NITTE (Deemed to be University) | NMAM INSTITUTE OF TECHNOLOGY

Scheme & Syllabus for

B.Tech Minor in

Climate, Health and Environmental Sustainability

DEPARTMENT OF CIVIL ENGINEERING

2023-24

DEPARTMENT OF CIVIL ENGINEERING

Vision

To uphold the Department as a leader in community development through innovation and excellence in diverse areas of Civil Engineering to meet the global challenges and market demands.

Mission

1. To provide the students a strong theoretical knowledge and practical skills to understand the basic concept and fundamentals of various Civil Engineering subjects.
2. To be competent and skilled enough to take the challenges in Research, Consultancy and Entrepreneurship.
3. To encourage the students in developing professional ethics through discipline and principles.

Programme Educational Objectives (PEOs)

The graduates of the program will be

PEO1	Equipped with fundamentals of civil engineering along with interdisciplinary science, engineering and management concepts.
PEO2	Equipped with advanced and emerging field of civil engineering practices to compete and match with the industrial requirements.
PEO3	Competent enough to conceive the ideas, prepare plan, design, execute, monitor and manage the project with the effective utilization of resources such as men, material, machine and money along with time effectively.
PEO4	Continue to learn and adapt to suit the needs and challenges of real-world problems and come up with optimal solutions.

Programme Outcomes (POs)

PO1	**Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**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.

PO3	**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.
PO4	**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.
PO5	**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.
PO6	**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.
PO7	**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.
PO8	**Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**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.
PO11	**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.
PO12	**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 Outcomes (PSOs)

PSO1	Ability to apply the knowledge of Civil Engineering domains, conduct experiments, analyze, interpret data and design the system components.

PSO2	Enrich the knowledge in Structural, Geo technical, Transportation, Environmental Engineering, Water Resources, Infrastructure and Development, Surveying and Geo-informatics by means of innovative practices.
PSO3	Competency to plan, produce detailed drawings, write specification, prepare cost estimates, selection of materials, schedule work plans, execute and value real properties.

B.Tech Minor in

Climate, Health and Environmental Sustainability

Scheme of Teaching and Examinations 2023-27

Outcome Based Education (OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2023 - 24)

Sl. No	Course Type	Course Code	Course Title	Teaching Department	Teaching Hours /Week				Examination				Credits
					Lecture	Tutorial	Practical/ Drawing	PBL	Duration in hours	CIE Marks	SEE Marks	Total	
					L	T	P	J					
1	PCC	CV1010-1	Sustainable water and Sanitation system	CV	3	0	0	0	3	50	50	100	3
2	PCC	CV1011-1	Environmental Policy and Risk Assessment	CV	3	0	0	0	3	50	50	100	3
3	PCC	CV1012-1	Lifecycle Assessment	CV	3	0	0	0	3	50	50	100	3
4	PCC	CV2110-1	Environmental Data Analysis and Visualization	CV	2	0	2	0	3	50	50	100	3
5	PCC	CV2011-1	Industrial Waste Water Treatment	CV	3	0	0	0	3	50	50	100	3
6	IPCC	CV2012-1	GIS Mapping and Geospatial Analysis	CV	2	0	2	0	3	50	50	100	3
				Total	**16**	**0**	**4**	**-**	**18**	**300**	**300**	**600**	**18**

Sustainable water and Sanitation systems

Course Code:	**CV1010-1**	**Course Type:**	**PCC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**CV1002 -1**		

Teaching Department: Civil Engineering

Course Objectives: This Course will enable students to

1.	Comprehend the importance of sustainable water management in addressing water scarcity challenges.
2.	Possess a comprehensive understanding of water economics, including the concept of water tariff.
3.	Evaluate the reliability and cost-effectiveness of various wastewater treatment systems
4.	Explain the mechanisms underlying these systems, their performance in removing pollutants, and the design considerations that ensure their effectiveness.
5.	Comprehend the principles of wastewater reuse and reclamation, and be able to analyze the technical, economic, and environmental considerations associated with these practices.

UNIT-I

Sustainability in water and waste management — **10 Hours**

Water Conservation, Rainwater Harvesting: Roof water harvesting, technology, quality, health issues, Groundwater recharge, techniques, case studies, Water tariff, sustainable water management.

UNIT-II

Decentralised wastewater treatment systems — **20 Hours**

Reliability and cost effectiveness of wastewater systems, Tertiary treatment, process selection, granular- medium filtration, micro screening, removal of toxic compounds and refractory organics, removal of dissolved inorganic substances, Natural Wastewater Treatment Systems, Natural and constructed wetlands, different types, Mechanisms, performance, design, case studies.

