdraft of groundwater, Salt-water intrusion etc. Aspects of integrated and conjunctive use of water & their constraints. A brief description of perspective water. resources development of Himalayan and Peninsular rivers of India.

Organization of Water Resources Development: Present administrative structures, problems involved therein, Organizational setup for execution of water resources development and river basin development.

Self-study component: Students shall collect the information from the internet on integrated and conjunctive use of water –water resource development of peninsular and Himalayan rivers-visit water resource department and collect details on the organizational setup.

Text Books:

1. Subramanya. K "Engineering Hydrology" Tata McGraw-Hill Publishing Company Ltd., New York,2008
2. Linsley.K& Frozini.J.B"Water Resources Engineering International Students Edition, McGraw-Hill Kogakusha Ltd.

Reference Books:

1. Garg. S.K "Hydrology and Water Resources Engineering"Khanna Publishers, New Delhi,India
2. Gupta.B.L& Amith Gupta "Water Resources Systems and Management" Standard Publishers & Distributors,Delhi

MOOC Course:

1. https://archive.nptel.ac.in/courses/105/108/105108081/

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3												3	
CO2	3												3	
CO3		3											3	
CO4							2					2	3	

Course Title	FINITE ELEMENT ANALYSIS		
Course Code	21CV751	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs.	**Hours/Week**	3
CIE + SEE	50 + 50 Marks	**Total Hours**	40

Course Objective: To learn and apply finite element solutions to structural, thermal, dynamic problems to develop the knowledge and skills needed effectively to evaluate finite element concepts

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

COs	Course Outcomes	Mapping to PO's	Mappi to PSC
CO1	Comprehend the importance & scope of finite element method of structural analysis.	PO1, PO3	
CO2	Comprehend finite element modeling, displacement functions, Element coordinates & global coordinates for one dimensional element.	PO2, PO3, PO4	
CO3	Apply the concept of two-dimensional truss element & solution of 2D truss problems & Comprehend beam element & analysis of continuous beams.	PO2, PO3	
CO4	Comprehend the application of 2D frame elements & the analysis of 2D plane stress & plane strain problems.	PO3, PO4	

Course Contents:

MODULE – 1	10 Hrs.

Introduction: Basic concepts and background review – stress-strain relations and strain displacement relations– matrix displacement formulation – energy concepts – equilibrium and energy methods for analyzing the structures – Rayleigh-Ritz and Galerkin's methods – simple applications in structural analysis; **Fundamentals of Finite Element Method:** Introduction, Finite Element modeling -Displacement functions–element coordinates- Global co- ordinates. Displacement functions for 1-D element and simple element.

Self study component: Students shall recapture the concept of stress strain displacement relations from theory of elasticity and learn energy methods of structural analysis.

MODULE – 2	10 Hrs.

Analysis of Pin Jointed Frames: 2-D truss element and its application to simple truss problems; **Continuous Beams and Stiff Jointed Frames:** Euler – Bernouli's beam element – Hermitian interpolation function – generation of stiffness matrix and nodal load vector – Analysis of Continuous beams.

Self-study component: Students shall recapture the matrix methods of analysis of pin jointed trusses, continuous beams and frames.

MODULE -3	10 Hrs.

2 D Frame Element: 2 D Frame Elements **-** Solution of simple stiff jointed Frames (maximum of three kinematic degrees of freedom); **Analysis of 2-Dimensional Plane stress / Plane Strain Problems:** Introduction – finite element modeling – different types of triangular and quadrilateral elements, characteristics and suitability for applications – polynomial shape functions – Lagrange's interpolation - compatibility and convergence requirements of shape functions – element strain and stresses – element stiffness matrices, nodal load vector - application of CST, LST and quadrilateral elements. Simple Problems

Self-study component: Students shall attempt to run a FEM package for the analysis of 2D frames and trusses.

MODULE -4	10 Hrs.

Isoparametric Elements, Numerical Integration and Higher Order Elements: Isoparametric, superparametric and subparametric elements – necessity – description of solution process using Isoparametric elements – characteristics of Isoparametric quadrilateral elements – computation of stiffness matrix – numerical integration – convergence criteria for Isoparametric elements.

Self-study component: Students shall attempt to run a FEM package for the analysis of Axi - symmetric structural problems.

Text Books:

1. Krishnamoorthy C. S "Finite Element Analysis", Theory and Programming II Edition,1994.
2. Rajashekaran"Finite Element Analysis in Engineering Design", Wheeler publisher-2008.

Reference Books:

1. Chandruptala T.R.,Belegundu.A.D.,"IntroductiontoFEM",3rd edition,Prentice Hall-2009.
2. Mukhopadyaya. M "Matrix, Finite Element, Structural Analysis", Oxford & IBH Publishers.
3. Robert D. Cook "Concept and Applications of Finite Element Analysis" John Wiley & Sonsinc.

MOOC Course:

1. Basics Of Finite Element Analysis - I - Course (nptel.ac.in)
2. Finite Element Method - Course (nptel.ac.in)

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PS**
CO1	3		1											
CO2		2	3	1										
CO3		3	2											
CO4			3	2										

Course Title	ATMOSPHERIC ENVIRONMENTAL ENGINEERING		
Course Code	21CV752	(L-T-P) C	(3-0-0) 3
Exam	3 Hrs	Hours / Week	3
CIE + SEE	50 + 50 Marks	Total hours	40

Course Objective:

To provide students with a scientific and technical background in air pollution monitoring, pollution control technologies and environmental management.

Course Outcomes (COs): At the end of course, student will be able to:

COs	Course Outcomes	Mapping to POs	Mapping to PSOs
CO1	Describe the importance of Air pollution control. and its applications and also its effects and related major episodes	PO1, PO6, PO7	
CO2	Illustrate the meteorological variables and the principles of sampling and analysis of air pollutants.	PO1, PO6, PO7	
CO3	Discuss about the causes of air pollution due to over usage of automobiles and method of control of air pollutants	PO1, PO6, PO7	
CO4	Discuss about the global environmental issues and the effect of air pollution on general environment	PO1, PO6, PO7	

Course Contents:

MODULE –1	10 Hrs.

Introduction: Definition - Classification and properties of Air pollutants, Primary and secondary Air pollutants, Concentrations of Air pollutants and sources. Behavior and Fate of Air Pollutants, photochemical Smog.

Effects of Air Pollution: On Human Health, Animals, Plant and properties, major Episodes.

Global Environmental Issues: Acid rain, Green House effect, Global warming, Ozone layer Depletion. Environmental Impact Assessment in industrial plant locations and planning.

MODULE –2	10 Hrs.
Meteorology: Introduction, Meteorological Variables, Lapse Rate-Adiabatic- Dispersion/ inversion, Stability Conditions, wind rose, General characteristics of stack plumes **Sampling and Analysis of Air Pollutants:** Sampling and measurement of Gaseous and particulate pollutants stack sampling, smoke and its measurements	
MODULE –3	**10 Hrs.**
Control of Air Pollutants: control methods – Particulate emission control, gravitational settling chambers, cyclone separators, fabric filters, Electrostatic precipitators, wet scrubbers, control of gaseous emissions - adsorption, absorption, combustion and condensation. **Air Pollution due to Automobiles:** Air pollution due to gasoline driven and Diesel driven engines, effects, control-direct and indirect methods	
MODULE – 4	**10 hrs.**
Standards and Legislation: Air quality and emission standards, legislation and regulation, Air pollution index. **Noise Pollution**: Sources of noise, effects of noise pollution, units and measurement of noise, control of noise, standards	
Self-Study: The Students shall visit Pollution Control Board office and learn about different methods of sampling and measurement of pollutants. The students shall submit a report of their observations under self-study components	
Text Books: 1. Rao, M.N, Rao, H.V.N "Air pollution", Tata McGraw Hill, 2004 2. Stern.A.C, "Air pollution", Academic press, 1977	
Reference Books: 1. Wark,K,Warner.C.F & Davis.W.T, "Air Pollution–Its Origin and Control" , Harper Row Publishers, Newyork, 1998 2. Trivedy.R.K and Goel.P.K, "An Introduction to Air Pollution", B.S. Publications, 2005	

MOOC/NPTEL Courses:

1. Air Pollution and Control by Prof. Bhola Ram Gurjar IIT Roorkee

   https://onlinecourses.nptel.ac.in/noc22_ce22

2. Indoor Air Pollution: Sources, Effects, Monitoring, Control and Modeling By Prof. Asif Qureshi, IIT Hyderabad

   https://onlinecourses.nptel.ac.in/noc24_ce102/preview

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3						2							
CO2	2						3							
CO3	2					3								
CO4						2	3							

Course Title	URBAN AND RURAL PLANNING		
Course Code	21CV753	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs.	**Hours/Week**	3
CIE + SEE	50 + 50 Marks	**Total Hours**	40

Course Objective: This Course will enable the students to

1. Gain Knowledge of Rural and Urban life
2. Gain comprehensive knowledge about development plans of a village, town with rules and regulations

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Comprehend the basic objects and principles of town planning and types of planning.	PO1, PO7, PO9	
CO2	Apply land use analysis, zoning regulations to development plan.	PO1,PO7, PO9	
CO3	Describe the concepts, principles, philosophies of great pioneers like Hebenezer Howard, Patrick Geddes, Le Corbusier, C.A. Doxiadies, etc. during and post-industrial revolution,transportation problems in the developing countries.	PO1,PO7, PO9	
CO4	Demonstrate the problems in rural areas, legislation in planning; Comprehend the knowledge on norms, procedures, etc., in planning;	PO1,PO7, PO9	

Course Contents:

MODULE – 1	10 Hrs.
Definition of Urban unit or town, Standard Urban areas, classification of towns and cities, Urban Infrastructure Management, Components of Urban Infrastructure, definition of planning by various planners, objects of town planning, aims of planning, main goals of Modern town planning, characteristics of successful planning, principles of town planning, necessity of town planning, physical, social and economic resources, origin of towns: Natural growth: Concentric spread, Ribbon Development, Satellite Growth, Scattered Growth, Planned Growth: Horizontal and Vertical Growth, types of planning, relationship between planning, policy and implementation, types of surveys, techniques of surveys, scale for structuring questionnaire. Selection of samples, type of selection of samples, errors in surveying. Population growth, density of population, occupational categories, evolution of towns in India: Ancient, medieval and modern, urbanization in India, Functional classification of towns. ***Self study component: Students shall collect the information from Census, the Hassan Development Authority, Municipality Office regarding population growth, occupational pattern of Hassan city and submit a report.***	
MODULE – 2	**10 Hrs.**
Definition of zoning, zoning regulations, principles of zoning, advantages of zoning, maps for zoning, Aspects of Zoning: Density, Height and Use Zoning, building bye-laws, developed and undeveloped area, developed and undeveloped land, land use and land use pattern in urban areas, the character of a town, categories of a town, densities of town, planning process, detailed classification of land uses, classification of urban road and rural roads, Perspective plan, Development plan, Annual plan and Plans of Projects/Schemes, Surveys to be conducted before Development Plan, objectives of a Master Plan, necessity, data to be collected, drawing to be prepared, features of a Master plan, planning standards, report, stages of preparation, method of execution, Outline and Comprehensive Development Plan. ***Self study component: Students shall collect the information from the internet on evolution of cities- visit the Hassan Development Authority and collect details on concept of zoning, Comprehensive Development plan for Hassan city submit a report.***	

MODULE -3	10 Hrs.

