For the academic years 2020-2024

NEW

with effect from AY 2023-2024

SCHEME OF INSTRUCTION & EXAMINATION
B.E. (Civil Engineering) VII– SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction			Scheme of Examination		Credits
			L	T	Pr/ Drg	CIE	SEE	
Theory Courses								
1	PC 417 CE	Estimation and Specification	2	-	-	30	70	2
2	ES 310 CE	Disaster Preparedness & Planning	3	-	-	30	70	3
3	PE-4	Professional Elective - 4	3	-	-	30	70	3
4	PE-5	Professional Elective - 5	3	-	-	30	70	3
5	PE-6	Professional Elective - 6	3	-	-	30	70	3
6	OE-2	Open Elective -2	3	-	-	30	70	3
7	MC 802 HS	Essence of Indian Traditional Knowledge	2	-	-	30	70	-
Practical/ Laboratory Courses								
8	PC 460 CE	Estimation and Specification Laboratory	-	-	2	25	50	1
9	PW 702 CE	Summer Internship Evaluation	-	-	-	50*		2
10	PW 703 CE	Project Work – I			6	50		3
			19	**-**	**8**			**23**

*Evaluation of Technical Report and Seminar based on summer industrial Internship/Mini Project

Professional Elective – 4		
S.No.	**Course Code**	**Course Title**
1	PE 513 CE	Prestressed Concrete
2	PE 514 CE	Highway Construction and Management
3	PE 515 CE	Environmental Impact Assessment of Civil Engineering Projects
4	PE 516 CE	Instrumentation & Sensor Technologies for Civil Engineering Applications

Professional Elective – 5			**Professional Elective – 6**		
S.No.	**Course Code**	**Course Title**	**S.No.**	**Course Code**	**Course Title**
1	PE 517 CE	Structural Engineering Design & Detailing	1	PE 521 CE	Finite Element Method
2	PE 518 CE	Intelligent Transportation Systems	2	PE 522 CE	Urban Transportation Planning
3	PE 519 CE	Water and Air Quality Modelling	3	PE 523 CE	Surface Hydrology
4	PE 520 CE	Green Building Technologies	4	PE 524 CE	GIS and Remote Sensing

Open Elective–II		
Sl.No	**Course Code**	**Course Title**
1.	OE 701 EE	Non- Conventional Energy Sources (Not for EEE & EIE)
2.	OE 702 EE	Transducers and Sensors (Not for EEE & EIE)
3.	OE 703 AE	Automotive Safety and Ergonomics (Not for Mech./Prod./ Automobile Engg. Students)
4.	OE 704 ME	Entrepreneurship (Not for Mech./Prod./Automobile Engg. Students)
5.	OE 705 CE	Principles of Green Buildings (Not for Civil Engg. Students)
6	OE 706 AS	Data Mining (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
7	OE 707 CS	Web Application Development (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
8	OE 708 CS	Principles of Python (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
9	OE 709 AL	Introduction to Deep Learning (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
10	OE 710 DS	Database Management System (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
11	OE 711 CB	Privacy & Security in IOT (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
12	OE 712 IT	Introduction to Cyber security (Not for CSE, IT , AI&ML,IOT,AI & DS Students)
13	OE 713 EC	Fundamentals of IOT (Not for ECE, CSE, IT , AI&ML,IOT,AI & DS Students)
14	OE 714 EC	Fundamentals of Neural Networks (Not for ECE, CSE, IT , AI&ML,IOT,AI & DS Students)

Note : Syllabus of OE s offered by other Departments can be accessed from the syllabus of respective Department from the OU website www.osmania.ac.in

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For the academic years 2020-2024 *with effect from AY 2023-2024*

ESTIMATION AND SPECIFICATION

PC 417 CE

Instruction: 2 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 2

Objectives:

1. Acquire knowledge on various types of specifications used in construction
2. Learn to prepare rate analysis for various item of works in construction
3. Evaluate the actual value of land and buildings

Outcomes:

After completing this course, the student will be able to

1. Estimate the quantities of materials used in various construction works
2. Compute and prepare estimates for buildings along with road estimates.
3. Estimation of buildings for steel quantities & preparation of bar bending schedule (BBS)
4. A Prepare rate analysis and asess the value of land and buildings
5. Perform valuation of Civil Engineering structures.

UNIT – I

Specification writing: Definition, purpose and importance of specifications, Types of specification, General and detailed specifications for major items of buildings as per Telangana State Standard Data and Schedule of Rates, modes of measurements, general rules for the measurements and its units of different items of civil engineering work.

UNIT – II

Detailed estimation: Definition, purpose, types of estimates, factors influencing estimation, various methods of approximate estimate of buildings, Detailed estimate for Flat roof building (load bearing and RCC framed) - long and short wall method - centre line method. Detailed estimate of road works for WBM roads, Bituminous and CC road (including earth work), single cell rectangular box culvert, retaining walls, overhead water tank and earth work of irrigation canals (cutting and banking).

UNIT – III

***Estimation of reinforcement quantities*:** Estimation of steel quantities and preparation of bar bending schedule (BBS) - RCC framed works for Slabs, Beams and Columns, Footings (Rectangular, Isolated), Stair Case, Overhead rectangular tank and Retaining wall.

UNIT – IV

Rate analysis of civil work: Preparation of analysis of rates and theoretical requirements of materials as per the Telangana State Standard Data and Schedule of Rates, for major items of works of buildings, bituminous and concrete roads.

UNIT – V

Valuation of Buildings: Introduction, Basic elements - Market Value, Book Value, Salvage Value, Replacement Cost, Earning Value, Potential Value, Written Down Value, Different Methods of Valuation - Land and Building Method - Land tenure - Freehold Land and Leasehold Land, Land Valuation, Replacement Cost of Building, Depreciation, Value as per Land and Building Method, A Typical Example for Valuation by Land and Building Method. Introduction to MS Project.