UNIT-III

Land treatment systems — **10Hours**

Wastewater reuse and reclamation. Rural water supply and sanitation, Low-cost sanitation, Dry sanitation methods, Pit latrines, VIP latrines, Aqua privy, septic tank, Soak pit, Dispersion Trenches

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
CV1010.1	2	1	-	-	-	2	2	1	-	-	-	-	2	3	-
CV1010.2	2	2	3	-	-	2	2	1	-	-	-	-	2	3	-
CV1010.3	1	2	1	-	-	2	3	2	-	-	-	-	1	3	-
CV1010.4	1	1	-	-	-	2	3	1	-	-	-	-	1	3	-
CV1010.5	1	2	3	-	-	2	3	2	-	-	-	-	1	3	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Ahluwalia P. and Nema A.K., *Water and Wastewater Systems: Source, Treatment, Conveyance and Disposal*, S. K. Kataria & Sons.

2.	Arceivala S.J. and Asolekar S.R. *Wastewater Treatment for Pollution Control and Reuse*, Tata McGraw Hill.
REFERENCE BOOKS:	
1.	Cites R.W., Middlebrooks E.J. and Reed S.C. *Natural Wastewater Treatment Systems*, CRC Taylor and Francis.
2.	Cairncross S. and Feachem R. *Environmental Health Engineering in the Tropics*, John Wiley & Sons.
3.	Metcalf and Eddy, *Wastewater Engineering- Treatment and Reuse* (Revised by Tchobanoglous, G., Burton, F. L. and Stensel, H. D.), Tata McGraw Hill.

Environmental policy and Risk Management

Course Code:	**CV1011-1**	**Course Type:**	**PCC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**CV1002-1**		

Teaching Department: Civil Engineering

Course Objectives: This Course will enable students to

1.	Describe the environmental legislative process, the jurisdiction of key government agencies involved in environmental health, and important legislation that governs our approach to protecting public and environmental health
2.	Apply knowledge of environmental legislation to case studies to determine jurisdiction and approach
3.	Evaluate current environmental policies and determine whether they are adequate to ensure a sustainable future
4.	Explain the risk assessment process as well as its application in risk management
5.	Develop a quantitative risk assessment framework for environmental hazards

UNIT-I

Introduction to Environmental Policy and Enforcement — **15Hours**

Environmental Policy: Air and Water, Solid and Hazardous Waste, Pesticides and Toxic Substances, Food Safety.

UNIT-II

Risk Assessment and Management — **15Hours**

Introduction and Hazard Characterization, Exposure and Effects Assessments, Risk Characterization, Risk Management.

UNIT-III

Special Topics in Environmental Policy — **10 Hours**

Occupational Safety and Health, Environmental Justice and Ethics, International Environmental Health Programs and Policy

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	2	3
CV1011.1	2	2	-	2	-	2	2	-	-	-	2	2	2	2	-
CV1011.2	2	2	-	2	-	2	2	-	-	-	2	2	2	2	-
CV1011.3	2	2	-	2	-	2	2	-	-	-	2	2	1	2	-
CV1011.4	2	2	-	2	-	2	2	-	-	-	2	2	1	2	-
CV1011.5	2	2	-	2	-	2	2	-	-	-	2	2	1	2	-

1: Low 2: Medium 3: High

TEXTBOOKS:	
1.	Environmental Policy and Public Health, 2nd edition Barry L. Johnson and Maureen Y. Lichtveld, CRC Press, 2017 ISBN 978-1498799393.
2.	"Environmental Policy: New Directions for the Twenty-First Century" by Norman J. Vig and Michael E. Kraft
REFERENCE BOOKS:	
1.	"Risk Management in the Outdoors: A Whole-of-Organisation Approach for Education, Sport and Recreation" by Neil Carr and Brent Moyle.

LIFE-CYCLE ASSESSMENT

Course Code:	**CV1012-1**	**Course Type:**	**PCC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**CV1010-1, CV1011-1**		

Teaching Department: Civil Engineering

Course Objectives: This Course will enable students to

1.	To provide students with an understanding of Life Cycle Assessment tool in sustainable engineering
2.	Explore methods to assess potential environmental impacts based on the LCI data, considering categories such as climate change, resource depletion, toxicity, etc
3.	Gain a foundational understanding of the principles, concepts, and methodologies of Life Cycle Assessment (LCA) as a tool for environment.
4.	Exploration of Advanced LCA Concepts and Applications
5.	Understanding the Significance and Process of Environmental Audits for Industry

UNIT-I

FUNDAMENTALS OF LIFE CYCLE ASSESSMENT **15 Hours**

LCA, LCA Goal and Scope, Life cycle inventory, Life Cycle Impact Assessment, Interpretation and presentation of Results, Iterative Nature of LCA, Methodological Choices, LCI Databases and LCA Softwares, Strength and Limitations of LCA.