The Industrial Revolution and Urban Planning **:** The Garden city concept, Satellite Towns, Philosophy of Patrick Geddes, Le Carbusier – C.A. Doxiades – Evolution of cities, Planning Theory: Land use theories – Descriptives – Exploratory and Speculative theories, Transportation Planning: Interdependence of the land use and traffic, Transportation problems in developing countries, Traffic flow characteristics, Transport Surveys and Parking Surveys.

Self study component: Students shall collect the information from the local village panchayat office and collect details on development plan of the village-socio economic aspects of housing, submit a report.

MODULE -4	10 Hrs.

Rural Planning **:** Definition – Surveys – Development plan for a village – Problems of rural housing – Areas of development –Socio Economic aspects of housing, Legislation in Planning: Objectives of Development Controls – Technical considerations for formation of Building Bye-laws – Urban local bodies – Public health and sanitation – Public works and public utilities –Education and Social Welfare Development – Administrative and General Functions–Obligatory and Discretionary function.

Self study component: Students shall collect the information from the Urban local bodies and present areport on the obligatory and discretionary functions.

Text Books:

1. Rangawala.S.C., Rangawala P.S & Rangawala.K.S " Town Planning" Charotar Publishing House, Anand, India, 1987. (Module 1, Module 2, Module3 and Module-4)
2. Abir Bandyapadhyay " Text Book of Town Planning" Books and Allied (P) ltd, Calcutta, India 2000 (Module 1, Module 2, Module3 and Module-4)
3. Rame Gowda. K.S " Urban and Regional Planning", Prasaranga, University of Mysore, Mysore, 1986 (Module 1, Module 2, Module3 and Module-4)

Reference Books:

1. Arthur.B.Gallion Simon Eisner "The Urban Pattern" CBS Publishers and Distributors,

NewDelhi, 1998.

2. Lewis Keeble, "Principles and Practices of Town & Country Planning", The Estates Gazette Limited, London, 1969.
3. Kadiyali L. R., "Traffic Engineering & Transport Planning" Khanna Publishers, Delhi, 2005.
4. C A O' Flahertly, "Transport Planning and Traffic Engineering", Butterworth-Heinemann, An Imprint of Elsevier, 2006. (Edited)
5. Partha Chakroborty & Animesh Das, "Principles of Transportation Engineering", Prentice Hall of India Private Limited, New Delhi, 2003.
6. Kulshrestha S. K., "Dictionary of Urban and Regional Planning", Kalpaz Publications, Delhi, 2006.
7. Urban Development Plans Formulation & Implementation (UDPFI) Guidelines, Ministry of Urban Affairs & Employment, Government of India, New Delhi.

MOOC Course:

1. https://onlinecourses.nptel.ac.in/noc20_ar11/course
2. https://onlinecourses.swayam2.ac.in/cec20_ar01/course?
3. https://onlinecourses.nptel.ac.in/noc24_ar11/preview?
4. https://onlinecourses.nptel.ac.in/noc24_ce80/preview

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3						2		1					
CO2	3						2		1					
CO3	3						2		1					
CO4	3						2		1					

Course Title	EARTHQUAKE RESISTANT DESIGN OF STRUCTURES		
Course Code	21CV754	(L-T-P) C	(3-0-0) 3
Exam	3 Hrs.	Hours/Week	3
CIE + SEE	50 + 50 Marks	Total Hours	40

Course Objective: The course focuses on equipping students with the knowledge and skills necessary to design buildings and other structures that can withstand seismic forces.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Comprehend earthquake phenomenon, engineering seismology and estimation ground motion parameters.	PO1, PO2, PO3	
CO2	Summarize meaning and need of seismic hazard assessment & response of structures to ground motion and construction of response spectrum	PO2, PO3, PO4	
CO3	Analyze response spectrum by different methods, concepts of earthquake resistant design	PO2, PO3, PO5	
CO4	Estimate the lateral forces in RC framed buildings and lateral stiffness of masonry walls	PO3, PO4	

Course Contents:

MODULE – 1	10 Hrs.
Introduction - Development of Earthquake engineering, Global & Indian scenario, Earthquake phenomenon, Seismo/plate tectonics, Engineering seismology, basic terms and definitions, Intensity, Magnitude, Seismic zoning of India, Liquefaction–Causes and remedial measures. **Earthquake/Ground motion Parameters**: Ground motion measuring instruments, Strong ground motion, Parameters of strong ground motion, Characteristics, estimation of strong ground motion parameters. ***Self-study component: Students shall collect the information from the internet on earthquake phenomenon - ground motion measuring instruments.***	
MODULE – 2	**10 Hrs.**
Seismic Hazard Assessment: Meaning and need of seismic hazard assessment, Deterministic approach, Gutenberg-Richter recurrence law, Poisson's probabilistic model, **Response of structures to ground motion;** Response to ground displacement/acceleration, Response Spectrum-Definition, construction and application. ***Self-study component: Students shall collect the information from the internet on seismic hazard assessment-response of structures to ground motion, submit a report***	
MODULE -3	**10 Hrs.**
Response spectrum analysis: Analysis by modal superposition method, absolute sum method, square root of sum of squares (SRSS) method Response spectrum analysis **Concepts of Earthquake Resistant Design;** Causes of damage, planning and architectural consideration, Philosophy & and principles of earthquake resistant design. ***Self-study component: Students shall collect the information from the internet on response spectrum analysis causes of damage due to earthquake-philosophy of earthquake resistant design, submit a report***	
MODULE -4	**10 Hrs.**
Seismic Analysis of RC Buildings; Lateral load resisting elements in RC structure, Lateral load analysis as per IS 1893, Centre of mass, Centre of rigidity, base shear **Seismic Analysis of**	

Masonry Buildings; Lateral load resisting elements in masonry structures, Behavior of unreinforced and reinforced masonry walls,Lateral Stiffness of wall with and without openings.

Self-study component: Students shall collect the information from the internet on seismic analysis of RC buildings, masonry buildings, and Earthquake resistant systems. Simple building - seismic assessment shall be attempted by the students

Text Books:

1. Chopra A.K, "Dynamics of Structures", Prentice Hall,India.
2. S.K. Duggal "Earthquake Resistant Design of Concrete Structures", Oxford university press, NewDelhi.
3. Kramer "Geotechnical Earthquake Engineering" Pearson education,India

Reference Books:

1. Pankaj Agarwal & Manish Shrikhande, "Earthquake Resistant Design of Concrete Structures", Prentice Hall of India. NewDelhi.
2. Ghosh S.K, "Earthquake Resistant Design of Concrete Structures", SDCPL-R&D center, New Delhi.
3. IS: 1893-2016, IS: 4326-1993, IS: 13920-1993
4. IITK-GSDMA guidelines for seismic design. National Information Center of Earthquake Engineering.
5. Murty, C. V. R. (2005). IITK-BMTPC Earthquake Tips Learning Earthquake Design and Construction. Indian Institute of Technology Kanpur,India.

MOOC Course:

1. https://archive.nptel.ac.in/courses/105/101/105101004/
2. https://archive.nptel.ac.in/courses/105/102/105102016/

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	2											
CO2		3	2	2										
CO3		3	2		2									
CO4			3	2										

Course Title	PAVEMENT MATERIALS & DESIGN		
Course Code	21CV755	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs.	**Hours/Week**	3
CIE + SEE	50 + 50 Marks	**Total Hours**	40

Course Objective: To learn broader understandings on various aspects of pavement materials & design

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Evaluate the various components of highway embankment and the suitability of various materials.	PO1, PO2, PO3	
CO2	Evaluate the various stresses acting on flexible & rigid pavement	PO1, PO2, PO3	
CO3	Design the flexible pavement as per codal provisions	PO1, PO2, PO3	
CO4	Design the rigid pavement as per codal provisions	PO1, PO2, PO3	

Course Contents:

MODULE – 1	10 Hrs.

Pavement Materials for embankment: Components of a highway embankment & materials: Materials for Highway embankment, cutting and subgrade material.

Bitumen: History, Manufacture of bitumen, Production of bitumen in India, Modified binders, Rubberized tar and bitumen, Advantages and general requirements of modifiers, Tar, Manufacturing of tar.

Self-study component: Students shall collect the information about types of pavement

materials, components and submit the report.	
MODULE – 2	**10 Hrs.**
Pavement types & stresses: Importance, Functions, Requirements, Types and Uses of Pavements - Factors affecting Design and Performance of Pavements – Functions and Significance of various layers – Factors affecting the choice and selection of pavement type. Distress: Distresses in Asphalt and Concrete pavements. **Traffic:** Different types of highway traffic, Measurement of traffic load, Load distribution concept, Load equivalency factors – ESAL and ESWL of Multiple Wheels. ***Self-study component: Students shall collect the information about pavement failures and different methods, pavement maintenance and submit the report on the same.***	
MODULE -3	**10 Hrs.**
Design of Flexible Pavements: Stresses, Strains and Deflections in Homogeneous Masses – Layered systems concept, Structural Design – Approaches, Development, Mechanistic-Empirical design Principles, Design steps – IRC method of Flexible Pavement Design for High Volume Roads (IRC 37) and for Low Volume Roads (IRC SP72). ***Self-study component: Students shall collect the information about design of flexible pavements and submit the report on the same.***	
MODULE -4	**10 Hrs.**
Design of Rigid Pavements: General conditions in Rigid Pavement Analysis, Types of Stresses and Causes – Wheel Load Stresses, Warping Stresses, Frictional Stresses, Combined Stresses. **Concept of Life Cycle Cost**: Approaches & Techniques, Cost-Saving Concepts – Perpetual Pavements, Recycling techniques; green highways. ***Self-study component: Students shall collect the information about design of rigid pavements and list the concepts of life cycle techniques and submit the report on the same.***	
Text Books: 1. Khanna and Justo – "Highway Engineering" Revised 10th edition, Khanna publications	

New Delhi (2017), ISBN: 8185240930.

2. Srinivasa Kumar, R, Pavement Design, Orient Blackswan Private Limited - New Delhi (2013) ISBN. 9788173718854.

Reference Books:

1. Kadiyali, L.R., "Highway Engineering, Khanna Publishers", New Delhi (2023), ISBN: 9788193328439.
2. Indian Roads Congress, Manual for Road Investment Decision Model, IRC Special Publication–38, IRC, NewDelhi,2014.
3. Relevant IRC codes.

