RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
FACULTY OF SCIENCE &TECHNOLOGY
M. Tech. (Infrastructure Engineering & Technology)
STRUCTURE

Sr No	Name of Course	CODE	Teaching Scheme					Examination Scheme				
			L	T	P	Hours	Credit	Duration of Exam	TI/PI	TU/PU	Total	Min. Passing Marks
	Semester 1											
1	Infrastructure Planning & Finance	PGIET101T	3	0	0	3	3	3	30	70	100	50
2	Urban Infrastructure Planning & Management	PGIET102T	3	0	0	3	3	3	30	70	100	50
3	Digital Surveying	PGIET103T	3	0	0	3	3	3	30	70	100	50
4	Earthquake Resistant Infrastructures	PGIET104T	3			3	3	3	30	70	100	50
5	Program Elective I	PGIET105T	3	0	0	3	3	3	30	70	100	50
6	Program Elective II	PGIET106T	3	0	0	3	3	3	30	70	100	50
7	Digital Surveying Lab	PGIET107P	0	0	2	2	1	-	25	25	50	25
8	Skill Training-I	PGIET108P	0	0	2	2	1	-	25	25	50	25
	Total		18	0	4	22	20	-			700	

Dr M G Pathan

Dr. K R Dabhekar (A. Agrawal)

(Dr. K. C. Tayade)

Dr Kshitija Kadam

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Sr No	Name of Course	CODE	Teaching Scheme					Examination Scheme				
			L	T	P	Hours	Credit	Duration of Exam	TI/PI	TU/PU	Total	Min. Passing Marks
	Semester 2											
1	Design of High Rise Structures	PGIET201T	3	0	0	3	3	3	30	70	100	50
2	Geotechnical Investigations and Ground Improvement Technique	PGIET202T	3	0	0	3	3	3	30	70	100	50
3	Bridge Engineering and Water Retaining Structures	PGIET203T	3	0	0	3	3	3	30	70	100	50
4	New Construction Materials and Technique	PGIET204T	2	0	0	2	2	3	30	70	100	50
5	Research Methodology+	PGIET205T	3	0	0	3	3	3	30	70	100	50
6	Program Elective III	PGIET206T	3	0	0	3	3	3	30	70	100	50
7	Advanced Communication Skills Lab	PGIET207P	0	0	2	2	1	-	25	25	50	25
8	Skill Training-II	PGIET208P	0	0	2	2	1	-	25	25	50	25
9	Design of High Rise Structures Lab	PGIET209P	0	0	2	2	1	-	25	25	50	25
	Total		17	0	6	23	20	-			750	

+ The student may complete this course through NPTEL/SWAYAM/MOOC or online however, the final examination will be conducted by university.

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Sr No	Name of Course	CODE	Teaching Scheme					Examination Scheme				
			L	T	P	Hours	Credit	Duration of Exam	TI/PI	TU/PU	Total	Min. Passing Marks
	Semester 3											
1	Program Elective IV[+]	PGIET301T	3	0	0	3	3	3	30	70	100	50
2	Open Elective I[+]	PGIET302T	4	0	0	4	4	3	30	70	100	50
3	Dissertation Phase – I	PGIET303P	0	0	3#	3#	13	-	50	150	200	100
	Total		7	0	3#	10#	20	-			400	
	Semester 4											
1	Dissertation Phase -II	PGIET401P	0	0	6#	6#	20		200	200	400	200
	Total						80				400	

[+] If students wish to complete Dissertation in industry/research institute then these courses may be completed through NPTEL/SWAYAM/MOOC or online. However, the final examination will be conducted by university.

Contact Hours per week per project

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Program Electives

Program Electives I	Program Electives II	Program Electives III	Program Electives IV
PGIET105T	PGIET106T	PGIET206T	PGIET301T
Forensic Infrastructure Engineering	Retrofitting and Rehabilitation of Structures	Advanced Foundation Engineering	Intelligent Building & Smart Cities
Machineries and Equipment in Infrastructure Engineering	Contract and Arbitration	Pre-stressed Concrete Structures	Quality Control & Safety in Construction
Airport Engineering and Pavement Design	Dock, Harbor and Tunnels	Infrastructure Construction Technology	Structural Health Monitoring
Environmental Impact Assessment	Green Building	Building Services and Engineering	Mass Transportation System

Open Electives

Open Electives 1
PGIET302T
Disaster Management and Mitigation
Water Resources Management

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Sem: I	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET101T	Subject: Infrastructure Planning & Finance	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	To impart the knowledge of various infrastructure and systems
2	To know the concept of infrastructure planning
3	To understand the infrastructure finance systems
4	To explore the financial instruments and markets.
5	To know advanced methods of infrastructure planning

Course Outcomes	
After completion of the course, students will be able to	
1	Understand different infrastructures and systems
2	Apply the concept of infrastructure planning
3	Explore the infrastructure financing systems
4	Understand the financial instruments and markets
5	Use advanced methods for infrastructure planning

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2				1						
CO2	2	2				1						
CO3	2	2				1					2	
CO4	2	2		2		1					2	
CO5	2	2		1		1					2	
Avg	2	2		1.5		1					2	