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***Suggested Reading*:**

1 Dutta, B.N. *Estimating and Costing in Civil Engineering* Theory and Practice. UBS Publishers" Distributers Pvt. Ltd., New Delhi. (2016).
2 Chakraborthi, M. *Estimating, Costing and Specifications in Civil Engineering*. Chakraborthi, Kolkata. (2002).
3 Jagjit Singh. *Estimating and Costing in Civil Engineering*. Galgotia Publications, New Delhi, (1996).
4 B. S. Patil," *Civil Engineering Contracts and Estimation*", Orient Black swan Private Ltd; Fourth edition 2015.
5 Gurcharan singh & Jagdish singh, "Estimating Costing and Valuation", Standard Publishers Distributors, 2012.

***References/Additional Resources*:**

1 Standard Scheduled Rates and Relevant BIS Codes (SP:27 & BIS: 1200).

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For the academic years 2020-2024 *with effect from AY 2023-2024*

DISASTER PREPAREDNESS AND PLANNING

ES 310 CE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1) To impart knowledge of the basic principles of disaster management.
2) To give knowledge of the various types of disasters.
3) To understand the disaster management cycle and framework.
4) To become aware of the disaster management systems in India.
5) To become aware of the applications of the latest technologies in disaster management

Outcomes:

After completing this course, the student will be able to

1) Define and explain the terms and concepts related to disaster management.
2) Describe the various categories of disasters and their specific characteristics.
3) Explain the pre-disaster, during disaster and post-disaster measures and framework
4) Describe the disaster management acts and frameworks specific to India
5) List and explain the various technological applications to aid disaster management.

UNIT-I

Introduction: Understanding the Concepts and definitions of Disaster, Hazard, Vulnerability, Risk, and Capacity – Disaster and Development, and disaster management.

UNIT-II

Disasters: Geological Disasters (earthquakes, landslides, tsunami, mining); Hydro-Meteorological Disasters (floods, cyclones, lightning, thunder-storms, hail storms, avalanches, droughts, cold and heat waves) Biological Disasters (epidemics, pest attacks, forest fire); Technological Disasters (chemical, industrial, radiological, nuclear) and Manmade Disasters (building collapse, rural and urban fire, road and rail accidents, nuclear, radiological, chemicals and biological disasters) Global Disaster Trends – Emerging Risks of Disasters – Climate Change and Urban Disasters.

UNIT-III

Disaster Management Cycle and Framework: Disaster Management Cycle – Paradigm Shift in Disaster Management Pre-Disaster – Risk Assessment and Analysis, Risk Mapping, zonation and Microzonation, Prevention and Mitigation of Disasters, Early Warning System; Preparedness, Capacity Development; Awareness.

During Disaster – Evacuation – Disaster Communication – Search and Rescue – Emergency Operation Centre – Incident Command System – Relief and Rehabilitation.

Post-disaster – Damage and Needs Assessment, Restoration of Critical Infrastructure – Early Recovery – Reconstruction and Redevelopment; IDNDR.

UNIT-IV

Disaster Management in India: Disaster Profile of India – Mega Disasters of India and Lessons Learnt Disaster Management Act 2005 – Institutional and Financial Mechanism National Policy on Disaster Management, National Guidelines and Plans on Disaster Management; Role of Government (local, state and national),Non-Government and Inter Governmental Agencies.

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UNIT-V

***Applications of Science and Technology for Disaster Management*:** Geo-informatics in Disaster Management (RS, GIS, GPS and RS) Disaster Communication System (Early Warning and Its Dissemination) Land Use Planning and Development Regulations Disaster Safe Designs and Constructions Structural and Non Structural Mitigation of Disasters S&T Institutions for Disaster Management in India.

Suggested Reading:

1. Rajib, S and Krishna Murthy, R. R, *Disaster Management Global Challenges and Local Solutions"* CRC Press, 2009.
2. Navele, P & Raja, C. K, *Earth and Atmospheric Disasters Management, Natural and Manmade. B. S. Publications.2009*
3. Battacharya, T., *Disaster Science and Management*. Tata McGraw hill Company, 2017
4. *An overview on natural & man-made disasters and their reduction*, R K Bhandani, CSIR, New Delhi
5. Jagbir singh, Disaster management–Future challenges and opportunities, I.K. International publishing house, 1st edition, 2007.
6. Coppala P Damon, Introduction to International Disaster management, Butterworth-Heinemann, 2015.

***References/Additional Resources*:**

1. *Disaster Management Act 2005*, Publisher by Govt. of India
2. *Publications of National Disaster Management Authority (NDMA) on Various Templates and Guidelines for Disaster Management*
3. National Disaster Management Policy, 2009, Govt. of India
4. Encyclopedia of disaster management, Vol I, II and IIIL Disaster management policy and administration, S L Goyal, Deep & Deep, New Delhi, 2006
5. Disasters in India Studies of grim reality, Anu Kapur & others, 2005, 283 pages, Rawat Publishers, Jaipur
6. Manual on natural disaster management in India, M C Gupta, NIDM, New Delhi

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For the academic years 2020-2024 *with effect from AY 2023-2024*

PROFESSIONAL ELECTIVES - 4
PRESTRESSED CONCRETE

PE 513 CE

Instruction: 3 periods per week
CIE: 30 marks
Credits : 3

Duration of SEE: 3 hours
SEE: 70 marks

Objectives:

1. Understand the basic concept of prestressed concrete, learn the analysis of prestress.
2. Learn the design of prestressed concrete continuous beam, study the flexural and shear design of prestressed concrete beam sections.
3. Know the concepts of deflections and end blocks of prestressed concrete sections.

Outcomes:

After completing this course, the student will be able to

1. Apply the concept of prestressing and determine the losses of prestress.
2. Analyze the prestressed concrete beam and suggest the cable profile for beam.
3. Analyze the prestressed continuous beam and determine the concordant cable profile.
4. Design the prestressed concrete beam for flexure and shear.
5. Estimate the deflection of a prestressed concrete beam and design the end block.

UNIT – I

Introduction to Prestressed Concrete: Historical development, principles of prestressed concrete, definition, classification and systems of prestressing. Materials for prestressed concrete. Losses of prestress in pre-tensioned and post-tensioned members.

UNIT – II

***Analysis of Prestress*:** Basic assumptions, analysis of prestress, resultant stress, pressure line, kern points, cable profiles, load balancing concept, stress diagrams for prestress, dead load and live load.