MOOC Course:

1. Analysis and Design of Bituminous Pavements, https://onlinecourses.nptel.ac.in/noc24_ce42/preview

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1											
CO2	3	2	2											
CO3	3	2	3											
CO4	3	2	3											

Course Title	REINFORCED EARTH STRUCTURES		
Course Code	21CV756	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs.	**Hours/Week**	3
CIE + SEE	50 + 50 Marks	**Total Hours**	40

Course Objective:

The students should be able to design the components of various structures covering material aspects of earth, analysis and design reinforced earth structure.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Identify, formulate reinforced earth techniques that are suitable for different soils and in different structures	PO1	
CO2	Design Reinforced Earth retaining structures.	PO3	
CO3	Apply soil nailing concepts to the field problems	PO2	
CO4	Asses the use of Geo synthetics in drainage requirements and landfill designs	PO2, PO3	

Course Contents:

MODULE – 1	10 Hrs.

Basics of Reinforced Earth Construction: Definition, Historical Background, Components, Mechanism and Concept, Advantages and Disadvantage of reinforced earth Construction, Sandwitch technique for clayey soil. Geosynthetics and Their Functions Classification based on materials type – Metallic and Non- metallic, Natural and Man-made. Geosynthetics – Geotextiles,

Geogrids, Geomembranes, Geocomposites, Geonets, Geofoam, Geomats, Geomeshes, Geowebs etc.	
MODULE – 2	**10 Hrs.**
Design of Reinforced Earth Retaining Walls: Concept of Reinforced earth retaining wall, Assumption made in designing, Internal stability: Check against Tie-break, check against pillout, External stability: Check against Sliding, Overturning, Tilting and Bearing Capacity Failure, Selection of materials, typical design problems.	
MODULE -3	**10 Hrs.**
Soil Nailing Techniques: Concept, Advantages & limitations of soil nailing techniques, comparison of soil nailing with reinforced soil, methods of soil nailing, Construction sequence, Components of system, Design aspects: Initial design considerations include wall layout (wall height and length),soil nail vertical & horizontal spacing, soil nail pattern on wall face, soil nail inclination, soil nail length & distribution, soil nail material & relevant ground properties & precautions to be taken. Applications in Embankment & Slopes.	
MODULE -4	**10 Hrs.**
Geosynthetics - Filter, Drain and Landfills: Filter & Drain – Conventional granular filter design criteria, Geosynthetic filter design requirements, Drain and filter properties, Design criteria – soil retention, Geosynthetic permeability, anticlogging, survivability and durability. Landfills – Typical design of Landfills – Landfill liner & cover.	
Text Books: 1) Design with geosynthetics- Koerner. R.M. -Prince Hall Publication,2005. 2) Construction and Geotechnical Engineering using synthetic fabrics- Koerner. R.M. & Wesh, J.P.- Wiley Inter Science, New York,1980. 3) An introduction to Soil Reinforcement and Geosynthetics – Sivakumar Babu G.L., 22 Universities Press, Hyderabad, 2006 4) Reinforced Soil and its Engineering Applications, Swami Saran, I. K. International Pvt. Ltd, New Delhi,2006	

Reference Books:

1) Earth reinforcement and Soil structure- Jones CJEP Butterworths, London,1996.
2) Geotextile Hand Book- Ingold, T.S. & Millar, K.S. - Thomas, Telford, London.
3) Earth Reinforcement Practices-HidetoshiOctial, Shigenori
4) Hayshi&JenOtani-Vol.I,A.A.Balkema,Rotterdam,1992.
5) Ground Engineer's reference Book- Bell F.G. - Butterworths, London,1987

MOOC Course:

1) NPTEL :: Civil Engineering - NOC:Geosynthetics and Reinforced Soil Structures.

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3													
CO2			3											
CO3		2												
CO4		3	2											

Course Title	ROCK MECHANICS		
Course Code	21CV757	(L-T-P) C	(3-0-0) 3
Exam	3 Hrs.	Hours/Week	3
CIE + SEE	50 + 50 Marks	Total Hours	40

Course Objective:

Resolve problems related to strata stability for safe underground and surface mining operations using knowledge and skills of rock mechanics.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Apprehend the mechanical behavior of rock materials, rock discontinuities and rock masses.	PO1, PO2, PO7	
CO2	Analyze the rock quality designation and also evaluate its strength.	PO1, PO2, PO7	
CO3	Apply stress concentration fields, rock strength, its associated problems & remedies to supervise and drive safe for the stable underground opening.	PO1, PO6, PO7	
CO4	Analyze and to determine mechanical and engineering properties of rocks for engineering applications.	PO1, PO6, PO7	

Course Contents:

MODULE – 1	10 Hrs.

Introduction: Definition, Importance, History of Rock Mechanics, Distribution of rocks – Archean Rocks, Cuddapah Rocks, Vindhyan Rocks, Paleozoic Rocks, Mesozoic rocks, Gondwana Rocks, Deccan Traps, Stereographic presentation of Geological data – Representation and plotting line and plane.

Tests on Rocks: Tests for Physical Properties, Compressive strength, Tensile strength, Direct shear, Triaxial Shear, Slake Durability, Schmidt Rebound Hardness, Sound Velocity, Swelling Pressure& Free Swell, Void Index

Self-study component: Students Should visit nearby mines and study different rock testing and rock exploration procedures and prepare a report on it.

MODULE – 2	10 Hrs.

Strength, Modulus and Stress Strain Behaviour of Rocks: Transport methods, Transfer station and route optimization techniques. Mechanical volume reduction, Chemical volume reduction, Mechanical size reduction, Component separation, Drying and dewatering.

Engineering Classification of Rock and Rock Mass: QD, RMR system, Terzaghi's rock load classification, Deere Miller, CMRS and RSR System. Classification based on strength and modulus, Classification based on strength and failure strain, rock discontinuity qualitative description, friction in rocks – Amonton's law of friction.

Self-study component: Study the process of radar testing to check different gradation and composition of rock mass in earth using sensors.

MODULE -3	10 Hrs.

Field Tests on Rocks and Rock Mass: Geophysical methods Seismic Refraction method, Electrical Resistivity method, Deformability tests– Plate Jack Test, Goodman Jack Test, Field shear test - Field Permeability Test – Open end Test, Packers Test.

Stability of Rock Slopes: Modes of failure – Rotational, Plane and wedge failures, Plane failure method of Analysis, Wedge method of Analysis, Toppling failure, Protection against slope failure.

Self-study component: Prepare a report on rock testing and rock exploration procedures by using pictures/films

MODULE -4	10 Hrs.

Rock Foundation: Estimation of Bearing Capacity – Intact, Fractured rocks, Stress distribution in rocks, Factor of Safety, Sliding stability of dam foundation, Settlement in rocks, Bearing capacity of piles in rock, Measures for strengthening rock mass – Concrete shear keys, Bored concrete piles, Tensioned cable anchors, concrete block at toe.

Methods: Drilling, Blasting and underground open excavation, Mining and other Engineering applications, criteria for design of underground excavations, tubular excavations, pillars and ribs support multiple excavations. Structural defects in Rock masses, their improvement by rock bolting, grouting and other methods. Rock Reinforcement Rock grouting

Self-study component: To study different case studies related to influence of groundwater on rock.

Text Books:

1. Rock mechanics for Engineers: Varma, B.P, Khanna Publishers
2. The elements of Mechanics of Mining Ground (Vol I & II), Dr. B. S. Verma.
3. Design Criteria for drll rigs equipments of drilling techniques, C. P. Chugh.
4. Ground Control in Mining, S. K. Sarkar. Goodman R E "Introduction to Rock Mechanics", John Wiley & Sons, New York, 1989
5. Principles of Engineering Geology and Geotechniques – Krynine and Judd
6. Rock Engineering – Jhon A Franklin and Maurice b Dusseault, McGraw Hill

Reference Books:

1. Lama R D and Vutukuri V S with Saluja S S "Handbook on Mechanical Properties ofRocks" Vols. I to IV, Trans Tech Publications, Rockport, MA.
2. Arora D S "A Text Book of Geology", Mahindra Capital Publishers, Chandigarh, 1988 Singh P "Engineering and General Geology" S. K. Kataria and Sons, New Delhi, 1992

MOOC/NPTEL Courses:

1. https://en.wikipedia.org/wiki/Rock_mechanics

2. http://home.iitk.ac.in/sarv/New%20Folder/Presentation-1.pdf

3. https://www.britannica.com/science/rock-mechanics

4. https://www.slideshare.net/1971995/rock-mechanics

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2					1							
CO2	3	2				2	1							
CO3	3					2	1							
CO4	3					2	1							

Course Title	OPERATION AND MAINTENANCE OF ENVIRONMENTAL FACILITIES		
Course Code	21CV758	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs.	**Hours/Week**	3
CIE + SEE	50 + 50 Marks	**Total Hours**	40

Course Objective: To provide knowledge and skills to effectively manage and sustain environmental infrastructure and facilities

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Acquire a comprehensive understanding of various types of environmental facilities	PO1, PO6, PO7	
CO2	Describe the maintenance procedures for environmental facilities	PO1, PO6, PO7	
CO3	Discuss on regulatory requirements and compliance standards governing the O&M of environmental facilities	PO1, PO6, PO7	
CO4	Comprehend about quality control and assurance measures in environmental facilities	PO1, PO6, PO7	

Course Contents:

MODULE – 1	10 Hrs.

Water Supply Facilities: Operational Problems and Corrective Measures for Intakes, pumps, rising mains, Distribution System - Loss of carrying capacity in pipes, Projection of Pipe Break Rates, Leak Detection and control.

Appurtenances – Valves**,** Valve Types and Functions, Valve Operation and Maintenance Hydrants, Hydrant Installation and Maintenance**,** Fittings and Safety Practices

Self-study component: Students shall visit various water supply system and study the functional treatments of water supply facilities, submit a report.

MODULE – 2	10 Hrs.

Water Treatment Facilities: Operational Problems and Corrective Measures for Screens, Aeration Unit, Sedimentation Tank, Clariflocculator, Pulsators, Filtration, Disinfection units and other treatment units, if any. Water Quality Parameters, Treatment Processes, Safety Protocols, Process Control and Automation (SCADA).

Self-study component: Students shall visit various water treatment plants and study the functional treatments of water treatment facilities, submit a report.

MODULE -3	10 Hrs.

Wastewater Collection Facilities: Operational Problems and Corrective measures in Sewer Network, Inspection Methods, Safety Methods**,** Appurtenances and pumps.

Wastewater Treatment Facilities: Operational Problems and Corrective Measures for Screening, Grit chamber, aeration tanks, trickling filters and bio-towers, settling tanks, Sludge Thickener, sludge digesters, sludge drying beds, Disinfection units.

Self-study component: Students shall visit various Wastewater treatment plants and study the functional treatments of Wastewater treatment facilities, submit a report.

MODULE -4	10 Hrs.

Air Pollution Control Facilities: Operational Problems and Corrective Measures for Gravity Settlers, Cyclone Separators, Bag Filters, Scrubbers, Electrostatic Precipitators, and Gaseous Emission Control Devices – Absorption Beds and Adsorption Columns, Thermal Oxidizers, Incinerators.

O & M for sanitary landfills and hazardous waste disposal sites.

Self-study component: Students shall visit various Industries and study the functional treatments of air pollution control facilities, submit a report.