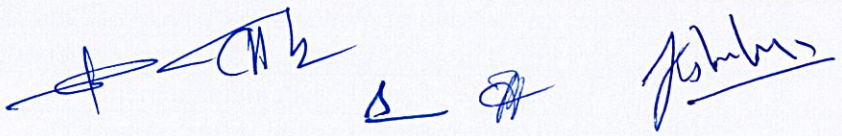
1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
Internal assessment to be based on Class tests (15 marks) and assignment & hands on Case studies covering various aspect of the course (15 marks)	L	T	CO
UNIT NO. 1: **Infrastructure**	9	-	1
Governing Features, Infrastructure Organizations & Systems, Definitions of infrastructure; Types of Infrastructure, An overview of basic concepts related to infrastructure, An overview of the Power sector, Health care and food processing aspects – smart concept, An overview of Water supply and Sanitation sector in India –smart concept, An overview of Road, rail, air and port transportation sectors in India-smart concept, Green Building infrastructure, Solar energy concept for power, generation, Green filled airport- helipad - smart concept, An overview of telecommunications sector in India, An introduction to special economic zones, Organizations and players in the field of infrastructure,			
Unit No. 2: **Infrastructure Planning**	9	-	2
Typical infrastructure planning steps, Planning and appraisal of major infrastructure projects, Screening of project ideas, Life cycle analysis, Multi-criteria analysis for comparison of infrastructure alternatives, Project risk analysis, Procurement strategies, Scheduling and management of planning activities, Infrastructure Project Budgeting and Funding, Regulatory Framework, Sources of Funding. Political and social perspectives of infrastructure planning; Project risk analysis			
Unit No. 3: **Infrastructure Finance**	9	-	3
Basics of Finance, Financial Needs of the Infrastructure Sector and Projects, Project finance as a tool for financing infrastructure projects: Basic features of project finance, A variety of financial instruments, Stakeholders, Public finance for infrastructure projects: Typical allocation of government funds, Sources of government funds, Procurement options analysis, Role of government investment plans. Case Studies on Infrastructure Project Financing.			
Unit No. 4: **Financial instruments & markets**	9	-	4
Financial instruments, Debt instruments, Loans and currency, Equity, Bonds, Financial engineering tools, Swaps, Asset-backed securities, Functions of financial markets, Money market, Bond market, Equities market, Foreign exchange (FX) market, Globalization of financial markets, Financial institutions.			
Unit No. 5: **Infrastructure projects finance planning and Case study**	9	-	5
Public–private partnerships: Basic principles and characteristics of PPPs, PPP framework, Examples of PPPs in infrastructure, Privatization as a method of financing infrastructure projects: Types of privatization, Regulation and privatization, Financial structures, Risks in the procurement of infrastructure projects: Financial risk, Risk management, Risk identification, Risk analysis, Risk response			

process Case study for advance infrastructure projects planning for special areas and mega projects: such as Smart city, SIR, SEZ, GIFT, DMIC Corridor, Technology Parks and other			

References	
1	J. Parkin and D. Sharma, "Infrastructure planning", Thomas Telford, London, 1999
2	Tony Merna and Faisal F Al-Than, "Financing Infrastructure Projects: A practical guide", Institute of Civil Engineering, https://www.icevirtuallibrary.com/isbn/9780727763365#
3	V. Elmer and A. Leigland, "Infrastructure Planning and Finance – A smart and sustainable guide for local practitioners",
4	A.S. Goodman and M. Hastak, "Infrastructure planning handbook: Planning, engineering, and economics", McGraw-Hill, New York, 2009
5	P. Chandra, "Projects: Planning, analysis, selection, financing, implementation, and review", Tata McGraw-Hill, New Delhi, 2009.
6	J. D. Finnerty, "Project financing - Asset-based financial engineering", John Wiley & Sons, New York, 1996.
7	L. Squire and H. G.van der Tak, "Economic analysis of projects", John Hopkins University Press, London, 1975.
8	T. J. Webster, "Managerial economics: Theory and practices", Elsevier, New Delhi, 2003
9	B. C. Esty, "Modern Project Finance: A Casebook", Wiley, 2003.
10	E. R. Yescombe, "Principles of Project Finance", Academic Press, 2002
11	Tony Merna and Faisal F Al-Than, "Financing Infrastructure Projects: A practical guide", Institute of Civil Engineering, https://www.icevirtuallibrary.com/isbn/9780727763365#
12	https://www.india.gov.in/topics/infrastructure



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Sem: I	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET102T	Subject: Urban Infrastructure Planning and Management	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	The course will provide students the knowledge regarding Urban Infrastructure Planning & road network
2	The course will provide students the knowledge of Water Supply Network
3	The course will provide students the knowledge of sanitation & sewerage network
4	The course will provide students the knowledge of solid waste management
5	The course will provide students the knowledge of social infrastructure

Course Outcomes	
After completion of the course, students will be able to	
1	Understand necessity of Urban Infrastructure Planning & road network
2	Acquaint knowledge of Water Supply Network in Infrastructure planning
3	Acquaint knowledge of sanitation & sewerage network
4	Apply knowledge of solid waste management
5	Understand the concept of social infrastructure

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2				3	3					1
CO2	2	2				3	3					1
CO3	2	2				3	3					1
CO4	2	2				3	3					1
CO5	2	2				3	3					1
Avg	2	2				3	3					1

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
Internal assessment to be based on Class tests (15 marks) and assignment & hands on Case studies covering various aspect of the course (15 marks)	L	T	CO
Unit No. 1: **Introduction to Urban Infrastructure Planning and Road Network:**	9	-	1
Types of infrastructures; Role of infrastructure in regional development, Infrastructure scenario in India, Rural development in India, Strategies to improve infrastructure in rural areas	3		
Classification of roads, Types of street systems, road aesthetics	2		
Traffic surveys, Traffic capacity of roads, Traffic control, traffic problems, parking	2		
Indian road network –current status National highway development projects, Express ways, Border road, PMGSY, CMGSY	2		
Unit No. 2: **Water Supply Network:**	9	-	2
Water supply: Surface and ground water sources, water requirement for different land uses, factors affecting water demand	3		
Components of water distribution and storage systems, Design of distribution system by various methods, Water supplies in rural area, Requirements of water supply projects	3		
Flood frequencies, flood protection measures in urban areas	3		
Unit No. 3: **Sanitation & Sewerage Network:**	9	-	3
Systems of sanitation, Quantity of sanitary sewage, determination of quantity of sewage, quantity of storm sewage, drains	3		
Sewerage drainage, refuse collection, storage, treatment, methods of disposal & utilization, minimum basic needs, formulation of objectives	3		
Norms and standards both for space allocation and quality control, Storm water Network.	3		
Unit No. 4: **Solid Waste Management:**	9	-	4
Solid waste management; types of wastes, quantum of waste generated from various land uses	3		
Collection and transportation, processing & disposal of solid waste; different methods of solid waste disposal systems	3		
Community participation and NGO's, involvement in efficient and solid waste management, study of best practices	3		
Unit No. 5: **Social Infrastructure:**	9	-	5
Health and Education hierarchy, norms and location	2		
Electricity & Communication Network: Location, transformer, station, street lighting requirements, telecommunication network requirement.	4		
Fire protection: requirements, norms and standards, planning provision, Recreation & Open Space Planning in Social Infrastructure	3		