UNIT-II

ENVIRONMENTAL LIFE CYCLE COSTING, SOCIAL LIFE CYCLE ASSESSMENT **15 Hours**

Introduction, Environmental Life Cycle Costing, Social Life Cycle Assessment, Life Cycle Sustainability, LCA Applications in Engineering: Environmental Product Declarations and Product Category Rules.

UNIT-III

INTRODUCTION TO ENVIRONMENTAL AUDIT **10 Hours**

Environmental audit Significance for Industry-Elements of Environmental audit. Process of environmental audit-Pre audit- Activity -Activities at site- Post audit

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
CV1012.1	2	1	-	-	-	2	2	1	-	-	-	-	2	2	-
CV1012.2	2	2	2	-	-	2	2	1	-	-	-	-	2	2	-
CV1012.3	1	2	1	-	-	2	2	2	-	-	-	-	1	2	-
CV1012.4	1	1	-	-	-	2	2	1	-	-	-	-	1	2	-
CV1012.5	1	2	2	-	-	2	2	2	-	-	-	-	1	2	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	System Analysis for sustainable Engineering: Theory and applications, Ni bin Chang, McGraw Hill Publications,1stEdn., 2010
2.	Engineering for Sustainable development: Delivery a sustainable development goals, UNESCO, International Centre for Engineering Education, France, 1stEdn., 2021

REFERENCE BOOKS:	
1.	Introduction to Sustainable Engineering, Rag. R.L. and Ramesh Lakshmi Dinachandran, PHI Learning Pvt. Ltd.2nd Edn, 2016
2.	Varma and Agarwal, Theory & practice of Management Forward Book Depot, New Delhi.

ENVIRONMENTAL DATA ANALYSIS AND VISUALIZATION

Course Code:	**CV2110-1**	**Course Type:**	**PCC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**CV1010-1**		

Teaching Department: Civil Engineering

Course Objectives: This Course will enable students to

1.	Collect and pre-process environmental data from various sources, ensuring data quality and
2.	Create informative and visually appealing data visualizations to effectively communicate environmental trends and patterns.
3.	Apply machine learning techniques to gain valuable insights from environmental data, such as identifying correlations, trends, or anomalies.
4.	Develop interactive data dashboards or web-based visualizations for exploring and interacting with environmental datasets.
5.	Ethically present and communicate environmental data and analysis results to diverse audiences, emphasizing the implications and significance of the findings.

UNIT-I

Data Collection and Pre-processing **14 Hours**

Data sources in environmental engineering (sensors, remote sensing, social media, etc.), Data acquisition, cleaning, and quality assessment, Exploratory data analysis techniques, Data visualization principles and tools.

UNIT-II

Machine Learning for Environmental Data Analysis **13 Hours**

Supervised and unsupervised machine learning algorithms, Feature extraction and selection for environmental data, Classification and clustering of environmental data, Model evaluation and validation techniques.

UNIT-III

Environmental Data Visualization and Communication **13 Hours**

Data visualization libraries (e.g., Matplotlib, Seaborn, Tableau), Interactive data visualization tools, Storytelling with data for effective communication, Ethical considerations in presenting environmental data.

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	2	3
CV2110.1	2	2	-	-	-	2	2	1	-	-	-	-	2	2	-
CV2110.2	2	2	2	-	-	2	2	1	-	-	-	-	2	2	-
CV2110.3	1	2	1	-	-	2	2	2	-	-	-	-	1	2	-
CV2110.4	2	1	-	-	-	2	2	1	-	-	-	-	1	2	-
CV2110.5	1	2	2	-	-	2	2	2	-	-	-	-	1	2	-

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	"Data Points: Visualization That Means Something" by Nathan Yau
2.	"Python for Data Analysis" by Wes McKinney

REFERENCE BOOKS:	
1.	"Environmental Data Analysis with MatLab" by William Menke and Joshua Menke
2.	"Fundamentals of Data Visualization" by Claus O. Wilke