UNIT – III

***Simply Supported Continuous Beams*:** Advantages of continuous member – codal provisions, concordant cable profile, analysis of continuous prestressed concrete beams.
Design of Sections: Flexural strength: design of rectangular, I and T sections using IS code provisions

UNIT – IV

***Design for Shear*:** Principle stresses – codal provisions – cracked and uncracked sections – Design of shear reinforcement.

UNIT – V

***Deflections*:** Importance of deflections, factors influencing deflections, codal provisions – short-term and long-term deflections of pre-stressed concrete beams with uniformly distributed and point loads.
End Block Design: Nature of stresses, stress distribution – codal provisions – IS code method of design

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Suggested Reading:

1 T.Y. Lin and N.H. Burns, *Design of prestressed concrete structure*, Jon Wiley and Sons, 1982.
2 A.H. Nilson, *Design of Prestressed Concrete*, John Wiley and Sons, 1982.
3 N. Krishna Raju, *Design of prestressed concrete structure*, Tata McGraw Hill Book Co., 1996.
4 G.S. Pandit and S.P. Gupta, *Prestressed Concrete*, CBS Publishers, 1995
5 Dayarathnam, Prestressed Concrete, Oxford & IBH Publication, 2010

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HIGHWAY CONSTRUCTION AND MANAGEMENT

PE 514 CE

Instruction: 3 periods per week
CIE: 30 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 marks

Course Objectives:

1. To understand the various equipment used for road construction and difficulties associated with highway drainage.
2. To analyze the defects in road construction and general pavement failures with remedies.
3. Characteristics of different types of bituminous layers and design of bituminous surfacing along with safety aspects needed for roads
4. To design the base course thickness and selection of materials as base layer for CC pavements.

Course Outcomes:

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

1. Design bituminous surfacing and other layers along with safety aspects needed during construction.
2. Design the base course thickness and select materials for base layer in CC pavements.
3. Analyze the defects in road construction and general pavement failures & propose suitable remedies.
4. Select suitable equipment for preparation of subgrade and preparation stages for base and sub base layers
5. Gain the knowledge on the equipment used for road construction and difficulties associated with highway drainage.

UNIT – I

Flexible Pavement Construction: Earthwork, compaction and construction of embankments, specifications of materials, construction methods and field control checks for various types of flexible pavement materials in sub-base, base, binder and surface course layers and their choice.

UNIT – II

Cement Concrete Pavement Layers: Specifications and method of cement concrete pavement construction; Construction of interlocking block pavements, Quality control tests; Construction of various types of joints

UNIT – III

Soil Stabilized Pavement Layers: Principles of gradation/proportioning of soil-aggregate mixes and compaction; Design factors, mix design, construction control and quality control checks for mechanical, soil-cement, soil-bitumen and soil-lime stabilization methods. Use of additives, Numerical problems on mix design and applications.

UNIT – IV

Pavement Evaluation - Pavement Distress - Functional and structural condition of pavements, Pavement distress survey, Functional condition evaluation of pavements- Roughness, Skid

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resistance. Structural evaluation of pavements - nondestructive testing, Benkelman beam and Falling Weight Deflectometer, Pavement strengthening based on deflection as per IRC, Maintenance and rehabilitation techniques.

UNIT – V

Pavement Management Systems - Pavement Management Systems Components, structure, data requirements, Project level and Network level needs, Pavement performance prediction – concepts, modelling techniques– AASTHO, CRRI and HDM models, Budget forecasting for maintenance and rehabilitation, Ranking and optimization methodologies, lifecycle costing.

Suggested Reading:

1 Peurifoy, R.L., and Clifford,J.S "*Construction Planning Equipment and Method*"- McGraw Hill Book Co. Inc
2 Sharma S.C., "*Construction Equipment and its Management*"- Khanna Publishers .
3 MoRTH "*Specifications for Roads and Bridge Works*"- 2001,IV revision, Indian Roads Congress
4 MoRTH "*Manual for Construction and Supervision of Bituminous Works*"- 2001, Indian Roads Congress
5 MoRTH "*Manual for Maintenance of Roads*"- 1989, Indian Roads Congress

References/Additional Resources:

1 "*Hand Book on Cement Concrete Roads*", Cement Manufacturers Association, New -Delhi

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ENVIRONMENTAL IMPACT ASSESSMENT FOR CIVIL ENGINEERING PROJECTS

PE 515 CE

Instruction: 3 periods per week
CIE: 30 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 marks

Objectives:

1. To impart knowledge on different concepts of Environmental Impact Assessment.
2. To know procedures of risk assessment
3. To learn the EIA methodologies and the criterion for selection of EIA methods.
4. To pre-requisites for ISO 14001 certification
5. To know the procedures for environmental clearances and audit & appreciate the importance of stakeholder participation in EIA

Outcomes:

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

1. Prepare EMP, EIS, and EIA report
2. Identify the risks and impacts of a project
3. Selection of an appropriate EIA methodology
4. Estimate the cost benefit ratio of a project
5. Know the role of stakeholder and public hearing in the preparation of EIA

UNIT – I

Basic concept of EIA: Elements of EIA-factors affecting EIA-Initial Environmental Examination-life cycle analysis preparation of Environmental Base map-Classification of environmental parameters – role of stakeholders in the EIA preparation –stages in EIA.

UNIT – II

EIA Methodologies: Introduction, Criteria for the selection of EIA Methodology, E I A methods, Ad-hoc methods, matrix methods, Network method Environmental Media Quality Index method, overlay methods, cost/benefit Analysis – EIS and EMP.

UNIT – III

Impact of Developmental Activities and Land use: Introduction and Methodology for the assessment of soil and ground water, Delineation of study area, Identification of actives-application of remote sensing and GIS for EIA. Impact prediction, Assessment of Impact significance, Identification and Incorporation of mitigation measures – E I A with reference to surface water, Air and Biological environment: Methodology for the assessment of Impacts on surface water environment, Generalized approach for assessment of Air pollution Impact.

UNIT – IV

Environmental Audit & Environmental legislation, objectives of Environmental Audit, Types of environmental Audit, Audit protocol, stages of Environmental Audit, onsite activities, evaluation of Audit data and preparation of Audit report, Post Audit activities. The Environmental Protection Act, The water Act, The Air (Prevention & Control of pollution Act.), Motor Act, Wild life Act. Case studies and preparation of Environmental Impact assessment statement for various Civil Engineering Projects.