References	
1	Fair, G.M., Gayer, J.C. And Okun, D.A., "Water and Waste Water Engineering", John Wiley & Sons, 3rd Edition, 2010
2	T.M. Vinodkumar, "Networks and services", ITPI Reading Manuals.
3	TCPO and Ministry of Works and Housing, "Norms and Standards for Urban Water Supply and Sewerage Services", New Delhi.
4	National Institute of Urban Affairs, "Status of Water Supply, Sanitation And Solid Waste Management In Urban Area" 2005,
5	Tan Yigitcanlar,"Sustainable Urban and Regional Infrastructure Development: Technologies, Application and Management", 2010 IGI Global publishing company.
6	CPHEEO, "CPHEEO Manuals on Water Supply, Sewerage, Drainage and Solid Waste Management".2005-08.
7	Gurcharan singh: Water supply and Sanitary Engineering-, Standard Publishers, Distributors, New Delhi.
8	A K. Chaterjee: Water Supply, Waste Disposal and Environmental Poll. Engineering – Khanna publishers
9	G.S. Birdie: Water supply and Sanitary Engineering
10	Michel Neuman: Sustainable Infrastructure For Cities And Societies

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Sem: I	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET103T	Subject: Digital Surveying	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	Provide basics of digital surveying of earth surface using total station, Drone, GPS and mapping software
2	Familiarize about the principles of remote sensing, data acquisition and analyze of satellite data.

Course Outcomes	
After completion of the course, students will be able to	
1	Develop skills in using Total Station & advanced surveying instruments and analyse data
2	Acquire information and explain the various applications of GPS technology in modern world.
3	Explain the fundamentals of Drone surveying
4	Understand and explain the basic concepts and principles of Remote Sensing, EMR and its characteristics, advantages and limitations of remote sensing.
5	Understand and explain the basic concepts Geography and Spatial Sciences with respect to GIS, its definition and components;

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3		2	3	1	1		1	2		2
CO2	3	3	3	2	3	1	1		1	2		2
CO3	3	3		2						2		
CO4	3	3		2						2		
CO5	3	3		2						2		
Avg	3	3	3	2	3	1	1		1	2		2

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
Unit No. 1: **Total Station**	8	-	1
EDM & Total Station: Principle, instrument characteristics, accessories, operation, EDM without reflecting prisms; Total Station – types, instrument description, field techniques, Traversing, motorized total stations; field procedures for total stations in topographic surveys.			
Unit No.2: **Global Positioning System (GPS)**	10	-	2
Introduction to GPS – History and Development – Kepler's Law – Doppler effect – Positioning concept – Transit, Timation – SECOR-NAVSTAR GPS-GNSSGLONASS system, Galileo System – Advantages and current limitations of GPS Applications of GPS Technology – Navigation vs. Mapping vs. Surveying – Environmental Monitoring – Commercial Applications – Engineering – Agricultural Applications – Precision Navigation – Military Applications	7 3		
Unit No. 3: **Drone Surveying**	9	-	3
Introduction to Drones, History of Drone/UAS/UAVs, payload, battery life, Specs for good results, Regulations of DGCA and Drone license, Pre and Post Flight planning- Flight execution and photography, Data collection- Image Format, GSD, Scale and Resolution. comparison on surveying drone and its accuracy, Techniques of controlling errors	6 3		
UNIT NO. 4: **Remote Sensing**	9	-	4
Definition and components of remote sensing – Active and Passive Remote sensing; Electromagnetic radiation and its characteristics – energy interaction with atmosphere and earth surface features – Spectral bands – Atmospheric window – Spectral signature – spectral reflectance profile for vegetation, soil and water; Advantages and limitations of remote sensing – Real and Ideal remote sensing system			
Unit No. 5: **Geographical Information System (GIS)**	9	-	5
Basic Concepts in Geography / Spatial Sciences – Space Place, Location, Time, Scale Distance and Direction – Data, Information and Knowledge: Definition and Relationship – Information System – Definition and Components – GIS – Definition and Components.			

References

1	Anji Reddy, M., (2001) Remote Sensing and Geographical Information Systems, 2nd edition, BS Publications, Hyderabad.
2	George Joseph,(2005) Fundamentals of Remote sensing 2nd edition , University press, Pvt, Ltd, Hyderabad .
3	Fundamental of GIS by MICHAEL N DEMERS – MN DEMERS, Published by John Wiley & Sons Inc
4	Principles of GIS by P.A. Burrough, Rachael Mc Donnell

5	Drones and Support for the Use of Force by James Igoe Walsh Oxford university press
6	One Nation Under Drones: Legality, Morality, and Utility of Unmanned Combat Systems by John E. Jackson. McGraw Hill Education
7	Global Positioning System – Theory and Practice –. By Hofmann W.B, Lichtenegger. H, Collins Springer Verlag Wein,

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Sem: I	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET104T	Subject: Earthquake Resistant Infrastructures	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	Understand engineering seismology
2	Understand basic concepts of theory of vibrations
3	Understand and interpret the nuances of site planning, building forms etc
4	Understand ductility and energy absorption in buildings with codal provisions
5	Understand the effect of earthquake on infrastructures

Course Outcomes	
After completion of the course, students will be able to	
1	To understand principles of engineering seismology
2	To know vibrations and related terms with their relations
3	To understand and interpret the nuances of site planning, building forms etc
4	To understand ductility and energy absorption in buildings with codal provisions
5	To understand the influence and behavior of infrastructures during earthquake

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3	1									
CO2	1	3	1									
CO3	1	3	1									
CO4	1	3	1									
CO5	1	3	1									
Avg	1	3	1									