Text Books:

1. Metcalf & Eddy Inc, (2003) , "Wastewater Engineering, Treatment and reuse"-4th Edition, Tata McGraw Hill Publishers Co. Ltd, New Delhi
2. Training Manual on O&M for Municipal Staff", Asian Development Bank, Government of Karnataka
3. CPHEEO, (1999), "Manual on water supply and Treatment", Ministry of Urban Development, GoI, New Delhi.
4. CPHEEO, (1999), "Manual on Sewerage and Sewage Treatment", Ministry of Urban Development, GoI, New Delhi.

Reference Books:

1. Hammer, M.J., (1986), "Water and Wastewater Technology–SI Version" - 2nd Edition, John Wiley and Sons.
2. William L Neumann, (1997) " Industrial Air Pollution Control Systems" – McGraw-Hill Professional.
3. Walski, T.M. (1987), "Analysis of Water Distribution Systems" – CBS Publications, New Delhi.
4. Raju, B. S. N., (1991), "Water Supply and wastewater Engineering by

i. B.S.N. Raju" – Tata McGraw-Hill Publishing Co. Ltd.,

5.Manual on Solid waste Management" – CPHEEO (Recent edition)

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3					1	2							
CO2	2					1	3							
CO3	3					2	1							
CO4	1					2	3							

Course Title	ENGINEERING SEISMOLOGY		
Course Code	21OECV761	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs.	**Hours/Week**	3
CIE + SEE	50 + 50 Marks	**Total Hours**	40

Course Objective: To learn different seismic hazard, global seismicity and risk.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Illustrate the concept of earthquake, Ground motion parameters and Seismic Zonation.	PO1	
CO2	Interpret different types ground motion simulation models and there relationships.	PO2	
CO3	Comprehend the Concept of Intensity and Magnitude; different earthquake scales.	PO1, PO2	
CO4	Analyze seismic optional of the region and better way of estimating the future seismic hazard.	PO1, PO2	

Course Contents:

MODULE – 1	10 Hrs.

Seismology: Introduction to seismology, Earthquake hazard: Mitigation and preparedness, Different Earthquake Hazards, Earthquake Terminologies, plate tectonics, Faults; Seismic Sources, Types of Earthquakes; Causes of Earthquakes, wave propagation, seismic instrumentation, Seismic Sensors, Seismic Instrumentation in India.

Self - study component: Students shall study the various earthquake around the world

MODULE – 2	10 Hrs.
Ground motion parameters: Frequency Domain Characteristics; Response Spectrum, Fourier Spectrum, Seismic Source Parameters, Time history; response Spectra; Stochastic models, Ground Motion Simulation models, Prediction Relationships, earthquake prediction, and seismic gap. ***Self-study component: Students shall understand importance of D-V-A plot.***	
MODULE -3	**10 Hrs.**
Intensity scales of Earthquake: Road Damage Intensity Scale; and Seismic Vulnerability assessment, Quantification of Earthquake (magnitude), Energy released due to earthquakes, Interpretation of Earthquake records, Time Domain Parameters earthquake intensity and magnitude, ***Self-study component: Students shall collect the information on damages due to earthquake in India***	
MODULE -4	**10 Hrs.**
Seismic Zonation: Seismic zonation, Seismic zonation of India, Global Earthquake risk map, Zonation Map of India, Seismo Tectonics of India, Seismic hazard analysis, Seismic Study area and Seismotectonic Map, Seismic Data Collection, ***Self-study component: Students shall collect the information on recent tectonic movement.***	
Text Books: 1. Jain S K (Guest Editor), Earthquake Engineering : An ICJ Compilation, Research & Consultancy Directorate, The ACC Ltd, Thane, 2004 2. Chopra A.K, "Dynamics of Structures", Prentice Hall,India. 3. S.K. Duggal "Earthquake Resistant Design of Concrete Structures", Oxford university press, NewDelhi.	

Reference Books:

1. Advances in Indian Earthquake Engineering and Seismology: Contributions in Honour of Jai Krishna
2. Ghosh S.K, "Earthquake Resistant Design of Concrete Structures", SDCPL-R&D center, New Delhi.
3. IITK-GSDMA guidelines for seismic design. National Information Center of Earthquake
    a. Engineering
4. Murty, C. V. R. (2005). IITK-BMTPC Earthquake Tips Learning Earthquake Design and Construction. Indian Institute of Technology

MOOC Course:

1) https://archive.nptel.ac.in/courses/105/108/105108204/#
2) https://archive.nptel.ac.in/courses/105/104/105104200/.

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO 1**	**PSO 2**
CO1	3													
CO2		3												
CO3	3	2												
CO4	3	2												

Course Title	WATER SUPPLY AND SANITATION		
Course Code	21OECV762	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs	**Hours / Week**	3
CIE + SEE	50 + 50 Marks	**Total hours**	40

Course Objective: To provide students with a scientific and technical background in air pollution monitoring, pollution control technologies and environmental management.

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

COs	Course Outcomes	Mapping to POs	Mapping to PSOs
CO1	Estimate average and peak water demand for a community.	PO1, PO2	
CO2	Evaluate water quality and plan suitable treatment system	PO1, PO7	
CO3	Discuss various treatment methods available for treating drinking water	PO1, PO7	
CO4	Evaluate wastewater quality and design suitable conveyance systems for sewage and design a comprehensive wastewater treatment system	PO1, PO7	PSO1

Course Contents:

MODULE –1	10 Hrs.

Introduction: Need for protected water supply, Factors affecting water supply scheme and benefits. **Demand Of Water**: Types of water demands - domestic demand, institutional and commercial, public uses, fire demand. Factors affecting per-capita demand, variations in demand of water, Peak factor, Design periods and factors governing the design period. Different methods of Population forecasting. **Sources**: Concept of hydrological cycle, Surface and subsurface sources - suitability with regard to quality and quantity. Factors governing the

selection of particular source of water.	
MODULE –2	**10 Hrs.**
Quality of Water: Concept of safe water: wholesomeness, palatability and potable. Physico Chemical characteristics (Drinking water standards: BIS & WHO standards). Numerical problems on pH and MPN **Collection and Conveyance of Water: Intake structures** - different types of intakes; factors for the selection and location of intakes. **Pumps** - Necessity, types and factors for the selection of a pump **Water Treatment**: Objectives and Treatment flowchart – significance of each unit. **Aeration** – Principle and types of aerators.	
MODULE –3	**10 Hrs.**
Sedimentation: Theory, settling tanks, types and design. **Filtration:** Mechanism - theory of filtration, types of filters- slow sand, rapid sand and pressure filters **Disinfection**: Definition, Requirements, methods of disinfection. **Softening**: Definition, methods of removal of hardness by lime soda-process and zeolite process with merits and demerits **Water Conservation** – Rain Water Harvesting.	
MODULE – 4	**10 hrs.**
Wastewater: Wastewater disposal - Necessity for sanitation, types of sewerage systems and their suitability. Quantification of sewage and estimation of storm water flow. **Sewer**: Sewer pipe materials, Shapes of sewers, laying of sewers, jointing and testing of sewers, ventilation and cleaning of sewer. **Sewer Appurtenances:** Catch basins, Manholes, Flushing tanks, oil and grease traps, Drainage traps, Basic principles of house drainage, typical layout plan showing house drainage connections **Analysis of Sewage**: Physical, chemical, and biological characteristics. **Treatment of Sewage**: Flow diagram of municipal sewage treatment plant	
Self-study: Students shall visit nearby water treatment plant and study various treatment techniques adopted.	

Student shall visit the nearby Industry and observe the methods adopted for sewage treatment and disposal.

The students shall submit a report of their observations under self-study components.

Text Books:

1. Water Supply Engineering: Environmental Engineering - Vol. I – 2017 Santosh Kumar Garg, Khanna Publisher, ISBN-10: 9788174091208
2. Punmia B.C. and Ashok Kumar Jain, "Environmental Engineering- I",Arihant Publications
3. S. K. Garg —Environmental Engineering: Sewage Disposal and Air Po llution Engineering
4. (Volume - 2), 33 Edition, 2015, Khanna Publishers, ISBN: 9788174092304, 8174092307.
5. Punmia B. C. and Jain A., "Environmental Engineering-II, ArihantPublications, 1995 (Ch. 1 & 2)

Reference Books:

1. Hammer and Hammer, "Water Technology", Mc Graw Hill Publications Howard S. Peavy, Donald R. Rowe. George Tchobanoglous, "Environmental Engineering" - McGraw Hill International Ed. ISBN-10: 9351340260
2. CPHEEO Manual on water supply and treatment engineering, Ministry of Urban Development, Government of India, New Delhi, 3rd Edition, 2018, Akalank Publications; ISBN-10: 8176393819
3. Waste Water Treatment, Disposal and Reuse -Metcalf and Eddy inc, Tata McGraw Hill Publications (2008 Edition), ISBN-10: 0071008241, ISBN-13: 978-0071008242
4. Wastewater treatment Concepts and Design Approach by Karia G.L., C hritian R.A. Second Edition, 2013. Prentice Hall India Private limited, ISBN-10: 8120328604, ISBN-13: 978-8120328600.

MOOC/NPTEL Courses:

1. Urban Utilities Planning: Water Supply, Sanitation and Drainage By Prof. Debapratim Pandit,IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc24_ar18/preview
2. Wastewater Treatment and Recycling by Prof. Manoj Kumar Tiwari, IIT Kharagpur
   https://onlinecourses.nptel.ac.in/noc24_ce105/preview

Course Articulation Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	2	3												
CO2	2						3							
CO3	2						3							
CO4	3						2						3	

Course Title	COMPOSITES AND SMART MATERIALS		
Course Code	21OECV763	(L-T-P) C	(3-0-0) 3
Exam	3 Hrs.	Hours/Week	3
CIE + SEE	50 + 50 Marks	Total Hours	40

Course Objective: The course aims to analyze the environmental impact on materials, study various composite characteristics and to study various types of smart materials used in engineering application.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Comprehend the fundamental properties, manufacturing processes, and applications across various industries for different types of composites	PO2, PO3	
CO2	Perceive different classes of ceramic and polymeric smart materials; development of actuators and sensors and their integration into a smart structure	PO2, PO3	
CO3	Apply the principles to various fields like automobile, space, medical, automotive, building construction, etc	PO2, PO3	
CO4	Design of embedded & surface mounted, piezoelectric devices	PO1, PO2, PO3	

Course Contents:

MODULE – 1	10 Hrs.

Introduction to Composite materials: Classifications and applications of fibers, volume fraction and load distribution among constituents, minimum & critical volume fraction, compliance & stiffness matrices.

Self-study component: Student shall gain knowledge about the innovative composite materials and their applications in civil engineering domain.

MODULE – 2	**10 Hrs.**

Anisotropic elasticity - Unidirectional and anisotropic lamina, thermo- mechanical properties, micromechanical analysis, classical composite lamination theory**.** Cross and angle–ply laminates, symmetric, antisymmetric and general asymmetric laminates, mechanical coupling and laminate stacking.

Self-study component: Student shall explore appropriate websites to observe the behaviour of composite material subject to varying temperature.