INDUSTRIAL WASTE WATER TREATMENT

Course Code:	**CV2111-1**	**Course Type:**	**PCC**
Teaching Hours/Week (L: T: P: S):	**3:0:0:0**	**Credits:**	**03**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**
Prerequisite	**CV1010-1**		

Teaching Department: Civil Engineering

Course Objectives: This Course will enable students to

1.	To understand the effect of industrial effluents on streams.
2.	To explain various primary treatment unit operations.
3.	To explain secondary, tertiary and combined treatment feasibility.
4.	To explain various treatment facilities for the specific industries
5.	To understand the design technique for the industrial wastewater treatment unit

UNIT-I

Introduction	**10 Hours**
Industries and environment, Sources and types of industrial wastewater, Characteristics of Industrial Wastewater and difference with respect to Domestic waste water, Effect on Streams and on Municipal Sewage Treatment Plants. Stream Sampling, Regulatory requirements for treatment of industrial wastewater Stream Quality, Dissolved oxygen Sag Curve in Stream	
Primary treatment of Industrial Wastewater	**05 Hours**
Volume Reduction, Strength Reduction, Neutralization, Equalization and Proportioning	

UNIT-II

Secondary Treatment and Tertiary Treatment:	**10 Hours**
Removal of Inorganic suspended solids, Removal of Organic Solids, Removal of suspended solids and colloids. Treatment and Disposal of Sludge Solids Chemical oxidation, Photocatalysis, Wet Air Oxidation, Membrane Technologies, Nutrient removal	
Combined treatment: Feasibility of combined Treatment of Industrial Raw Waste with Domestic Wastewater, Layout, Discharge of Raw, Partially Treated and completely treated Wastes to Streams.	**05 Hours**

UNIT-III

Treatment of selected industrial waste water	**05 Hours**
Process flow sheet showing origin / sources of wastewater, characteristics of waste, alternative treatment methods, disposal, reuse and recovery along with flow sheet. Effect of waste disposal on water bodies	
The Industries to be covered	**05 Hours**
Tanning Industry, Textile Industry, Distillery Industry, Pulp & Paper Industry, Cement Industry, Dairy Industry	

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→ / ↓ Course Outcomes	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓ 1	PSO↓ 2	PSO↓ 3

CV2111.1	2	1	-	-	-	2	2	1	-	-	-	-	2	3	-
CV2111.2	2	2	3	-	-	2	2	1	-	-	-	-	2	3	-
CV2111.3	1	2	1	-	-	2	3	2	-	-	-	-	1	3	-
CV2111.4	1	1	-	-	-	2	3	1	-	-	-	-	1	3	-
CV2111.5	1	2	3	-	-	2	3	2	-	-	-	-	1	3	2

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Nemerow N.N., "Liquid Waste of industry theories, "Practices and Treatment. Addison Willey New York.
2.	Eckenfelder, "Industrial Water pollution Control"-McGraw hill Company, New Delhi American Chemical Society, Washington D.C. USA 7. Bioremediation books

REFERENCE BOOKS:

1.	Rao MN, and Dutta A.K., "Waste Water Treatment", Oxford & IBH Publishing Co.Pvt Ltd. 2008.
2.	Azad N. S.,–"Industrial Wastewater Management Hand Book" McGraw Hill book Co., Newyork.
3.	Metcalf and Eddy, "Waste Water Treatment, Disposal and Reuse", Tata McGraw Hill Publications, 2003.
4.	Patwardhan A.D., "Industrial Wastewater Treatment", PHI Learning Private Ltd., New Delhi, 2009
5.	Ross R.D. "Industrial Waste Disposal", Reinhold Environmental Series –New York.
6.	Mahajan S.P., "Pollution Control Processes in industries", Tata McGraw Hill Publications, 2004

E Books / MOOCs/ NPTEL

1.	https://nptel.ac.in/courses/105104099/2
2.	https://nptel.ac.in/courses/105104099/4
3.	https://nptel.ac.in/courses/105104099/5
4.	https://nptel.ac.in/courses/105104099/20

GIS Mapping and Geospatial Analysis

Course Code:	**CV2012-1**	**Course Type:**	**IPCC**
Teaching Hours/Week (L: T: P: S):	**2:0:2:0**	**Credits:**	**01**
Total Teaching Hours:	**40**	**CIE + SEE Marks:**	**50+50**

Teaching Department: Civil Engineering

Course Objectives: This Course will enable students to

1.	Explain the basic principles of GIS
2.	Summarize the concepts of Vector and Raster data
3.	Explain the components of GIS
4.	Study the GPS techniques
5.	Explains the concepts of GIS and applications

UNIT-I

Concepts Geographic Information System — 15 Hours

Definition of GIS, history and evolution of GIS, GIS Technology, functions, components, tools, capabilities. Geospatial data, GIS data formats, data storage formats. GIS data acquisition, source – primary and secondary data, generation, display and thematic mapping. GIS software and integration. Real world model, entity and relationships. Applications of GIS.