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
UNIT NO. 1: **Engineering Seismology**	9	-	1
Introduction to Engineering Seismology, Plate tectonics, seismic waves, characteristics of earthquake and its quantification – Magnitude and Intensity scales; seismic instruments. Study of response of buildings and structures during past earthquakes.			
Unit No. 2: **Vibrations**	9	-	2
Introduction to Theory of Vibration, Single degree of freedom systems, period, frequency, resonance, damping, response spectrum, seismic design philosophy, ductility, base shear calculation by seismic coefficient method (Numerical based on fundamentals only).			
Unit No. 3: **Nuances of Site Planning**	9	-	3
Site planning, building forms, horizontal and vertical irregularities, mass and stiffness irregularities; Soft-storey effects; Architectural design concepts for earthquake resistance; Shear walls; setbacks, effects of torsion in buildings, pounding – IS 1893 provisions (No Numerical).			
Unit No. 4: **Ductility and Energy Absorption**	9	-	4
Ductility and Energy Absorption in Buildings, Reinforced concrete for earthquake resistance; confinement of concrete for ductility; ductility of columns and beams – codal provisions – Relevant IS codes.			
Unit No. 5: **Behavior- Cause & Effect on Infrastructure due to Earthquake**	9	-	5
Bridges-simply supported continuous bridge across river, viaduct, Dams- gravity and earthen dams, Roads- flexible and rigid pavement with case studies			

References

1	P. Agarwal, M. Shrikhande, Earthquake Resistant Design of Structures, McGraw Hills, 2006
2	Chopra, Dynamics of Structures: Theory and Applications to Earthquake Engineering, Prentice Hall, 4th Edition, 2015
3	S. K. Duggal, (2007), "Earthquake Resistant Design of Structures", Oxford University Press, New Delhi 2007.
4	Damodaraswamy S. R and Kavitha. S, "Basics of Structural Dynamics and Aseismic Design", PHI Publication, 1st Edition, 2009, ISBN: 978-8120338432
5	IS 1893 (Part I): 2016, IS 13920-2016, IS 4326: 1993, IS 13828: 1993 and other relevant & recent codes
6	M. Kevin Parfitt, Norbert J. Delatte, Pamalee Brady, Paul A. Bosela, (2013), "Failure Case Studies in Civil Engineering Structures, Foundations, and the Geoenvironment", ASCE

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Sem: I	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET105T - Program Elective I	Subject: Forensic Infrastructure Engineering	

Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	To impart knowledge of various testing methods of Failed Structures.
2	To learn about aspects of failures connected with various structural systems and materials.
3	To impart knowledge about foundation failures.
4	To know about strategic measures against failures
5	To gain insight into previous structural failures.

Course Outcomes	
After completion of the course, students will be able to	
1	Understand various testing methods of Failed Structures.
2	Understand the aspects of failures connected with various structural systems and materials.
3	Plan the strategic measures against failures.
4	Can write the legal and technical report of the failure in lucid manner.
5	To impart knowledge about structural failures

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2		2	3							
CO2	2	2		3								
CO3	1	3		3								
CO4		3		2								
CO5	2	2		2								
Avg	1.75	2.4		2.4	3							

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
UNIT NO. 1: **Forensic Engineering**	9	-	1
Introduction to forensic engineering, Forensic investigations tools and techniques. Scope and extent of application of Forensic Engineering techniques in various fields of Civil Engineering.			
Unit No. 2: **Structural Failures**:	9	-	2
Failure of construction materials steel, concrete - Joints by Bolt and weld. Failure of compression members and tension members by reversal of loads , Failure aspects of post tensioned concrete systems, space frame, plane frame, precast buildings, failure of bridges. Geo-Technical Failures: Soil liquefaction, failure of foundation systems – Causes and prevention			
Unit No. 3: **Testing of Failures**	9	-	3
Various methods of testing of failed structures & instrumentation-Laser scanning, microscope, Radio graphic evaluation, Load Testing of shoring systems and repair technology Back analysis: Selection of theoretical model - methods of analysis, Instrumentation and Monitoring. Development of the most probable failure hypothesis - cross-check with original design			
Unit No. 4: **Designing Against Failure**:	9	-	4
Quality control – Material selection, workmanship, design and detailing Performing reliability checks, Legal issues involving jurisprudence system, insurance, reducing potential liability, responsibility of engineers and contractors. Professional practice and ethics.			
Unit No. 5: **Case Studies**	9	-	5
Case Studies on famous failures – Reasons and lessons learnt Aspects of professional practice. Forensic analysis of R. C. frames, Construction of historic monuments, destruction due to environmental changes and survival of monuments among them, such as leaning tower of Pisa, Egyptian pyramids, tall structural foundations in Mexico city, pre historic caves in India etc.,			

References

1	Guidelines for Forensic Engineering by Practice-Gary L Lewis, ASCE Publication .
2	Introduction to Forensic Engineering - Randall K Noon, CRC Press
3	Forensic Engineering by Sam Brown, ISI Publication
4	Indo-US Forensic Practices: Investigation Techniques and Technology – Shen En Chen, R Janardhanan, C Natarajan, Ryan Schmidt, American Society of Civil Engineers
5	Forensic Geotechnical Engineering – V V S Rao and G L Sivakumar Babu , Springer India

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Sem: I	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET105T- Program Elective I	Subject: Machineries and Equipment in Infrastructure Engineering	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	To study various conventional and modern methods of construction equipment for earthwork, material handling and other miscellaneous purposes.
2	To study the working of the equipment's mentioned above and apply scientific principles for effectively utilizing them

Course Outcomes	
After completion of the course, students will be able to	
1	Perform comparative cost analysis for owning and operating heavy equipment
2	Analyze life and pay load of earthwork equipment's.
3	Analyze life and pay load of material handling equipment's.
4	Understand use of loading and Lifting equipment for different construction process
5	Understand the working of concreting equipment's and Trenchless technology

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		1		1						2	3
CO2	3		1		2						2	3
CO3	3		1		2						2	3
CO4	3		1		2						2	3
CO5	3		1		2						2	3
Avg	3		1		1.8						2	3