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UNIT – V

Provisions in the EIA notification, procedure for environmental clearance, procedure for conducting environmental impact assessment report- evaluation of EIA report. Environmental legislation objectives, evaluation of Audit data and preparation of Audit report. Post Audit activities, Concept of ISO and ISO 14000. Case studies and preparation of Environmental Impact assessment statement for various Industries.

Suggested Reading:

1. *Environmental Impact Assessment Methodologies*, by Y. Anjaneyulu, B.S. Publication, Sultan Bazar, Hyderabad. 2011
2. *Environmental Impact Assessment: Theory and Practice,* by M. Anji Reddy, Butterworth-Heinemann, 2017
3. *Environmental Pollution and Control*, by H.S. Bhatia – Galgotia Publication (P) Ltd., Delhi.
4. *Environmental Science and Engineering*, by Suresh K. Dhaneja – S.K. Katania & Sons Publication, New Delhi.
5. *Environmental Impact Assessment*, Canter Larry W., McGraw-Hill education Edi (1996)

References/Additional Resources:

1 *Environmental Science and Engineering,* by J. Glynn and Gary W. Hein Ke – Prentice Hall Publishers.

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INSTRUMENTATION AND SENSOR TECHNOLOGIES FOR CIVIL ENGINEERING APPLICATIONS

PE 516 CE

Instruction: 3 periods per week
CIE: 30 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 marks

Objectives:

1. Understand measurement units, types of measurement and errors in measurement
2. Evaluate electrical variables, converse various measurements
3. Understand various types of sensors and understand sensors used for temperature measurement

Outcomes:

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

1. Able to measure the errors in instruments
2. Apply the knowledge of electrical instruments for measurement
3. Apply various sensors used in Temperature measurement,
4. Apply pressure measurement
5. Apply flow measurement and its level measurement

UNIT – I

Introduction to measurement, instrument types: Introduction, Measurement units, Review of instrument types, Static characteristics of instruments, dynamic characteristics of instruments
Measurement errors Introduction, Gross and systematic errors, absolute errors and relative errors, accuracy precision, resolution and significant figures, measurement error combinations

UNIT – II

Electrical indicating and test instruments: Introduction, Digital Meters, Analog Meters, Cathode ray oscilloscope, Digital storage oscilloscope
Variable conversion elements: Introduction, Bridge circuits, Resistance Measurement, Inductance measurement, capacitance measurement, current measurement, frequency measurement, phase measurement

UNIT – III

Sensor technologies: Introduction, Types of Sensors, Piezo electric Transducers, Ultrasonic Transducers
Temperature measurement: Introduction, Principles of Temperature measurement, Thermoelectric effect sensors, Varying resistance devices, semiconductor devices, Radiation thermometers, thermography, Thermal expansion methods, Intelligent temperature measuring instruments

UNIT – IV

Pressure measurement: Introduction, Diaphragms, Capacitive Pressure sensor, Fibre-Optic Pressure sensor, Bellows, Bourbon tube, Manometers, Resonant Wide devices, Dead-weight gauge, Special measurement devices for low pressures, high-pressure measurement, Intelligent pressure transducers

UNIT – V

Flow measurement & level measurement: Introduction, Mass flow rate, Volume flow rate, Intelligent flow meters, Introduction to level measurement, Dipsticks, float systems, ultrasonic level gauge, radar methods, radiation methods, intelligent level measuring systems

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Suggested Reading:

1 Bell D. A., *Electronic Instrumentation and Measurements*, Oxford, LN, UK, 2007.
2 Morris A. S. *Measurement and Instrumentation Principles*, Butterworth Hienemann,LN, UK, 2001.
3 Tumanski S. *Principle of Electrical Measurement*, Taylor & Francis, LN, UK, 2006.
4 Gertsbakh I. *Measurement Theory for Engineers*, Springer, BL, Germany, 2010

References/Additional Resources:

1 https://www.sensy.com/en/blog/instrumentation-for-civil-engineeringapplications b38
2 https://www.iitk.ac.in/nicee/wcee/article/13_1791.pdf

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PROFESSIONAL ELECTIVES - 5

STRUCTURAL ENGINEERING DESIGN & DETAILING

PE 517 CE

Instruction: 3+1 periods per week
CIE: 30 marks
Credits : 3

Duration of SEE: 3 hours
SEE: 70 marks

Objectives:

1. To understand and designing of Soil Retaining structures
2. To familiarize with the types, suitability, selection, design criteria of various types of RCC& Steel bridges
3. To understand the design of welded plate girder and gantry girders

Outcomes:

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

1. Analyse and design the RCC Deck slab bridge.
2. Analyse and design of R.C.C Tee beam bridge.
3. Design of welded plate girder
4. Analyze and design Plate girder steel bridge.
5. Analyze and design Bearings of steel bridge.

UNIT – I

Design of RCC Slab Bridges: IRC loadings, Elastic Design and Detailing of RC bridge deck slab using effective width methods.

UNIT – II

Design of RCC T Beam Bridges:. Use of Pigaud"s curves for the design of slab. Design and detailing of Cross beams and Tee Beam of a Tee beam bridge.

UNIT – III

Plate Girder: Limit State Design of welded plate girder for static loads – including flange curtailment, connections, Intermediate and bearing stiffeners, web and flange splice.