MODULE -3	**10 Hrs.**

Analysis of simple laminated structural elements - Ply-stress and strain, lamina failure theories - first fly failure, environmental effects and manufacturing of composites.

Self-study component: Student shall learn different types of composite materials and their application in aircraft design.

MODULE -4	**10 Hrs.**

Smart materials - Introduction, Types of smart structures, actuators & sensors, embedded & surface mounted, piezoelectric coefficients, phase transition, piezoelectric constitutive relation.

Self-study component: Student shall learn about self-healing materials used in aircraft industry etc.

Text Books:

1. Robart M Jones, "Mechanic of Composite Materials", McGraw Hill Publishing Co, ISBN 10: 0891164901 ISBN, 13: 9780891164906, Wonder book seller , Frederick, USA.
2. Bhagwan D Aggarwal and Lawrence J Broutman, "Analysis and Performance of Fiber Composites", ISBN: 978-1-119-38997-2, John Willy and Sons, NewYork.

Reference Books:

1. Crawley, E and de Luis, J., "Use of piezoelectric actuators as elements of intelligent structures", AIAA Journal, Vol. 25 No 10, Oct 1987, PP 1373-1385.

2. Crawley, E and Anderson, E., "Detailed models of Piezoceramic actuation of beams", Proc. of the 30th AIAA /ASME/ASCE/AHS/ASC- Structural dynamics and material conference, AIAA Washington DC, April 1989.
3. Lecture notes on "Smart Structures", by Inderjith Chopra, Department of Aerospace Engg., University of Maryland.

MOOC Course:

1. https://archive.nptel.ac.in/courses/105/108/105108124/
2. https://nptel.ac.in/courses/112104173

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1		3	2											
CO2		3	2											
CO3		2	1											
CO4	3	2	1											

Course Title	URBAN DESIGN AND REGENERATION		
Course Code	21OECV764	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs.	**Hours/Week**	3
CIE + SEE	50 + 50 Marks	**Total Hours**	40

Course Objective:

The course in Urban Design and Regeneration, aims to explore sustainable urban regeneration processes considering all dimensions (including environmental and socioeconomic) with an integrated and multidisciplinary framework approach.

This allows for planning, assessing, and evaluating urban regeneration processes and projects considering the different perspectives of local authorities, real estate and financial operators, investors, and other key stakeholders.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Discuss the strategies involved in Urban regeneration.	PO6, PO7	
CO2	Interpret the various planning tools regarding the urban assets	PO6, PO8	
CO3	Review the public and private sector roles and relationships and project phasing in the implementation of the urban regeneration projects	PO7, PO8	
CO4	Report on the translation of the concepts of urban regeneration in a case study project.	PO9,PO10 , PO12	

Course Contents:

MODULE – 1	10 Hrs.
Definition, the three orientations, the interrelated groups of spaces in the domain of urban design, the eight elements of urban design. The process of urban regeneration projects. The fundamental first phase– Scoping: The key components, macro and microlevel scoping. The Planning Process: defining the planning framework, master planning, developing design standards, Setting the scene, defining the implementation process and Institutional arrangements, partnering arrangements with the private sector, defining early wins. The Financial tools: Municipal finance tools, land specific financial and regulatory tools for public land. Financial tools for private lands (non capital markets and capital markets), Regulatory tools for private lands (policy and fiscal). ***Self-study component: Study of the Review of the Book "The Urban Design Process" by Hamid Shirvani.***	
MODULE – 2	**10 Hrs.**
Urban assets – First asset land: ownership regimes, tools for land assembly (voluntary and involuntary), land tools for public asset management, land regulatory frameworks. Second asset community: Tools for community participation, charrettes, using technology for public participation.. Third asset: Environment: Site assessment, site investigation, EIA and site remediation plan. ***Self-study component: Examine the tools for public participation in case studies from theworld Bank report Regenerating Urban Land: A Practitioner's Guide to Leveraging Private Investment.***	
MODULE -3	**10 Hrs.**
Social equity aspects of regeneration. Interventions for a more socially equitable regeneration project. The potential undesirable impacts of urban regeneration: Gentrification and Loss of social capital. Tools to mitigate the undesirable social impacts: resettlement, principle of minimizing displacement, compensation, Inclusionary zoning and housing vouchers.	

Self-study component: Reading of the book "Uses of Disorder" by Richard Senett and short review writing on any one chapter of the book.

MODULE -4	**10 Hrs.**

Implementation Phase. Political leadership, Public and private sectors roles and responsibilities, phases of implementation, Framework for assessing and mitigating risks : political, financial, technical environmental, Land ownership and regulation, stakeholders, fiduciary and commercial risks.

The parameters that influence the urban regeneration strategy: Land Use and zoning, historical preservation, environmental features, open spaces, building form, people participation, economic base, infrastructure and transportation networks, urban planning policies and political leadership. case study for each parameter.

Self-study component: Collect information and read about Government of India strategies like Swachh Bharat Mission - Urban (SBM-U), Pradhan Mantri Awas Yojana - Urban (PMAY-U), Smart Cities Mission (SCM), Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Deendayal Antyodaya Yojana - National Urban Livelihoods Mission (DAY-NULM) and Heritage City Development and Augmentation Yojana (HRIDAY)

Text Books:

1. Hamid Shirvani, "The Urban Design Process" Van Nostrand Reinhold, 1985

2. Amirtahmasebi, Rana, Mariana Orloff, Sameh Wahba, and Andrew Altman. Regenerating Urban Land: A Practitioner's Guide to Leveraging Private Investment. 2016. Urban Development Series. Washington, DC: World Bank. doi: 10.1596/978-1-4648-0473-1. License: Creative Commons Attribution CC BY 3.0 IGO

Reference Books:

1. Urban Regeneration, A Handbook, edited by Peter Roberts and Hugh Skyes. Sage Publications Limited 2008.

2. Ministry of Housing and Urban Affairs, Government of India, "Transforming Urban Landscape" 2014-19

MOOC Course:

1. https://onlinecourses.nptel.ac.in/noc21_ar12/preview
2. https://archive.nptel.ac.in/courses/124/107/124107158/

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1						3	2							
CO2						2		1						
CO3							2	1						
CO4									3	2		1		

Course Title	HAZARDOUS WASTE MANAGEMENT		
Course Code	21OECV765	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs.	**Hours/Week**	3
CIE + SEE	50 + 50 Marks	**Total Hours**	40

Course Objective: Foster critical thinking, problem-solving, and ethical decision-making skills necessary for addressing the complex challenges and ethical dilemmas associated with hazardous waste engineering and environmental protection

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Summarize the fundamentals of hazardous waste, relevant regulations, and the magnitude of the problem because of its improper management	PO1, PO2	
CO2	Explain various physical, chemical & biological methods of treating hazardous wastes and remediation of polluted sites	PO1, PO2	
CO3	Estimate the concentrations of hazardous pollutants in different phases & engineering design of treatment units and disposal facilities	PO1, PO2	
CO4	Assess risks for toxic substances and their adverse effects on living organisms, environment and human health	PO1, PO6	

Course Contents:

MODULE – 1	10 Hrs.
Fundamentals of Hazardous Waste Management- Definition of hazardous waste, properties and characteristics of hazardous wastes, past waste management practices, Partitioning coefficients, Conceptual Site Model, Source – Pathway – Receptor Analyses. Environmental legislations for hazardous waste disposaL, Land transport. ***Self-study component: Student shall have a deeper understanding of hazardous waste management principles and practices.***	
MODULE – 2	**10 Hrs.**
Risk Assessment and Waste Handling- Concept of risk and hazard, exposure pathway, calculation of risk, hazard identification, toxicity assessment, carcinogenic effects and non-carcinogenic effects, exposure assessment, applications of risk assessment, and Uncertainties. Waste minimization – factors & case studies, Solutions to major problems associated with hazardous wastes ***Self-study component: students shall understanding of risk assessment and waste handling***	
MODULE -3	**10 Hrs.**
Treatment of Hazardous Wastes- Physico – chemical treatment - Stabilization, Sorption, Volatilization – Air stripping, Soil Vapor Extraction, Advanced Oxidation Process, Permeable Reactive Barrier Biological treatment - Difference between biological treatment of solid waste with hazardous waste, Composting, Bioremediation – growth kinetics, inhibition, in situ and ex situ bioremediation - Reductive dehalogenation, Bioreactors, and Constructed Wetlands ***Self-study component: students shall know different advanced treatment methods to reduce the toxic waste.***	
MODULE -4	**10 Hrs.**
Storage & Disposal of Hazardous Wastes- Treatment, Storage and Disposal Facilities (TSDFs) - Facility Design & Operation - Hazardous waste landfills – landfill design parameters, Landfill gases and leachate generation, Air strippers – operating requirements and their design aspects, Incinerators - types of devices, operating & regulatory requirements and their design aspects	

Self-study component: students shall gain insights into current practices and emerging trends in hazardous waste storage and disposal.

Practical Component:

Text Books:Text Books:

1. Pichtel, J. (2014). Waste Management Practices: Municipal, Hazardous, and Industrial. CRC Press. 2. La Grega, M. D., Buckingham, P. L., & Evans, J. C. (2010). Hazardous Waste Management. WavelandPress.

Reference Books:

1. Bhat, S. (2019). Handbook on Chemicals and Hazardous waste manageWaste Management and Handling in India. Ministry of Environment, Forests & Climate ChangeNew Delhi & National Law School of India University,Bengaluru

2. Hazardous and Other Wastes (Management & Transboundary Movement) Rules. (2016). Ministry of Environment, Forests & Climate Change, New Delhi.

MOOC Course:

1. https://archive.nptel.ac.in/content/syllabus_pdf/105106056.pdf

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2												
CO2	3	2												
CO3	3	2												
CO4	3					2								

Course Title	WATER RESOURCES MANAGEMENT		
Course Code	21OECV766	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs.	**Hours/Week**	3
CIE + SEE	50 + 50 Marks	**Total Hours**	40

Course Objective: To develop an understanding of the availability and occurrence of freshwater, its uses, and problems related to water resources management

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Apply your understanding of the Scope and Economics of Water Resources Engineering in assessing its importance	PO1	PSO1
CO2	Apply Principles of Engineering Economy and Optimization in Water Resources Management	PO1	PSO1
CO3	Analyze Integrated Water Resource Management (IWRM) Strategies for Sustainable Development	PO2	PSO1
CO4	Describe Environmental Sustainability and Lifelong Learning in Water Resources Engineering through Project-Based Initiatives	PO7, PO12	PSO1

Course Contents:

MODULE – 1	10 Hrs.

Introduction: Applications of water resources engineering, Economics in Water resource planning, social aspects, planning of water resources surveys, Water resources of the world, Water resources in India, Water demand for various purposes, Integrated Water Resources, Rejuvenation and conservation of water resources.

Water Law: Riparian right, Appropriative rights, Permit system, Water codes. Groundwater laws, Interstate problems,international problems

Self-study component: Students shall collect the information from the internet on water resource Planning, interstate river disputes, international problems. submit a report.

MODULE – 2	10 Hrs.