1 Low 2 Medium 3 High

Syllabus

Details of Topic:	Allotment of Hours		Mapped with CO Number
	L	T	
Unit No.1: Planning and Cost Estimation	10		
Factors affecting equipment selection, Planning equipment utilization, Equipment utilization chart. Elements of ownership cost, Depreciation accounting methods, Cost Estimation using Average Annual Investment method. Use of compounding factors in Equipment cost estimation based on time value method Illustrations on use of Caterpillar method and Peurifoy method for estimation of total equipment cost.			1
Unit No.2 Life Analysis	9		2
Equipment Life and Replacement Analysis – Physical life, Profit life, Economic life, Illustrations on determination of economic life of equipment. Equipment Replacement analysis- Intuitive method, Minimum cost method, Maximum profit method. Determination of economic life based on equivalent annual cost (using time value concept). Engineering Fundamentals of Moving Earth– Machine Performance-Required power, Available power, Usable power, Rolling resistance, tractive force, co-efficient of traction, Effect of grade on tractive effort, Effect of altitude on performance of IC engines, Performance chart, ways to define payload of equipment.			
Unit No.3 Dozer and Loader	9		3
Bull Dozers-Types of dozer blades, blade adjustments, Blade performance, production estimation. Scrapers, Scraper operation, types of scraper, Components of production cycle of scraper and pusher. Illustrations on production estimation of scraper and balancing interdependent machines. Front-End loaders –loader attachments, productivity estimation. Excavators-Front shovels and backhoes, operation, factors affecting selection, production estimation. Trucks– Production cycle, cycle time estimation, Productivity of trucks, balancing interdependent machines.			
Unit No.4 Pile Driving Equipment & Crane	9		4

Piles and Pile driving equipment - Types of pile hammer: Drop hammer, Single acting and double acting steam hammers, Diesel hammers, Vibratory pile drivers. Pile Extraction Equipment and Methods, Non-Destructive Integrity Testing of Pile equipment's Cranes, Crane motions, Principles of lifting mechanism of crane, types of cranes-lattice boom crawler crane, lattice boom truck mounted cranes, telescopic boom crane. Types of cranes-Tower cranes, Factors affecting lifting capacity of crane, Range diagram.			
Unit No.5 Concreting and Trenchless technology	**8**		5
Concreting equipment – Steps in concrete making process, types of concrete mixer machines including RMC, Vibrators types and applications Methods of handling and transporting concrete, Consolidation of concrete, Methods of finishing and curing of concrete. NDT equipment con concrete Trenchless Technology – Methods, Materials and Equipments			

References	
1	Peurifoy, R., Schexnayder, C., Shapira, A., & Schmitt, R. (2011). "Construction Planning, Equipment, and Methods" (8th ed.). McGraw-Hill.
2	Gransberg, D. D., Popescu, C. M., & Ryan, R. C. (2006). "Construction equipment management for engineers, estimators, and owners" (2nd ed.). CRC Press.
3	Day, D. A., & Benjamin, N. B. H. (1991). "Construction equipment guide" (2nd ed.). John Wiley & Sons.
4	Harris, F. (1994). "Modern construction and ground engineering equipment and methods" (2nd ed.). Pearson Longman.
5	Nunnally, S. W. (2011). "Construction methods and management" (8th ed.). Prentice Hall.

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
FACULTY OF SCIENCE &TECHNOLOGY
M. Tech. (Infrastructure Engineering & Technology)

Sem: I	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET105T- Program Elective I	Subject: Airport Engineering and Pavement Design	

Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	Analyze the various components of an airport and aircraft characteristics affecting the design of airports
2	Understand the runway and taxiway geometrics based on the likely aircrafts using the airport.
3	Plan the requirements of terminal area and suggest an optimum layout for the terminal area based on passenger and baggage volume.
4	Study different types of pavement construction procedures.
5	Knowledge of airport grading and drainage system

Course Outcomes	
After completion of the course, students will be able to	
1	Analyze the various components of an airport and aircraft characteristics
2	Understand factors affecting the design of airports.
3	Design the runway and taxiway geometrics based on the likely aircrafts using
4	Design & evaluate the various airport pavements.
5	Understand suitable method of grading and various air traffic control aids required for safe landing and

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3										
CO2	2	2										
CO3	2		3	1								
CO4	2		3	1								
CO5	2	2										
Avg	2	2.33	3	1								

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
UNIT NO.1 :General	8	-	1
Introduction: Growth of air transport, airport organization and associations, Classifications of airports airfield components, airport traffic zones and approach areas. **Aircraft Characteristics Related to Airport Design**: Components, size turning radius, speed, airport characteristics.			
UNIT NO.2: Airport Planning, Surveys and Design	9	-	2
Airport Site Selection, Runway length and width, sight distances, longitudinal and transverse grades, runway intersections, taxiways, clearances, aprons, numbering, holding apron, noise control, Wind rose diagram, terminal building, airport marking and lighting.			
UNIT No.3 : Planning and Design of the Terminal Area	9	-	3
Operational concepts, space relationships and area requirements, vehicular traffic and parking at airports. Capacity and Delay: Factors affecting capacity, Determination of runway capacity related to delay, gate capacity and taxiway capacity.			
UNIT NO.4 : Airport Pavement Design	11	-	4
Under carriage system for aircraft, type and contact pressure, load repetition and distribution for airfield pavement, airport traffic area, analysis of flexible and rigid pavement, flexible pavement design, LCN-ACN methods of rigid Pavement Evaluation. Introduction of Pavement Management Systems (PMS) for the airport pavements.			
UNIT NO.5 : Airport Grading and Drainage	8	-	5
Grading of airport area, hydrology, design of drainage systems, construction methods, layout of surface drainage and subsurface drainage system. **Air Traffic Control and Aids**: day and night landing aids, ILS and other associated aids.			

References

1	"Planning and Design of Airports" - Robert Horenjeff, 2nd edition, McGraw Hill Book Co.
2	"Airport Engineering" - G. Glushkov, V.Babkov, Mir Publuishers, Moscow.
3	"Airport Planning and Design"- Khanna, Arora and Jain, Nem Chand and Bros., Roorkee
4	Harry.R.Cedergern. "Drainage of Airfield pavements" - John Wiley and Sons.
5	Virender Kumar and Satish Chandra, "Airport Planning and Design"- Galotia Publication press.