UNIT – IV

Steel Bridges: Deck and through type bridges - Economical span – Indian standard Railway broad gauge train loadings - permissible stresses – Detailed design and drawing of plate girder

UNIT – V

Bearings: Introduction to bridge bearings, Types of bearings – Rocker and Roller – Elastic Design of bearings for bridge

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Suggested Reading:

1 David Darwin, Charles W. Dolan, Arthur H. Nilson, "Design of Concrete Structures" , 15th Edition, McGraw Hill, 2016.

2 Krishna Raju, N., "Structural Design and Drawing: Reinforced Concrete", Universities Press,1992- 2009.

3 Bhavikatti, S.S., "Design of Steel Structures", I.K. International Publishing House, Pvt. Ltd., 2010

4 Shiyekar, M.R. "Limit State Design of Structural Steel",PHI publishers, third edition, 2017

5 Duggal, S. K., "Limit State Design of Steel Structures", Tata McGraw-Hill Publications, 2009

References/Additional Resources:

1 Johnson Victor, D., "*Essentials of Bridge Engineering*", Oxford & IBH Publishing Co., New Delhi, Fourth Edition, 1991

2. Subramanian, N, "*Limit State Design of Steel Structures*", Oxford University Press, 2008

Relevant IS Codes:

1. IS: 456-2000, "Code of Practice for Plain and Reinforced concrete", Bureau of Indian Standards, New Delhi, India.
2. IS- 800-2007 " General Construction in steel - Code of Practice" Bureau of Indian Standards. ,New Delhi, India
3. IRC:6 -2000 "Standard specification and code of practice for Road Bridges" Section II Load and Stresses. The Indian Road Congress.
4. Bridge Rule : Third Reprint 2014- Ministry of Railways. Govt. of India

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INTELLIGENT TRANSPORTATION SYSTEMS

PE 518 CE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

The objectives of this course is to impart knowledge of
1.To introduce the concept of intelligent transportation systems.
2.To understand the functional area of ITS.
3.To study the ITS architecture and its applications.

Outcomes:

After completing this course, the student will be able to:
1.Plan and specification requirements using ITS
2.Plan and management aspects for ITS
3.Prepare architecture and application for ITS
4. Illustrate the functional areas of ITS and their user needs and services.
5. Explain the overview of ITS in highway incident management systems.

UNIT – I

Introduction to Intelligent Transportation Systems (ITS) – Definition of ITS and Identification of ITS Objectives, Historical Background, Benefits of ITS - ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

UNIT – II

Telecommunications in ITS – Importance of telecommunications in the ITS system, Information Management, Traffic Management Centres (TMC). Vehicle – Road side communication – Vehicle Positioning System.

UNIT – III

ITS functional areas – Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS).

UNIT – IV

ITS User Needs and Services – Travel and Traffic management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle safety systems, Information Management.

UNIT – V

Automated Highway Systems - Vehicles in Platoons – Integration of Automated Highway Systems. ITS Programs in the World – Overview of ITS implementations in developed countries, ITS in developing countries. Traffic and incident management systems – ITS and sustainable mobility, travel demand management, electronic toll collection.

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Suggested Reading:

1. ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chan, Adda Wins.
2. Bretman, J. M., Perspectives on ITS, Artech House Publishers, 2000
3. Joseph, S.S. (2009), "Perspectives on Intelligent Transportation Systems" Springer publishers, USA.
4. Chowdhury, M. A., Sadek, A. and Sinnan, M.A. (2003), "Fundamentals of Intelligent Transportation Systems Planning" Artech House, USA.

Reference/additional Resources:

National ITS Architecture Documentation, US Department of Transportation, 2007 (CD-ROM)

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WATER AND AIR QUALITY MODELLING

PE 519 CE

Instruction: 3 periods per week
CIE: 30 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 marks

Objectives:

After completing the course, the students will be knowing

1. The modeling concept of air and water quality
2. Applicability in the Control of Air and Water pollution

Outcomes:

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

1. Describe the modeling concepts.
2. Will be able to understand the importance of Diagnostic Models.
3. The students will learn the mass balance equation and knowing the water quality models.
4. The ability to apply the linear programming models and experimental design.
5. Will get an insight on air quality model softwares.

UNIT – I

Modeling Concepts: Casual and statistical models-characteristics-steps in model development-importance of model building conservation of mass and mass balance-calibration and verification of models.

UNIT – II

Air Quality Modelling

Modelling for nonreactive pollutants, single source, short term impact, multiple sources and area sources, Metrological Modelling – Diagnostic Models -Prognostic Models – diffusion models, modifications of Gaussian plume equation -long term average- receptor oriented and source oriented air pollution models ,Numerical Models, model performance, accuracy and utilization.

UNIT – III

Water Quality Models

Mass balance equation -Mathematics of Pollutant Transport – Advection- dispersion-In-Water Transformation- Waste load allocations – Basic mechanisms of river self-purification, Dissolved Oxygen dynamics Streeter-Phelps and Dobbins models, Pollutant and nutrient dynamics, Temperature dependence and transport, Dissolved oxygen in Rivers and estuaries; Lake Water Quality Models; Models for Nitrogen, Bacteria, Phosphate and toxicants – Ground Water Quality Modelling – Contaminant solute transport equation, Numerical methods.

UNIT – IV

Computer Based Simulation

Formulation of linear optimization models. Linear programming. Sensitivity testing and duality. Solutions techniques and computer programming, Formulation of linear optimization models. Finite difference finite element method of pollutant dispersion- Optimization river pollutant and management models finite element method of pollutant dispersion-optimization river pollutant and management models-Application of models- simulation, parameters estimation of experiment design. Model uncertainty reliability.

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UNIT – V

Air and Water Quality Modeling Soft wares:

Air quality Model -ARMOD, CALPUFF. – UNAMAP- BLP-RAM-ISCMPTER-CRSTER-
Surface water quality models -HSPF, QUAL2K,.

Suggested Reading:

1 Deaton, M.L and Winebrake, J.J., Dynamic Modelling of Environmental Systems, Verlag, 2000.

2 Chapra, S.C. Surface Water-Quality Modelling, McGraw-Hill, 2008.

3 Arthur C. Stern., Air Pollution (Third Ed.) Volume I – Air Pollutants, their transformation and Transport, (Ed.), Academic Press, 2006.

4 Wainwright, J and Mulligan, M., Environmental Modelling Finding simplicity in complexity, John Wiley and Sons Inc., New York, 2013

5 Dykes, A.P., Mulligan, M., and Wainwright, J, Monitoring and Modelling dynamic environment, Wiley – Blackwell 2015.

References/Additional Resources:

1. Paolo Zanetti, Air Pollution Modelling – Theories, computation Methods and available Software Springer. New York, 1990

2. Benedini G. Tsakiris Water Quality Modelling for Rivers and streams Springer , New York , 2013

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For the academic years 2020-2024 *with effect from AY 2023-2024*

GREEN BUILDING TECHNOLOGIES

PE 520 CE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

1. To impart knowledge of the principles behind the green building technologies
2. To know the importance of sustainable use of natural resources and energy.
3. To understand the principles of effective energy and resources management in buildings
4. To bring awareness of the basic criteria in the green building rating systems
5. To understand the methodologies to reduce, recycle and reuse towards sustainability.