Floods: Importance of flood studies, Definition of flood, causes of floods Factors affecting flood flow. Estimating the magnitude and frequency of floods, Empirical formulae, Rational method, Envelope curve, Unit hydrograph method and probability methods, Design floods, Standard project flood & probable maximum flood.

Engineering Economy in Water Resources Projects: Introduction, Steps involved in economy study, Economics of combined flood projects and multipurpose projects. Principle of Optimization in planning, Capital budgeting.

Self-study component:Students shall collect information from the internet on causes of flood-estimation of design flood-economics of multipurpose projects-capital budgeting, submit a report.

MODULE -3	10 Hrs.

Planning for Water Resources Development: Definition of Planning, Levels and Phases of planning, Objectives of Project Planning. Formulation Project evaluation, Environmental aspects in planning, System analysis, Pit falls in Planning;

Multi-purpose Projects: Functional requirements, Compatibility of multipurpose uses, Cost Allocation to various uses in multipurpose projects planning, Components of a multipurpose river basin development, Operation of multipurpose reservoirs, Watershed management, small dam’s v/s big dams, Economic height of a dam.

Self-study component: Students shall collect the information from the internet on objectives of planning- cost allocation in multipurpose projects-watershed management-visit small dams, submit a report.

MODULE -4	**10 Hrs.**

Integrated Water Resource Development: Main Objectives, Secondary objectives like reclamation of waterlogged areas. Control of overdraft of groundwater, Salt-water intrusion etc. Aspects of integrated and conjunctive use of water & their constraints. A brief description of perspective water. resources development of Himalayan and Peninsular rivers of India.

Organization of Water Resources Development: Present administrative structures, problems involved therein, Organizational setup for execution of water resources development and river basin development.

Self-study component: Students shall collect the information from the internet on integrated and conjunctive use of water –water resource development of peninsular and Himalayan rivers-visit water resource department and collect details on the organizational setup.

Text Books:

1. Subramanya. K "Engineering Hydrology" Tata McGraw-Hill Publishing Company Ltd., New York,2008
2. Linsley.K& Frozini.J.B"Water Resources Engineering International Students Edition, McGraw-Hill Kogakusha Ltd.

Reference Books:

1. Garg. S.K "Hydrology and Water Resources Engineering"Khanna Publishers, New Delhi,India
2. Gupta.B.L& Amith Gupta "Water Resources Systems and Management" Standard Publishers & Distributors,Delhi

MOOC Course:

1. https://archive.nptel.ac.in/courses/105/108/105108081/

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3												3	
CO2	3												3	
CO3		3											3	
CO4							2					2	3	

Course Title	GREEN BUILDINGS		
Course Code	21OECV767	(L-T-P) C	(3-0-0) 3
Exam	3 Hrs.	Hours/Week	3
CIE + SEE	50 + 50 Marks	Total Hours	40

Course Objective: To learn broader understandings on various aspects of green building

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Illustrate the idea of green building with relevant to various key elements.	PO1, PO2, PO3	
CO2	Evaluate suitable materials for green buildings, and the impacts on the environment.	PO1, PO2, PO3	
CO3	Explain the various rating system adopted for green building.	PO1, PO2, PO3	
CO4	Explain the concept of built environment, safety aspects during construction stages.	PO1, PO2, PO3	

Course Contents:

MODULE – 1	10 Hrs.
The need of green building: Sources of pollution, greenhouse gas emissions, climate change , Challenges of climate change, National action plan on climate change, ecological footprint, urban environmental issues, climate change,possible impacts & potential impacts on cities. Policy directions with relevant examples, conventional model and sustainable model. ***Self-study component: Students shall visit pollution control board and collect the details regarding pollution factors, impacts of greenhouse gases on the environment.***	
MODULE – 2	**10 Hrs.**
Green building overview: Definition of green building, Material efficiency, sustainable city planning, enhancing biodiversity, green roof, reducing solar heat gain, materials with low environmental impacts, solid waste management, energy efficiency, water conservation, efficiency and recycling, life cycle assessment. ***Self-study component: Students shall visit nearby houses constructed with green building concept and collect the details and submit the report on the same.***	
MODULE -3	**10 Hrs.**
Green building rating system: LEED rating system, green rating system in India, GRIHA, SVAGRIHA, green roads rating system, green rating for business & industry. **Building Environment:** Climate sub systems, effect of sun on earth, wind rose, solar radiation, urban heat island, indoor & outdoor air quality. ***Self-study component: Students shall collect the various standards as per norms for various rating systems in India adopted for various buildings and submit the report on the same.***	
MODULE -4	**10 Hrs.**
Built environment: City planning, transport safety, safety from disasters, safety of structures, occupational health and safety, materials for retrofitting of non – engineered buildings,key elements of safe construction, Conversion of existing buildings to green buildings. case studies on eco buildings.	

Self-study component: Students shall collect the information regarding various aspects of smart city, safe city concept and submit the report on the same.

Text Books:

1. A K Jain,"The idea of green building", Khanna publishers, NewDelhi (2014), ISBN: 8174092560
2. Harhara Iyer G, Green Building Fundamentals, Notion Press(2022) , ISBN: 979-8886416091

Reference Books:

1. Dr. Adv. HarshulSavla, Green Building: Principles & Practices, Notion Press Media Pvt Ltd, Channai (2021), ISBN: 1685866042
2. Relevant IS codes.

MOOC Course:

1. Sustainable Engineering Concepts and Life Cycle Analysis

https://onlinecourses.nptel.ac.in/noc23_ce90/preview

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]												
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2	1											
CO2	3	2	1											
CO3	3	2	1											
CO4	3	2	1											

Course Title	SUSTAINABLE DEVELOPMENT GOALS		
Course Code	21OECV768	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs.	**Hours/Week**	3
CIE + SEE	50 + 50 Marks	**Total Hours**	40

Course Objective:

1. The course CIE + SEE ks to build an inter-disciplinary perspective on understanding sustainable development concerns and challenges..
2. This course familiarizes students with current debates and perspectives in analyzing constraints and opportunities for sustainable development

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Apply the basic concept of Sustainable Development (SD), the environmental, social and economic dimensions	PO1, PO2, PO6, PO7	
CO2	Analysis of factors that support to achieve sustainability and resilience in an individual level and in a community	PO2, PO6, PO7	
CO3	Develop an encompassing understanding of sustainability issues	PO1, PO2, PO6	
CO4	Categorize the embedment of sustainability issues in environmental, societal, and economic systems,	PO1, PO6, PO7	

Course Contents:

MODULE – 1	10 Hrs.
Introduction Glimpse into History and Current practices - Broad introduction to SD - its importance, need, impact and implications; definition coined; Changing Perspectives Definitions· & Principles of Sustainable Development Goals Millennium Development Goals: Status (global and Indian),· Inclusive Growth and Poverty Reduction, Impact on approach to development policy and practice in India, future directions. ***Self-study component: Explore India's National Action Plan on Climate Change, Swachh Bharat Abhiyan, and National Rural Employment Guarantee Act (NREGA) to grasp their objectives and implementation methods.***	
MODULE – 2	**10 Hrs.**
Poverty, Hunger, Good Health and Well-being Eradication of poverty and hunger to help all societies achieve a higher quality of life Gender Equality, Reduced Inequalities Reduce inequalities worldwide Clean Water and Sanitation, Affordable and Clean Energy Universal access to basic essential services including clean drinking water, hygiene and sanitation, and safe renewable energy ***Self-study component:Identify local challenges in India that correspond to specific Sustainable Development Goals (SDGs) and examine how governmental and grassroots initiatives address these issues.***	
MODULE -3	**10 Hrs.**
Quality Education, Decent Work and Economic Growth ,Universal access to inclusive education and decent work to support fair and socially just economic opportunities Industry, Innovation, and Infrastructure; Sustainable Cities and Communities; Responsible Consumption and Production Innovative solutions and resilient infrastructure to enable societies to produce and consume in a more sustainable way Climate Action, Life Below Water, Life on Land The protection of human and non-human life by combating climate change and safeguarding oceans and terrestrial habitats including inland surface water Peace, Justice, and Strong Institutions; Partnerships for Goals Collaboration between all society partners and stakeholders to create a world of peace and justice	

for all

Self-study component: Explore Karnataka's initiatives aimed at achieving Sustainable Development Goals.

MODULE -4	**10 Hrs.**

Implementing the SDGs Solutions and best practices at the individual, local, national, and international level– Monitoring, Evaluation, Reporting Measuring SDG success through indicators, monitoring, evaluation, and reporting– Beyond Sustainability to Radical Transformation The course will close with an introduction to taking the SDGs to the next level – changing world-views and perspective through radical transformation and thinking beyond sustainability.

Self-study component:Investigate successful state-level projects like Kerala's healthcare model and community-driven efforts such as the Sunderbans mangrove conservation project to learn about effective strategies for achieving SDGs

Text Books:

1. Hazell P. and Diao X. (2005) The Role of Agriculture and Small Farms in Economic Development, Washington, D.C.: International Food Policy Research Institute.
2. Sachs J. (2006) The End of Poverty: Economic Possibilities for Our Time, Penguin (Chapters 1-4, 8, 14-18).

Reference Books:

1. Franco, I.B. and Tracey, J. (2019), "Community capacity-building for sustainable development: Effectively striving towards achieving local community sustainability targets", International Journal of Sustainability in Higher Education, Vol. 20 No. 4, pp. 691-725
2. Our Common Journey: A Transition Toward Sustainability. National Academy Press, Washington D.C. Soubbotina, T. P. 2004.
3. Elliott, Jennifer. 2012 An Introduction to Sustainable Development. 4th Ed. Routledge, London.4. National Building Code (NBC), Bureau of Indian Standards

MOOC Course:

1) https://archive.nptel.ac.in/courses/109/106/109106200

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2				2								
CO2		3				2	3							
CO3	3	2				2								
CO4	3					2	3							

Course Title	REMOTE SENSING AND GIS		
Course Code	21OECV769	(L-T-P) C	(3-0-0) 3
Exam	3 Hrs.	Hours/Week	3
CIE + SEE	50 + 50 Marks	Total Hours	40

Course Objective: Develop knowledge on RS and GIS technologies to collect , analyze and interpret spatial data for solving real life problems.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Comprehending remote sensing entails understanding of Energy interactions.	PO2, PO6	
CO2	Applying remote sensing in data collection and analysis through different types of sensors & platforms	PO3,PO 5,PO6	
CO3	Comprehend GIS : Managing , Analyzing ,Visualizing spatial data solutions.	PO1, PO7	
CO4	Apply RS & GIS expertise to effectively interpret and process data	PO5, PO8	

Course Contents:

MODULE – 1	10 Hrs.

Remote Sensing:

Basic concept of Remote sensing, Data and Information, Remote sensing data collection, Remote sensing advantages & Limitations, Remote Sensing process. Electromagnetic Spectrum, Energy interactions with atmosphere and with earth surface features (soil, water, and vegetation), Resolution, image registration and Image and False color composite, elements of visual interpretation techniques.