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FACULTY OF SCIENCE &TECHNOLOGY
M. Tech. (Infrastructure Engineering & Technology)

Sem: I	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET105T- Program Elective I	Subject: Environmental Impact Assessment	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	The course will provide students the knowledge of importance of environmental impact assessment in various engineering projects.
2	The course will provide students the knowledge regarding various methodologies involved in environmental impact assessment
3	The course will provide students to identify the prediction tools for the assessment of different environmental impacts.
4	The course will provide students to describe the concepts of environmental management system.
5	The course will provide students the knowledge of EIA notification by MoEF

Course Outcomes	
After completion of the course, students will be able to	
1	Understand importance of EIA as an integral part of planning process
2	Examine different environmental attributes and selecting the environmental parameters affecting project
3	Apply various methods to Predict the Air, Water & noise quality impacts of project after deciding various environmental attributes
4	Apply various methods to Predict the impacts on land, vegetation & wildlife of project after deciding various environmental attributes
5	Understand the EIA notifications by MoEF & Create the EIA report for getting Environmental clearance

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1						3	3					1
CO2		1				3	3					1
CO3		1				3	3					1
CO4		1				3	3					1
CO5						3	3	3				1
Avg		1				3	3	3				1

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
Unit No. 1: **Concepts of Environmental Impact Assessment**	9	-	1
Environment; Environmental Impacts; Environmental Impact Analysis; Environmental Impact Assessment And Environmental Impact Statement; EIA- As An Integral Part of The Planning Process, Engineering Projects in brief like Energy Generation Projects both thermal and Hydal, Infrastructure projects, Power Transmission, Mining etc. and their social impact assessment			
Unit No. 2: **Methods of Analysis of Impacts on Environment:**	10	-	2
Detailed Contents of EIA: Introduction; Project Description; Description of The Environment; Anticipated Environmental Impacts And Mitigation Measures: Analysis of Alternatives; Environmental Monitoring Programme; Additional studies; Project Benefits; Environmental Cost Benefit Analysis			
Unit No. 3: **Air Quality, Water & Noise Quality Impact Analysis:**	10	-	3
Environment attributes: air; water; noise; land and soil. Description of the Baseline Environment : Purposes for defining the Environmental Setting; Selection of parameters, Monitoring of physical environmental parameters, Collection and interpretation of baseline data for various environmental attributes, Prediction and Methods of Assessment of Impacts on Various aspects of Environment; Application of various models for the Prediction of impact on Air Environment, Water Environment, Noise Environment and Land, Practicalconsideration in impact assessment			
Unit No. 4: **Land, Vegetation and Wildlife Impact Analysis, Life Cycle Assessment:**	9	-	4
Collection and interpretation of baseline data for various environmental attributes, Prediction and Methods of Assessment of Impacts on Land, Vegetation and Wildlife Impact Analysis, Application of various models for the Prediction of impact on Land, Vegetation and Wildlife, Practical consideration in impact assessment, Life Cycle Assessment			
Unit No. 5: **EIA notification by Ministry of Environment and Forest (Govt. of India):**	10	-	5

Provisions in the EIA notification, Categorization of Industries for seeking environmental clearance from concerned authorities, procedure for environmental clearance, Procedure for conducting EIA report, Rapid and Comprehensive EIA, general structure of EIA document, Environmental management plan, Post environmental monitoring, Public participation in environmental decision making process, role of NGO in public hearing, Case studies on EIA for Industries and Infrastructure projects			

References	
1	Larry Canter, "Environmental Impact Assessment", Mc Graw Hill Pub.
2	Handbook of EIA by John Ray and Rau Whooten.
3	R K Jain, L. V. Urban and G.S. Stacey, "Environmental Impact Analysis - a Decision MakingTool", Publishers: Van Nostrand Reinhold New York.
4	Judith Prett, "Handbook of Environment Impact Assessment".
5	Abbasi and Ramesh, "Theory and Practice of Environmental Impact assessment".
6	Shrivastava, "Environmental Impact Assessment".
7	John E. Heer, Joseph Hoggerty , "Environmental Impact Assessment and Statement".
8	http//www.nptel.ac.in

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FACULTY OF SCIENCE &TECHNOLOGY
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Sem: I	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET106T-Program Elective II	Subject: Retrofitting and Rehabilitation of Structures	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	To understand strategies of various maintenance and repair
2	To understand concepts of serviceability and durability of concrete
3	To understand materials and techniques for repair
4	To understand repairs, rehabilitation and retrofitting of structures
5	To understand concepts of demolition techniques

Course Outcomes	
After completion of the course, students will be able to	
1	Develop various maintenance and repair strategies.
2	Evaluate the existing buildings through field investigations.
3	Understand and use the different techniques for repairs.
4	Demonstrate various techniques for structural retrofitting
5	Demolished the structures

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	2	2		1						
CO2	2	3	2	2		1						
CO3	2	3	2	2		1						
CO4	2	3	2	2		1		1				
CO5	2	3	2	2		1		1				
Avg	2	3	2	2		1		1				

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
UNIT NO. 1: **Maintenance and repair strategies**	9	-	1
Maintenance, repair and rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection,			

Assessment procedure for evaluating a damaged structure, causes of distress and deterioration of concrete- Evaluation of existing buildings through field investigations, Seismic evaluation of existing buildings			
Unit No. 2: **Serviceability and durability of concrete:**	9	-	2
Quality assurance for concrete construction concrete properties – strength, permeability, thermal properties and cracking. – Effects due to climate, temperature, chemicals, corrosion – design and construction errors – Effects of cover thickness and cracking.			
Unit No. 3: **Materials and techniques for repair:**	9	-	3
Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete. Rust eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning - Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coating and cathodic protection.			
Unit No. 4: **Repairs, Rehabilitation and Retrofitting of structures:**	9	-	4
Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure , Repair of Structure – Common Types of Repairs – Repair in Concrete Structures – Repairs in Under Water Structures – Guniting – Shot Create – Underpinning. Strengthening of Structures –Strengthening Methods – Retrofitting – Jacketing. Special techniques for structural Retrofitting (Bracing, Shear walls, Base isolation etc).			
Unit No. 5: **Demolition techniques:**	9	-	5
Advanced techniques and sequence in demolition and dismantling, Engineered demolition techniques for Dilapidated structures, Case Studies on Restoration of fire damaged buildings, strengthening corrosion damaged buildings, composite fibre wraps strengthening of building components, demolition of building, demolition of bridges etc.			