Outcomes:

After completing this course, the student will be able to

1. Define a green building, along with its features, benefits and rating systems
2. Describe the criteria used for site selection and water efficiency methods
3. Explain the energy efficiency terms and methods used in green building practices
4. Select materials for sustainable built environment & adopt waste management methods
5. Describe the methods used to maintain indoor environmental quality

UNIT-I

***Introduction to Green Buildings*:** Definition of green buildings and sustainable development, typical features of green buildings, benefits of green buildings towards sustainable development. Green building rating systems – GRIHA, IGBC and LEED, overview of the criteria as per these rating systems.

UNIT- II

***Site selection and planning*:** Criteria for site selection, preservation of landscape, soil erosion control, minimizing urban heat island effect, maximize comfort by proper orientation of building facades, day lighting, ventilation, etc.

Water conservation and efficiency: Rainwater harvesting methods for roof & non-roof, reducing landscape water demand by proper irrigation systems, water efficient plumbing systems, water metering, waste water treatment, recycle and reuse systems.

UNIT-III

Energy Efficiency: Environmental impact of building constructions, Concepts of embodied energy, operational energy and life cycle energy.

Methods to reduce operational energy: Energy efficient building envelopes, efficient lighting technologies, energy efficient appliances for heating and air-conditioning systems in buildings, zero ozone depleting potential (ODP) materials, wind and solar energy harvesting, energy metering and monitoring, concept of net zero buildings.

UNIT-IV

Building materials: Methods to reduce embodied energy in building materials: (a) Use of local building materials (b) Use of natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks, (c) use of materials with recycled content such as blended cements, pozzolona cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. (d) reuse of waste and salvaged materials

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Waste Management: Handling of construction waste materials, separation of household waste, on-site and off-site organic waste management

UNIT-V

Indoor Environmental Quality for Occupant Comfort and Well being: Daylighting, air ventilation, exhaust systems, low VOC paints, materials & adhesives, building acoustics. Codes related to green buildings: NBC, ECBC, ASHRAE, UPC etc.

Suggested Readings:

1. *IGBC Green Homes Rating System*, Version 2.0., Abridged reference guide, 2013, Indian Green Building Council Publishers
2. GRIHA version 2015, GRIHA rating system, *Green Rating for Integrated Habitat Assessment*
3. „*Alternative building materials and technologies*" by K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao.
4. „*Non-Conventional Energy Resources*" by G. D. Rai, Khanna Publishers.
5. *Sustainable Building Design Manual*, Vol.1 and 2, TERI, New Delhi 2004

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For the academic years 2020-2024 *with effect from AY 2023-2024*

PROFESSIONAL ELECTIVES - 6

FINITE ELEMENT METHOD

PE 521 CE

Instruction: 3 periods per week
CIE: 30 marks
Credits: 3

Duration of SEE: 3 hours
SEE: 70 marks

Course Objectives

The objectives of this course is to impart knowledge of:

1. To introduce the transition from 2D to 3D structural problems (linear and non-linear).
2. Analysis of all kind of loads and their respective effects.
3. To introduce a high-end computer oriented numerical analysis tool.

Course Outcomes

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

1. Define the behavior of structural elements (2D and3D).
2. Analyse and evaluate structural frames through stiffness matrices.
3. Analyse the Stiffness matrix for 3 noded & 4 noded elements
4. Evaluate the problems in numerical solution, integration jacobian.
5. Model structures using FEM based software"s such as ANSYS, ABAQUS, MSC NASTRAN etc

UNIT - I

***Introduction to Finite Element Method*:** Variational approach, Rayleigh-Ritz and Galerkin"s methods. Stiffness matrix for two noded bar, truss, and beam elements, problems with three degrees of freedom.

UNIT – II

***Stiffness Matrix*:** Two noded beam element with three degrees of freedom per node. Transformation, generation of stiffness matrix for frames. Strain-displacement and stress – strain relationship in an elastic continuum (linear problems). Equations of equilibrium, and boundary conditions. Plane stress and plane strain problems.

UNIT – III

***Formulation of Finite Element Method*:** Using principle of virtual displacement. Determination of stiffness matrix for three noded triangular element (constant strain triangle), and four noded rectangular element for plane stress and plane strain problems. Convergence criteria for selection of displacement models. Discretisation of continuum. Assembly of global stiffness and load matrices. Displacement boundary conditions.

UNIT – IV

***Isoparametric Finite Elements*:** Direct construction of shape functions for higher order elements using natural co-ordinate system. Shape functions for eight noded parabolic curved iso-parametric element. Determination of element stiffness matrix for four noded quadrilateral element. Use of Jacobian, and Gauss quadrature techniques. Load matrix for eight noded rectangular isoparametric element (for body forces and surface traction).

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UNIT – V

***Strain Displacement*:** Stress – strain relation for axisymmetric problems. Stiffness matrix for three noded ring element. Volume co-ordinates and stiffness matrix for four noded tetrahedron element. Exposure to FEM based softwares.

Suggested Readings:

1. O.C. Zienkiewicz and R.L. Taylor, *The Finite Element Method*, Vol. I, McGraw Hill,1989.
2. K.J. Bathe, *Finite Element Procedures*, Pearson Education,2006.
3. S. M. Jalaludeen, *Finite Element Analysis*, Anuradha Publications,2016.
4. T.R. Chandrupatla, *Finite Element Analysis for Engineering and Technology*, Universities Press, 2004.
5. C.S.Krishnamoorthy, *Finite Element Analysis, Tata Mcgraw Hill publishing Company.2014*

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For the academic years 2020-2024 *with effect from AY 2023-2024*

URBAN TRANSPORTATION PLANNING

PE 522 CE

Instruction: 3 periods per week *Duration of SEE: 3 hours*
CIE: 30 marks *SEE: 70 marks*
Credits: 3

Objectives:

The objectives of this course is to impart knowledge of

1. To discuss various urban transportation systems planning process and its components
2. To understand a variety of travel surveys and data collection procedures
3. To review different travel demand forecasting models

Outcomes:

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

1. Describe and evaluate various urban transportation issues and planning methodologies
2. Identify the appropriate data collection methods and its procedures
3. Demonstrate effective way of understanding trip distribution and mode split models
4. Explain various issues related to trip assignment and land use transportation models
5. Apply Route Assignment Techniques

UNIT – I

Introduction: Transport and socioeconomic activities - Historical Development of Transport - Role of transportation in the economic development of nations, overview of transport modes, growth trends - Fundamentals of transportation , Principles of planning, evaluation, selection, adoption, financing, and implementation of alternative urban transportation systems - Emerging future trends in Transportation Systems.