Concepts of Geodesy, Maps and Transformation

Shape of earth, Georeferencing systems, Continuous and discrete georeferencing. Geodetic datums, representations of earth, coordinate reference systems, GCS and PCS. Map, features of a map, Topographic map, scale of a map. Geometric transformation, map projection and types, projection distortion, preserving map properties, Universal Transverse Mercator (UTM) projection.

UNIT-II

Vector, Raster Data Model and Analysis — 13 Hours

Vector data: Nature and characteristics, data input, map digitizing procedures, topology building, errors, topological and non-topological editing. Vector data analysis, buffering, overlay, distance measurement, vector functions, spatial query, pattern analysis.

Raster data: Nature and elements, types, data structure and compression, quad tree data representation, data input, scanning, map transformations, resampling. Surface representation, DEMs. Raster versus vector. Raster data analysis, map calculator, reclassification, local-neighborhood-zonal analysis, raster functions, terrain analysis, slope direction, hydrological modeling.

UNIT-III

GIS & GPS — 12 Hours

Introduction, basics of GIS- definition of GIS, components of GIS, GIS work flow, representing spatial data, raster and vector data.

Coordinate systems and map projections, datums, spatial data input, Non spatial data Brief introduction to measurements in GIS.

Global Positioning System, The 3 segments of GPS, How GPS Works, Triangulation, Sources of GPS Error, GPS Terminology, Applications

Tutorial component: Creating features in terms of points, line and polygons, feature editing, adding attributes – adding coordinates, length, area calculation, vector functions – Join, splitting, merging, dissolve, clip, difference, spatial query.

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

1.	Explain the concepts of GIS
2.	Interpretation of RASTER and Vector
3.	Explain the components of GIS
4.	Understand the photogrammetric technique
5.	Explain the application of GIS

Course Outcomes Mapping with Program Outcomes & PSO

Program Outcomes→	1	2	3	4	5	6	7	8	9	10	11	12	PSO↓		
↓ Course Outcomes													1	2	3
CV2012.1	2	1	2	1	-	-	-	-	-	-	-	1	1	2	1
CV2012.2	2	1	2	1	-	-	-	-	-	-	-	1	1	2	1
CV2012.3	2	1	2	1	-	-	-	-	-	-	-	1	1	2	1
CV2012.4	2	1	2	1	-	-	-	-	-	-	-	1	1	2	1
CV2012.5	2	1	2	1	2	-	-	-	-	-	-	1	1	2	1

1: Low 2: Medium 3: High

TEXTBOOKS:

1.	Lillesand T.M., and R.W. Kiefer, "Remote sensing and Image interpretation", 4th edition, John Wiley & Sons – 2012.
2.	Christopher Jones "GIS and Computer Cartography"publication Prentice-Hall(2009)
3.	Lilly Sand, "Remote sensing and Image interpretation, John Willey and Sons, New York 1999.
4.	Manoj K. Arora, R.C. Badjatia, " Geomatics Engineering", Nemichand & Bros. Roorkee –2011.

REFERENCE BOOKS:

1.	Chang, "Geographical Information Systems", McGraw Hill Book Co., 2007.
2.	Jensen J.R., "Introductory digital image processing: A remote sensing perspective", 2nd Edition, Prentice Hall – 1996.
3.	T.M Lillesand,. R.W Kiefer,. and J.W Chipman, Remote sensing and Image interpretation , 5th edition, John Wiley and Sons India.
4.	Richards J A., X. Jia, "Remote sensing digital image analysis: an introduction", 3 rd Edition, Springer - 1999.
5	Peter A. Burrough & Rachel A. McDonnel "Principles of geographic information systems"- (1998), Oxford University press, Great Britain.
6	Mather P.M., "Computer processing of remotely sensed images: an introduction", Wiley. – 1988.

E Books / MOOCs/ NPTEL

1.	https://onlinecourses.nptel.ac.in/noc20_de04/preview
2.	https://onlinecourses.nptel.ac.in/noc22_ce26/preview