References

1	Denison Campbell, Allen and Harold Roper, Concrete Structures, Materials, Maintenance and Repair, Longman Scientific and Technical UK, (1991).
2	R.T. Allen and S.C. Edwards, Repair of Concrete structures, Blakie and Sons, UK, (1987)
3	M. S. Shetty, Concrete Technology – Theory and Practice, S. Chand and Company, New Delhi, (1992).
4	Sidney, M. Johnson "Deterioration, Maintenance and Repair of Structures".
5	Raikar, R.., Learning from failures – Deficiencies in Design, Construction and Service – R &D centre (SDCPL), RaikarBhavan, Bombay, (1987).
6	Bhattacharjee, Concrete structures Repair, Rehabilitation and Retrofitting, CBS Publishers, 2017
7	B. Vidivelli, Rehabilitation of concrete Structures, standard Publishers and distributors, 2007
8	R T Allen, S C Edwards and D.N. Shaw, Repair of Concrete Structures, CRC press,1992

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M. Tech. (Infrastructure Engineering & Technology)

Sem: I	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET106T-Program Elective II	**Subject:** Contract and Arbitration	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	To develop concepts related with Construction contracts & Tendering which involves Planning, management and Execution of the project with economic development & prosperity.
2	To learn basic principles of Construction contracts, Tendering & Arbitration in the context of various construction aspects.
3	To finalize quantities of items and labour requirement of civil engineering Works
4	To know the co-relation of client, consultant and contractor for the construction project with practical aspects

Course Outcomes	
After completion of the course, students will be able to	
1	Explain the procedure of tendering and selection of successful contractor for projects
2	Discuss the salient features of laws related to construction industry.
3	As an infrastructure manager, the knowledge on contracts and arbitration is it essential
4	As an arbitrator discuss the procedural difference between a judge and an arbitrator. Who is more powerful in what situation?
5	Resolve the dispute

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3		1								1	1
CO2	3		1								1	1
CO3	3		1								1	1
CO4	3		1			1	1		1			1
CO5	3		1			1	1		1			1
Avg	3		1			1	1		1		1	1

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	
Unit No.1: Introduction to Contract	10		1
Introduction to contracts: Definitions, Essentials for a legally valid contract, Salient features of contract, Discharging of a contract, Documents for an Engineering Contract; Types of contracts: Classification Based on – Tendering Process, Economic Consideration, Applicability of the various types of contracts in Construction.	**5**		**1**
Tendering process: Definitions, List of Documents, EMD, Security Deposit, Invitation for Tenders and sale of Documents, Preparation of Tender Documents and its submission, Receipt of Tender Documents and its opening, Evaluation of Tender and Award of contract – Letter of Award, Letter of Intent, Issues in tendering process: Pre - Registration, Pre – Qualification, Nominated Tendering, Rejection of Tenders, Repeat Orders, Revocation of Tenders, Unbalanced Bidding	**5**		**1**
Unit No.2 Administration/Performance of contract	**9**		1
Administration/Performance of contract: Responsibilities (Duties and Liabilities) of Principal & Contractor, Monitoring and Quality control/assurance, Settlement of claims – Advances, Bills, Extension for time, Extras & Variations, Cost Escalations. Security Deposit, Retention Money, Performance Bond, Liquidated Damages, Penalties, Statutory Requirements.			
Unit No.3 Laws related to construction Industry	**8**		3
Indian Contract act 1872, Labour and industrial laws - payment of wages act, contract labor. Workmen's compensation act – Insurance, industrial dispute act, The Buildings and Other Construction Workers (Regulation of Employment and Conditions of Service) Act, 1996, Land Acquisition act 2013, Real Estate (Regulation And Development) Act, 2016, Bye – Laws of Cooperative Housing Society,			
Unit No.4 Arbitration of Engineering Contracts	**9**		4
Background of Arbitration in India, Indian Arbitration Act 1937, UNCITRAL model law, forms of arbitration – arbitration agreement, Commencement of arbitral proceedings, Constitution of arbitral tribunal, Institutional procedure of arbitration, Impartiality and independence of arbitrator's jurisdiction of arbitral tribunal, Interim measures, Enforcement of awards.			
Negotiation, Mediation and conciliation – concepts and purpose, statutory back ground ADR and mediation rules, Duty of mediator and disclose facts, Power of Court in mediation			
Unit No.5 Alternate Dispute resolution	**9**		

Dispute resolution: General, Methods for dispute resolution – Negotiations, Mediation, Conciliation, Dispute Resolution Boards, Arbitration, Litigation/Adjudication by courts. Conciliation – Appointment of Conciliator, Role of Conciliator, Special Features of Conciliation Dispute Resolution Boards (DRB) – Constitution Of DRB, Functioning of DRB, Procedure for Hearings, Status of Award.	**8**	**0**	**5**

References	
1	Patil B. S. (2009) "Civil Engineering Contracts and Estimates", University Press.
2	John G. Betty (1993/ Latest Edition) "Engineering Contracts", McGraw Hills.
3	Vasavada B. J., (1997), "Engineering Contracts and Arbitration", (Self Publication by Jyoti B. Vasavada).
4	Vaid K.N., (1998) "Global perspective on International Construction Contracting Technology and Project Management", NICMAR, Mumbai
5	Prakash V. A., (1997) "Contracts Management in Civil Engineering Projects", NICMAR, Mumbai.
6	Albett Robert W., (1961/Latest Edition) "Engineering Contracts and Specifications", John Willey and Sons, New York.

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M. Tech. (Infrastructure Engineering & Technology)

Sem: I	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET106T-: Program Elective II	Subject: Dock, Harbor and Tunnels	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	Explain the modern trends in water transportation, port development
2	Explain the design features of docks, harbor.
3	Plan and supervise the construction and maintenance of docks, harbors.
4	To understand the need of utilization of Underground Space for various applications.
5	Utilization of underground space for strategic and engineering utilities

Course Outcomes	
After completion of the course, students will be able to	
1	To study the modes of water transportation and classification of harbors.
2	Prepare master plan for harbor site considering natural phenomenon and different harbor elements
3	Identify the requirement of navigational aids and cargo storage facilities
4	Supervise the tunnel construction work
5	Carry out maintenance process of tunnel

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3										
CO2	2	3		1								
CO3	2	3		1	1							
CO4	2	3		1	1							
CO5	2	3		1								
Avg	2	3		1	1							