Self - study component: Students shall collect the information on space research

organizational structure ,Types of Indian satellites, and data products	
MODULE – 2	**10 Hrs.**
Remote Sensing Platforms and Sensors: Indian Satellites and Sensors characteristics, Remote Sensing Platforms, Sensors and Properties of Digital Data, Data Formats: Introduction, platforms IRS, Landsat , SPOT, Cartosat , Ikonos , Envisat etc. sensors, sensor resolutions (spatial, spectral, radiometric and temporal). Basics of digital image processing- introduction to digital data, systematic errors(Scan Skew, Mirror-Scan Velocity, Panoramic Distortion, Platform Velocity , Earth Rotation) and non-systematic [random] errors(Altitude, Attitude), Image enhancements(Gray Level Thresholding, level slicing, contrast stretching),image filtering. ***Self-study component: Students shall collect the information on commercial and open-source Remote Sensing data for use in GIS. Download free DEM and LULC data.***	
MODULE -3	**10 Hrs.**
Geographic Information System: Introduction to GIS; components of a GIS; Geographically Referenced Data, Spatial Data-Attribute data-Joining Spatial and attribute data, GIS Operations: Spatial Data Input – Attribute data Management, Geographic coordinate System, Datum; Map Projections: Types of Map Projections, Projected coordinate Systems. UTM Zones. ***Self-study component: Students shall collect the information on different commercial and open-source GISsoftware***	
MODULE -4	**10 Hrs.**
Introduction to Global Positioning System (GPS): GPS satellites constellations; GPS segments: Space, Control, User; GPS antennas, signals, and codes; GPS receivers; Modes of measurements and post processing of data; Accuracy of GPS measurements; Application of GPS.	

Integrated Applications of Remote sensing and GIS:

Applications in land use land cover analysis, change detection, water resources, urban planning, environmental planning, Natural resource management and Traffic management. Location Based Services And Its Applications.

Self-study component: Students shall collect the information on different GPS system in world and their working.

Text Books:

1. Lillesand, Kiefer, Chipman, "Remote Sensing and Image Interpretation", Wiley2011.
2. Basudeb Bhatta "Remote sensing and GIS" Oxford university Press, New Delhi, India,2021
3. Narayan Panigrahi, "Geographical Information Science", and ISBN 10: 8173716285 / ISBN 13: 9788173716287, University Press2008.
4. Kang – T surg Chang, "Introduction to Geographic Information System". Tata McGraw Hill Education Private Limited2015.

Reference Books:

1.Anji Reddy M., "Remote sensing and Geographical information system", B. S. Publications2008.

2.S Kumar,"Basics of remote sensing & GIS", Laxmi publications 2005

3. John R. Jensen, "Remote sensing of the environment", an earth resources perspective–2nd edition–byPearson Education2007

4. Chor Pang Lo and Albert K.W Yeung, "Concepts & Techniques of GIS", PHI,2006

MOOC Course:

1. https://onlinecourses.nptel.ac.in/noc22_ce84/preview
2. https://www.iirs.gov.in/pgdiploma

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1		3				1								
CO2			2		3	1								
CO3	3						1							
CO4					2									

Course Title	ENGINEERING OPTIMIZATION		
Course Code	21OECV770	**(L-T-P) C**	(3-0-0) 3
Exam	3 Hrs.	**Hours/Week**	3
CIE + SEE	50 + 50 Marks	**Total Hours**	40

Course Objective: The objective of this course is to provide students with a comprehensive understanding of optimization techniques and their applications in engineering.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Discuss the concept and need of optimization in engineering.	PO2, PO3, PO4	
CO2	Discuss conventional methods of optimization under constraints and the concept of linear programming to typical Engineering problems	PO2, PO3	
CO3	Apply the numerical methods for design optimization problems	PO1, PO3	
CO4	Apply genetic algorithms for optimum design of structural elements	PO2, PO4	

Course Contents:

MODULE – 1	10 Hrs.
Classical Optimization Techniques: Engineering applications, Statement of optimization problem, Classification of optimization problems, Optimization techniques. Single variable optimization, Multivariable optimization with no constraints, with equality constraints - Lagrange multiplier - method, constrained variation method. ***Self-Study Component- Students shall develop excel programming spreadsheets to solve classical methods by method of calculus.***	
MODULE – 2	**10 Hrs.**
Linear Programming: Standard form of linear programming problem, simplex method, two phase simplex method - application problems. ***Self-Study Component- Students shall use any programming tools to solve Linear programming problem with graphical and simplex methods.***	
MODULE -3	**10 Hrs.**
Design optimization of structural elements. Application Problems: Optimum design of steel structural elements. Algorithms for optimum designs ***Self-Study Component- Students shall Visit the construction site to CIE + SEE the actual RC working drawings. Understand the same and compare with the theory and prepare the report on the same.***	
MODULE -4	**10 Hrs.**
Genetic Algorithms: Introduction _ fitness function, crossover and mutation - Application problems. ***Self-Study Component- Students shall write the flow-charts and algorithms for application of fitness function and mutation genetics.***	

Text Books:

1. Rao, S.S. - Optimization Theory and Applications, Wiley Eastern Limited,1978.
2. Fox, R.L. - Optimization Methods for Engineering Design, Addison Wesley, 1971

Reference Books:

1. Tark. R.M. Nicholls.R.L., Mathematical Foundations for Design, McGraw Hill Book Company.
2. NarsingkDeo – System simulation with digital computer, Prentice – Hall of India Pvt, Ltd. New Delhi – 1989.

MOOC Course:

1. https://nptel.ac.in/courses/111105039
2. https://archive.nptel.ac.in/courses/105/103/105103210

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1	3	2		1										
CO2	3	2		1										
CO3	2		3											
CO4		2		3										

Course Title	MAIN PROJECT WORK PHASE- 1		
Course Code	21PROJ1	**(L-T-P) C**	(0-0-4) 2
Exam	3 Hrs.	**Hours/Week**	4
CIE + SEE	50 + 50 Marks	**Total Hours**	48

Course Objective: To be able to identify a relevant problem that requires technical solution and conduct survey for the same.

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Identify a problem, through Extensive literature Survey leading to publication of a survey paper in a Conference/Journal.	PO1, PO2	
CO2	Plan & design the solution to the selected problem	PO3	PSO2
CO3	Make oral presentation and documentation of the work carried out	PO9, PO10	

Course Contents:

During VII semester, candidates in consultation with the guides shall carry out literature survey to finalize the topic of the project. ***The same project will be continued in Eighth semester***. Students are expected to present the project synopsis, system analysis, requirements specification and **should publish a technical paper on Literature Survey. The evaluation will be carried out in three stages**

- Project Stage 1 – Team Formation , Topic Selection & Guide allotment (No marks)
- Project Stage 2 – Extensive Literature Survey , Problem Definition
- Project Stage 3 – Preliminary Design, Report Preparation and Publication

The evaluation of the project phases shall be carried out by the evaluation committee comprising of project guide & other faculty members. The committee will be constituted by the project coordinator in consultation with the Head of the department.

For Multidisciplinary projects guides will be allotted from each concerned branch.

Performance Indicators	Low	Medium	High
Literature Survey and Problem Definition (20 Marks)	Literature Survey not pertaining to the title of the project (8)	Incomplete literature survey and improper problem definition (14)	Extensive literature survey with clear state of the art problem definition (20)
Preliminary Design (10 Marks)	Has no coherent strategies for problem Solving (4)	Has some strategies for problem – solving, but does not apply them consistently (7)	Formulates strategies for solving problems (10)
Presentation (10 marks)	Disorganized and ineffective presentation (4)	Organized, but ineffective presentation (7)	Effective organized presentation (10)
Report Preparation (30 Marks)	Disorganized and contents are not sufficient	Organized but not good content wise	Effectively organized and well framed contents
Paper Publication (20 Marks)	Paper submitted & awaiting results (8)	National conference International Conference (14)	Journal (20)
Punctuality(Project Dairy Maintenance) (10 marks)	Not meeting the guide regularly (4)	Meeting regularly but doesn't document details of every session (7)	Up to date dairy maintenance(10)

PROJECT WORK, PHASE 1 EVALUATION RUBRICS

Parameter	Excellent	Good	Average	Acceptable	Unacceptable
	Marks range (90 – 100)	**(75– 89)**	**(60 – 74)**	**(40 – 59)**	**(0 - 39)**
Identification of Problem Domain & Detailed Analysis	Detailed and extensive explanation of the purpose and need of the project	Good explanation of the purpose and need of the project	Average explanation of the purpose and need of the project;	Moderate explanation of the purpose and need of the project	Minimal explanation of the purpose and need of the project
Objectives and Methodology of the Proposed Work	All objectives of the proposed work are well defined; Steps to be followed to solve the defined problem are clearly specified	Good justification to the objectives; Methodology to be followed is specified but detailing is not done	Incomplete justification to the objectives proposed; Steps are mentioned but unclear; without justification to objectives	Only Some objectives of the proposed work are well defined; Steps to be followed to solve the defined problem are not specified properly	Objectives of the proposed work are either not identified or not well defined; Incomplete and improper specification
Design Methodology	Division of problem into modules and good selection of materials Appropriate design methodology and properly justification	Division of problem into modules and good selection of materials Design methodology not properly justified	Division of problem into modules but inappropriate selection of materials Design methodology not defined properly	Partial division of problem into modules and inappropriate selection of materials Design methodology not defined properly	Modular approach not adopted Design methodology not defined properly
Planning of Project Work and Team Structure	Time frame properly specified and being followed Appropriate distribution of project work	Time frame properly specified and being followed Distribution of project work inappropriate methodology not defined	Time frame properly specified, but not being followed Distribution of project work un-even	Time frame properly specified, but not being followed Un-even distribution of project work	Time frame not properly specified In-appropriate Distribution of project work
Demonstration and Presentation	Objectives achieved as per time frame	Objectives achieved as per time frame of	Objectives achieved as per time frame	Objectives not achieved as per time frame	No objectives achieved

	Contents of presentations are appropriate and well arranged Proper eye contact with audience and clear voice with good spoken language	Contents presentations are appropriate but not well arranged demonstration, clear voice but eye contact not proper	Contents of presentations are appropriate but not well arranged Presentation not satisfactory and average demonstration	Contents of presentations are not appropriate Eye contact with few people and unclear voice	Contents of presentations are not appropriate and not well delivered Poor delivery of presentation

Course Title	RESEARCH METHODOLOGY AND INTELLECTUAL PROPERTY RIGHTS		
Course Code	21RMIP	**(LTP)C**	(2-2-0) Audit
CIE	100 marks	**Hours / Week**	4
CIE + SEE	--	**Total hours**	48

Course objective: Understand research methodology, design, data collection, and analysis techniques and gain knowledge of Intellectual Property Rights (IPR) with a focus on patents, designs, trademarks, and copyrights, including their registration and protection procedures.