UNIT – II

Data Collection and Travel Surveys; Collection of data - design of survey format - organization of surveys and analysis - study area definition, zoning system, types and sources of data, road side interview method, home interview survey, in-vehicle surveys, sampling, types, various techniques, expansion factors, logical checks, use of secondary sources of data, planning variables, vehicles ownership, projection of data and statistical techniques.

UNIT – III

Travel Demand Forecasting; Various trends, overall planning process, short and long term planning, travel attributes, traffic analysis zones, trip generation, category analysis, concept of gravity model, trip distribution, model split and trip assignment and land use transportation interaction.

UNIT – IV

***Trip Distribution*:** Gravity Model of Trip Distribution - Calibration of Gravity Model - Growth Factor method, - Uniform factor method - average factor method - time series models - aggregate and disaggregate models.

Mode Split Analysis: Influencing Factors - Earlier Modal Split Models, Trip-End Type Modal Split Model, Trip-Interchange Modal Split Model - Disaggregate Mode-Choice Model, Logit Model of Mode Choice - Binary Choice Situations - Multinomial Logit Model - Model calibration.

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UNIT – V

Route Assignment: Description of transport network, Route Choice Behavior, The Minimum Path, Minimum Path Algorithm, Route Assignment Techniques, All-or-Nothing Assignment, Multipath Traffic Assignment, Capacity-Restrained Traffic Assignment.

Suggested Reading:

1 Hutchinson, E.G., *Principles of Urban Transport Systems Planning*, McGraw Hill, New York,1974.
2 Kadiyali, L. R. "*Traffic Engineering and Transport Planning, 2003.*"
3 John W.Dickey.(1975). *Metropolitan Transportation Planning*. Mc Graw Hill Book Company, New York.
4 Ortuzar, J. and Williamson, E.G., *Modelling Transport*, Wiley, Chinchestor,1994.
5 Oppenheim, N., *Urban Travel Demand Modelling: From Individual Choices to General Equilibrium*, Wiley, New York,1995.

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SURFACE HYDROLOGY

PE 523 CE
Instruction: 3periods per week
CIE: 30 marks
Credits :3

Duration of SEE: 3 hours
SEE: 70 marks

Objectives:

1. Understand theoretical concepts of water and sediment movements in rivers
2. Understand the hydrologic extremes of floods and the mitigation measures to combat them.
3. Understand the concepts of Statistical methods and its applications in Engineering.
4. Understand the concepts of urbanization and its impact on the natural water cycle

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

1. Able to apply the knowledge of soil erosion and sedimentation to estimate the life of the reservoir
2. Develop the flood inundation modeling and suggest suitable flood control measures.
3. Able to estimate the various losses of precipitation, stream flow and runoff.
4. Development of Rainfall-Runoff relationship
5. Able to understand the planning and operation of Urban water management.

UNIT – I

Formation of surface water Resources-Streams, rivers, lakes, swamps, caves, seas and oceans: Definition of river, river basins and water divides, formation of river valleys, fluvial deposits, alluvial fans, meandering of rivers, formation of different types of lakes, deltas and valleys.

Sediment discharge, Sediment transport, Sediment yield of watersheds, suspended load and bed load measurements, reservoir sedimentation-sediment movement and deposition, reduction in reservoir capacity, reservoir sedimentation control.

UNIT – II

Flood Routing- Introduction, basic equation, Hydrologic storage routing, attenuation, Hydrologic channel routing, Hydraulic methods of flood routing.
Flood Control- Structural and non-structural methods, flood control in India, national and state bodies involved for mitigation and management of floods as a natural disaster.

UNIT – III

Stream flow Measurement – Stage and Velocity Measurement – Gauges – Current meter and Doppler flow velocity meter - Discharge measurement – direct methods (Area-Velocity method, Dilution techniques, electromagnetic method, ultrasonic method), indirect methods (Slope-area method, discharge measuring Structures(weirs, flumes and gated structures),Stage-Discharge relationship , Selection of a Stream Gauging Site.

UNIT – IV

Statistics in Hydrology- Introduction, Statistical parameters, central tendency parameters, dispersion characteristics, skewness, probability distribution, discrete and continuous distribution, frequency

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analysis, log Pearson type III distribution, regression and correlation, standard forms of bivariate equations, multivariate linear regression and correlation, analysis of time series, selection of a design return period, determination of permissible risk.

UNIT – V

Urban Water Management- urban hydrology, major issues in urban storm water management, objectives and limitations, airport drainage design, urban water resource management models, urban storm water management practices, rainwater harvesting.

Suggested Reading:

1. Chow V.T., Maidment D.R., Mays L.W., "*Applied Hydrology*", McGraw Hill Publications, NewYork, 1995.
2. Subramanya K., "*Hydrology,Tata McGraw Hill Co.*, New Delhi, 1994.
3. Patra.K.C, "*Hydrology and Water Resources Engineering*",Narosa Publications, 2008, 2nd Edition, New Delhi.
4. Jay Rami Reddy.P, "*Hydrology*", Laximi Publications, New Delhi, 2004
5. Raghunath H.M., "*Hydrology*", New Age International Publishers, New Delhi, 2014.

References/Additional Resources:

1. Martin, P. Wanelista and Yousef, A. Yousef., *Storm Water Management*, John Wiley and sons,1993
2. Jay L.Devore, "*Probability and statistics for Engineering and the Sciences*", 5th Edition, Thomson and Duxbury, Singapore, 2002

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For the academic years 2020-2024 *with effect from AY 2023-2024*

GIS AND REMOTE SENSING

PE 524 CE

Instruction: 3 periods per week
CIE: 30 marks
Credits : 3

Duration of SEE: 3 hours
SEE: 70 marks

Course Objectives: The objectives of the course is to provide
1.Basic concept of Remote Sensing and know about different types of satellite and sensors
2.Comprehend concepts of GIS and its applications
3.Knowledge of GIS software and able to work with GIS software in various application fields

Course Outcomes:
After completing this course, the student will be able to:
1.Explain the basics of Remote Sensing, different types of satellite and sensors
2.Define the principles of satellite remote sensing, able to comprehend the energy interactions with earth surface features, spectral properties of water bodies
3.Demonstratethe basic concept of GIS and its applications, know different types of data representation in GIS
4.Create the spatial data using various techniques
5. Develop models using spatial & Terrain Analysis

UNIT – I
Basics of Remote Sensing: Definition, History, Advantages, Aerial Photography and Satellite Remote Sensing, Components of Remote Sensing System: Energy Source, Energy-Atmosphere Interaction, Energy Interaction with Atmosphere and Surface Materials, Spectral Signatures

UNIT – II
Remote Sensing Platforms: Aircrafts and Satellites, Orbital Characteristics of Sun-synchronous and Geostationary satellites - Special Purpose Satellites; Remote Sensing Sensors: Types of Sensors, Active and Passive; Framing Systems (Cameras) - Scanning System; Sensor Characteristics: Spatial Resolution, Spectral Resolution, Radiometric Resolution, Temporal Resolution.

UNIT – III
Introduction to GIS: History of development of GIS- GeoSpatialData - GIS operations- Standard GIS packages, Applications of GIS;
Datum and Map Projections: Concept of Datum, Coordinate Systems and Map Projections , Transformations

UNIT – IV
Data Models: Spatial and Non-Spatial Data models; Spatial Digital formats
Spatial Data Creation: Scanners, digitizers; Digital Elevation Models; Sources of Errors & Corrections- Rotation and Resampling methods, Morphometric analysis-Triangular Irregular Network (TIN).

UNIT – V
Spatial Data Analysis: Raster data analysis; Vector data analysis - Buffering, Overlay, Union, Intersect, Merging, splitting operations
Terrain Modelling & Analysis: Contouring, Vertical profiling, Hill shading, 3D perspectives; Slope & Aspect analysis, Viewshed & watershed analysis.
Softwares: Introduction to QGIS or ARCGIS software and its interface to perform spatial analysis

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Suggested Reading:

1 Chang, K. T. (2016). Geographic information system. *International Encyclopedia of Geography: People, the Earth, Environment and Technology*, 1-10.

2 Lillesand, T., Kiefer, R. W., & Chipman, J. (2015). *Remote sensing and image interpretation*. John Wiley & Sons.

3 Reddy, M. A., & Reddy, A. (2008). *Textbook of remote sensing and geographical information systems* (pp. 4-4). Hyderabad: BS publications.

4. Burrough, P. A., and McDonnell R. A. *Principles of Geographical Information Systems*. Oxford University Press, New York, Pp.333. 1998

5. Lilysand T.M., and Kiefer R.W. *Remote Sensing and Image Interpretation*. John Wiley and Sons, Fourth Edition, New York, Pp.724. 2002

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For the academic years 2020-2024 *with effect from AY 2023-2024*

OPEN ELECTIVES - 2

OE 705 CE

PRINCIPLES OF GREEN BUILDINGS

Instruction: 3 periods per week
CIE: 30 marks
Credits : 3

Duration of SEE: 3 hours
SEE: 70 marks

Objectives:

1. To impart knowledge of the principles behind the green building technologies
2. To know the importance of sustainable use of natural resources and energy.
3. To understand the principles of effective energy and resources management in buildings
4. To bring awareness of the basic criteria in the green building rating systems
5. To understand the methodologies to reduce, recycle and reuse towards sustainability.

Outcomes:

After completing this course, the student will be able to

1. Define a green building, along with its features, benefits and rating systems
2. Describe the criteria used for site selection and water efficiency methods
3. Explain the energy efficiency terms and methods used in green building practices
4. Select materials for sustainable built environment & adopt waste management methods
5. Describe the methods used to maintain indoor environmental quality.

UNIT-I

***Introduction to Green Buildings*:** Definition of green buildings and sustainable development, typical features of green buildings, benefits of green buildings towards sustainable development. Green building rating systems – GRIHA, IGBC and LEED, overview of the criteria as per these rating systems.

UNIT- II

***Site selection and planning*:** Criteria for site selection, preservation of landscape, soil erosion control, minimizing urban heat island effect.

Water conservation and efficiency: Rainwater harvesting methods for roof & non-roof, reducing landscape water demand by proper irrigation systems, water efficient plumbing systems, water metering, waste water treatment, recycle and reuse systems.

UNIT-III

Energy Efficiency: Environmental impact of building constructions, Concepts of embodied energy.

Methods to reduce operational energy: Energy efficient building envelopes, efficient lighting technologies, energy efficient appliances for heating and air-conditioning systems in buildings, wind and solar energy harvesting, energy metering and monitoring, concept of net zero buildings.

UNIT-IV

Building materials: Methods to reduce embodied energy in building materials: (a) Use of local building materials (b) Use of natural and renewable materials like bamboo, timber, rammed earth, stabilized mud blocks, (c) use of materials with recycled content (d) reuse of waste and salvaged materials

Waste Management: Handling of construction waste materials, separation of household waste, on-site and off-site organic waste management

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UNIT-V

Indoor Environmental Quality for Occupant Comfort and Well being: Daylighting, air ventilation, exhaust systems, low VOC paints, materials & adhesives, building acoustics. Codes related to green buildings: NBC, ECBC, ASHRAE, UPC etc.

Suggested Readings:

1. *IGBC Green Homes Rating System, Version 2.0.*, Abridged reference guide, 2013, Indian Green Building Council Publishers
2. GRIHA version 2015, GRIHA rating system, *Green Rating for Integrated Habitat Assessment*
3. „*Alternative building materials and technologies*" by K.S. Jagadish, B.V. Venkatarama Reddy and K.S. Nanjunda Rao.
4. „*Non-Conventional Energy Resources*" by G. D. Rai, Khanna Publishers.
5. *Sustainable Building Design Manual, Vol.1 and 2*, TERI, New Delhi 2004

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