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

COs	Course Outcomes	POs	PSOs
CO1	Acquire research skills and conduct comprehensive literature reviews	8,10, 12	
CO2	Apply research design knowledge to create prototype	3,4, 8, 10, 12	
CO3	Evaluate methods for data collection, analysis, and sampling design	4, 8, 10, 12	
CO4	Comprehend global and Indian patent scenarios, as well as registration requirements, infringements and protections related to trademarks, copyrights, and designs	6,8, 10, 12	

Course Contents:

MODULE - 1	7 Hrs.

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Types of Research, Ethics in Research, Types of Research Misconduct. Literature Review and Technical Reading. **Citations:** Functions and Attributes, Impact of Title and Keywords on Citations, Knowledge flow through Citations, Acknowledgments.

MODULE -2	7 Hrs.
Research Design: Need for Research Design, Important Concepts Related to Research Design: Dependent and Independent Variables, Extraneous Variable, Variable, Common Control, Confounded Relationship, Research Hypothesis. **Experimental Designs:** Introduction to Randomized Block Design, Complete Randomized Design, Latin Square Design, and Factorial Design.	
MODULE - 3	**7 Hrs.**
Method of Data Collection: Primary and Secondary Data Collection. **Sampling Design:** Sampling fundamentals, Measurement, and Scaling Techniques, Criteria of Selecting a Sampling Procedure, Characteristics of a Good Sample Design, and Types of Sample Design. **Data Analysis:** Testing of Hypotheses: Null Hypothesis, Alternative Hypothesis, Type I and Type II Errors. Procedure for Hypothesis Testing: Mean, Variance, and Chi-square Test.	
MODULE - 4	**7 Hrs.**
Introduction to IPR: Different forms of IPR, Role of IPR in Research and Development. **Patents:** Principles Underlying Patent Law, Types of Patent Applications in India, Procedure for Obtaining a Patent. **Design:** What is a Design? Essential Requirements for a Registrable Design, Procedure of Registration of a Design. **Trademarks:** Essentials of a Trademark, Registration, and Protection of Trademarks, Rights Conferred by Registration of Trademarks, Infringements. **Copyrights:** Characteristics of Copyrights, Rights Conferred by Registration of Copyrights, Registration of Copyrights, Infringements, Remedies against Infringement of Copyrights.	

Activity Components
➢ Students select a research topic and perform a literature review, identifying existing knowledge, synthesizing prior art, and compiling relevant citations leading to publishing a survey paper. ➢ Students develop research proposals, including the formulation of research hypotheses. ➢ Students collect primary or secondary data, design a sampling procedure, and perform data analysis using statistical techniques. ➢ Students analyze real-world case study/studies for legal issues and propose solution/s to infringement cases.

The rubrics for evaluation will be set suitably as decided by the BOS and will be announced to the students at the beginning of the semester.

Text Book

1. Kothari C R. Research methodology: Methods and techniques. New Age International; 2004.
2. Pandey N, Dharni K. Intellectual property rights. PHI Learning Pvt. Ltd.; 2014 Jul 30.
3. Deb D, Dey R, Balas V E. Engineering research methodology. A Practical Insight for Researchers. 2019;153.

Reference Book:

Thiel D V. Research methods for engineers. Cambridge University Press; 2014 Sep 11.

Course Articulation Matrix

Course Outcomes	Program Outcomes [POs]													
COs	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**
CO1								3		2		3		
CO2			3	3				3		2		3		
CO3				3				3		2		3		
CO4						3		3		2		3		

Course Title	MAIN PROJECT WORK PHASE 2		
Course Code	21PROJ2	**(L-T-P) C**	(0-0-8) 4
Exam	3 Hrs.	**Hours/Week**	8
CIE + SEE	50 + 50 Marks	**Total Hours**	96

Course Objective: To involve in team work to demonstrate the acquired skill & knowledge gained to identify, formulate, analyze, evaluate and to provide meaningful engineering solutions to industrial/ societal needs

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

COs	Course Outcomes	Mapping to PO's	Mapping to PSO's
CO1	Implement the design with appropriate techniques, resources and contemporary tools	PO3, PO5	PSO1, PSO2
CO2	Communicate effectively with team members and mentors, make presentations and prepare technical document	PO9, PO10, PO11, PO12	PSO2
CO3	Use ethical practices in all endeavors	PO8	
CO4	Share the responsibilities for carrying out the project & playing individual roles appropriately	PO9,	

The project teams will implement the project started in their seventh semester

Stage I (30M) - First internal evaluation shall be taken up during this phase. This includes presentation on fine tuning of SRS & Design carried out in seventh semester.

Stage II (20 M) –Mid phase evaluation shall be taken up during this phase. This includes presentation, intermediate project demonstration, draft copy of the paper

Stage III (50 M) – Final project Demo, report submission and details of technical paper publication.

The evaluation of the project stages shall be carried out by the evaluation committee comprising of project guide & other faculty members. The committee will be constituted by the project coordinator in consultation with the Head of the department.

For Multidisciplinary projects guides will be allotted from each concerned branch.

PROJECT WORK, PHASE 2 EVALUATION RUBRICS

Parameter	Excellent	Good	Average	Acceptable	Unacceptable
	Marks range (90 – 100)	**(75– 89)**	**(60 – 74)**	**(40 – 59)**	**(0 - 39)**
Incorporation of Suggestions	Changes are made as per modifications suggested during mid term evaluation and new innovations added	Changes are made as per modifications suggested during midterm evaluation and good justification	All major changes are made as per modifications suggested during mid term evaluation	Few changes are made as per Modifications suggested during mid term evaluation	Suggestions during mid term evaluation are not incorporated
Project Demonstration	All defined objectives are achieved All modules of project are well integrated	All defined objectives are achieved Integration of all modules not done and system working is not very satisfactory	All defined objectives are achieved Project are not properly integrated	Some of the defined objectives are achieved Modules of project are not properly integrated	Defined objectives are not achieved Modules are not in proper working form
Presentation	Contents of presentations are appropriate and well delivered Proper eye contact with audience & clear voice with good spoken language	Contents of presentations are appropriate and well delivered Clear voice with good spoken language but less eye contact with audience	Contents of presentations are appropriate but not well delivered Eye contact with few people and unclear voice	Contents of presentations are not appropriate Eye contact with few people and unclear voice	Contents of presentations are not appropriate and not well delivered Poor delivery of presentation
Project Report	Project report is according to the specified format References and citations are appropriate and well mentioned	Project report is according to the specified format References and citations are not mentioned well	Project report is according to the specified format but some mistakes In-sufficient references	Project report is not fully according to the specified format In-sufficient references	Project report not prepared according to the specified format References and citations are not appropriate
Conclusion and Discussion	Results are presented in very appropriate manner Project work is well summarized and concluded Future extensions in the project are well specified	Results are presented in good manner Project work summary and conclusion not very appropriate Future extensions in the project are specified	Results presented are not much satisfactory Project work summary and conclusion not very appropriate Future extensions in the project are specified	Results presented are not much satisfactory Project work summary and conclusion not very appropriate Future extensions in the project are not specified	Results are not presented properly Project work is not summarized and concluded Future extensions in the project are not specified

Course Title	RESEARCH/INDUSTRY INTERNSHIP III		
Course Code	21INT3	**(L-T-P)C**	(0-0-12) 12
Exam	3 Hrs.	**Weeks**	24
CIE	100 Marks	**Total Hours**	14-16 weeks

Course Objective: It involves a short theoretical or experimental research project supervised by a researcher/ To bridge the gap between the theoretical knowledge obtained in the classrooms and the practical skills required in the actual workplace

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

COs	Course Outcomes	Mapping to PO's
CO1	Get exposure to real world job environment and gain practical experience	1,2,3,4,5,10,12
CO2	Generate technical paper/s and publish in refereed journal/s and conferences	1,2,8,9,10,12

Guidelines for Research Internship III	
Purpose	It involves a short theoretical or experimental research project supervised by a researcher.
Skills acquired	● Planning and scheduling. ● Documentation. ● Critical thinking. ● Data collection. ● Data analysis. ● Appreciating and practicing the ethical values.

Expected Outcomes	● Generating technical paper/s and publish in refereed journal/s. ● Possibility of acquiring an intellectual ownership and patent. ● Build a prototype for an idea on which the research was carried out. ● File patent/s.
Selection	● In consultation with a researcher/ researchers working in MCE research Centre ● A research institute ● Company's R and D department.
Team Size	Can be carried out either individually or in a team(**Upto 5 students**)
Venue	Laboratory of college A research institute Company's R and D department.
Supervision	Internship shall be carried out under the supervision of a faculty mentor* at the department level For all students attending in-house internship, the attendance should be maintained by the Faculty mentor

Parameters for Assessment	Diary Report Presentation skill Technical Paper Recommendation Letter from the guide

Evaluation	**CIE (100 Marks)–**The CIE marks shall be awarded by a committee* consisting of the faculty mentor and two faculty members of the Department, one of whom shall be the Guide (applicable for in-house interns). The schedule for evaluation will be announced by chairman BOE at the end of the semester. The Evaluation can be done in ***phases as decided by the internal BOS*** of the department. The contents of the report and the evaluation Rubrics will be set by the Department based on the assessment parameters **CIE + SEE (100 Marks)–** Contribution to the internship and the performance of each group member shall be assessed individually in semester end examination (CIE + SEE) conducted at the department. Marks shall be awarded based on the evaluation of the diary, report, presentation skill and viva voce
*For interdisciplinary internship its necessary to involve an expert from each discipline	
Guidelines for Industry Internship III	
Purpose	To bridge the gap between the theoretical knowledge obtained in the classrooms and the practical skills required in the actual workplace
Skills acquired	● Applying the theoretical knowledge in a practical scenario ● Build confidence in applying the skills learnt ● Documentation ● Communication ● Appreciating and practicing the ethical values

Expected Outcomes	● Get exposure to a real world job environment and gain practical experience ● Build confidence in applying the skills learnt. ● Enhances Placement Opportunity
Selection	● Can select individually ● Can CIE + SEE k the help from the department
Team Size	Can be carried out either individually or in a team(**not exceeding 5 students**).
Venue	In a domain specific organization

Supervision	Internship shall be carried out under the supervision of a faculty mentor* at the department level. One faculty mentor can supervise a maximum of 20 students.
Parameters for Assessment	Diary Report presentation skill Recommendation Letter from the guide
Evaluation	**CIE (100 Marks) -**The CIE marks shall be awarded by a committee* consisting of the faculty mentor and two faculty members of the Department, one of whom shall be the Guide (applicable for in-house interns). The schedule for evaluation will be announced by chairman BOE at the end of the semester. The Evaluation can be done in ***phases as decided by the internal BOS*** of the department. The contents of the report and the evaluation Rubrics will be set by the Department based on the assessment parameters **CIE + SEE (100 Marks)-** Contribution to the internship and the performance of each group member shall be assessed individually

	in semester end examination (CIE + SEE) conducted at the department. Marks shall be awarded based on the evaluation of the diary, report, presentation skill and viva voce
*For interdisciplinary internship its necessary to involve an expert from each discipline	

Course Articulation Matrix

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	3	3	3	3	3	-	-	-	-	3	-	3		
CO2	3	3	-	-	-	-	-	3	2	2	-	3		