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
UNIT NO.1 Water Transportation	8	-	1
History, Advantages and disadvantages of water transportation, Modern trends in water transportation, Elements of water transportation, Historical development in India, Classification of			

harbours, Ports development in India, Port authorities ,Bodies and association.			
UNIT NO.2 Natural Phenomenon, Planning and Marine Structure	9	-	2
Natural Phenomenon: Tides, Wind, Water waves, Currents phenomena, Characteristics and effects on marine structures, Littoral drift. **Harbour Planning** - Selection of site and planning of harbours, Ship characteristics, Characteristics of good harbour, Size of harbour **Marine Structure** - General design aspects, Breakwaters - function, types general design principles, Wharves, Quays, Jetties, Piers, Pier heads, Dolphin, Fenders, Mooring Accessories			
UNIT NO.3 Docks and Port	10	-	3
Docks and Repair Facilities- Harbor docks, Wet docks, Repair docks, Lift docks, Floating docks, Slipways **Port Facilities** - Port building facilities, Transit sheds, Warehouses, Cargo handling facility, Services for shipping terminals ,Inland port facilities planning **Dredging**- General ,Classification of dredging works, Types of dredgers, Uses of dredged material ,Execution of dredging work **Coastal Protection**- Sea wall, Revetment ,Bulkhead, Cathodic Protection and Navigation Aid			
UNIT NO.4 Introduction to Tunnel, Its Surveying and Construction	9	-	4
Necessity, classification, advantages and disadvantages of Tunnel, Shape and size of Tunnel, Surveying work operation for tunnel, Types of Explosives, Method of blasting. Classification, Location, size, Shape, and construction of Shaft Method of Tunneling in Soft soil and in Rock. Introduction of TBM			
UNIT NO.5 Tunnel Lining, Ventilation and Drainage System	9	-	5
Objective of lining and Types of lining, Advantages of concrete lining, Materials for lining, Method of tunnel Ventilation, Source of water, water handling, dewatering and permanent drainage			

References	
1	Alonzo Def. Quinn, "Design and Construction of Ports and Marine Structure", McGraw - Hill Book Company, New York
2	S. P. Bindra, "A Course in Docks and Harbour Engineering", 1992, Dhanpat Rai & Sons, New Delhi
3	R. Srinivasan and S. C. Rangwala, "Harbour, Dock and Tunnel Engineering", 1995, Charotar Pub House, Anand
4	Silvino Pompeu-Santos "Innovation in TBM Traffic Tunnels" 2023 CRC Press
5	Hasan Tosun "Theory and Practice of Tunnel Engineering" 2022 Book Metrics Overview
6	Donna Latham "Bridges and Tunnels: Investigate Feats of Engineering with 25 Projects"2012 Nomad Press

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FACULTY OF SCIENCE &TECHNOLOGY
M. Tech. (Infrastructure Engineering & Technology)

Sem: I	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET106T-: Program Elective II	Subject: Green Building	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course 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

Course Outcomes	
After completion of the course, students 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

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2					2					
CO2	2	3					2					
CO3	2	2					2					
CO4	2	1					2					
CO5	2	2					2					
Avg	2	2					2					

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
UNIT NO. 1: **Introduction to Green Building**	9	-	1
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 No. 2: **Site Selection and Water efficiency**	9	-	2
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 No. 3: **Energy Efficiency**	9	-	3
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 No. 4: **Material Efficiency**	9	-	4
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, pozzolana cements, fly ash bricks, vitrified tiles, materials from agro and industrial waste. (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			
Unit No. 5: **Indoor Environment Quality and Occupational Health**	9	-	5
Day lighting, air ventilation, Indore air quality, Measure of IAQ, Reasons for poor IAQ, Measures to achieve Acceptable IAQ levels, exhaust systems, low VOC paints, materials & adhesives, building acoustics. Codes related to green buildings: NBC, ECBC, ASHRAE, UPC etc.			

References	
1	IGBC Green Homes Rating System Ver 3.0, Abridged Reference Guide September 2019 , IGBC Green Homes Rating System Ver 3.0.pdf
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	Mike Montoya, Green Building Fundamentals, Pearson, USA, 2010
5	Charles J. Kibert, Sustainable Construction - Green Building Design and Delivery, John Wiley & Sons, New York, 2008
6	Regina Leffers, Sustainable Construction and Design, Pearson / Prentice Hall, USA, 2009

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
FACULTY OF SCIENCE &TECHNOLOGY
M. Tech. (Infrastructure Engineering & Technology)

Sem: I	Total Hours Distribution per Week		
Total Credit: 01	Lecture: 0 Hrs	Tutorial: 0 Hrs	Practical (P) : 2 Hrs
Subject Code	PGIET107P	Subject: Digital Surveying Lab	

Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
50 Marks	50 Marks	50 Marks	-

Course Objectives	
1	Use the GIS, GPS, total station and drone technology for digital surveying
2	Draw maps and determine the area of land
3	Do curve layout and layout for area under construction

Course Outcomes	
After completion of the course, students will be able to	
1	Survey the land using total station GPS, GIS and Drone technology
2	Do risk zoning and assessment using GIS
3	Prepare maps of the area

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2			3	1						
CO2	2	2			3	1						
CO3	2	2			3	1						
Avg	2	2			3	1						

1 Low 2 Medium 3 High

Syllabus

Minimum eight practical to be performed from the list below;

1. Measuring Construction field size by using GPS.
2. Drone surveying for contour mapping
3. Water body capacity calculation using Total station
4. Curve setting using Total station
5. Layout of Playground using Total station
6. Collection of data from different sources for a given natural hazard
7. Study of an image processing and GIS software.
8. Preparation of Watershed Maps by using GIS
9. Preparation of Drainage Maps by using GIS
10. Risk zonation and assessment by GIS
11. Flood plan mapping using temporal satellite data (pre and post flood) using GIS

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
FACULTY OF SCIENCE &TECHNOLOGY
M. Tech. (Infrastructure Engineering & Technology)

Sem: I	Total Hours Distribution per Week		
Total Credit: 01	Lecture: 0 Hrs	Tutorial: 0 Hrs	Practical (P) : 2 Hrs
Subject Code	PGIET108P	Subject: Skill Training-I	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
25 Marks	25 Marks	25 Marks	-

Course Objectives	
1	To know housing development strategy for the selected city and housing development.
2	Understand software, in management, modeling, surveying and water resources engineering
3	Prepare a model of civil engineering structures

Course Outcomes	
After completion of the course, students will be able	
1	To plan and develop housing layouts and development plan of city
2	To use modern tools to develop skills in management, , modeling, surveying and water resources engineering
3	To model a civil engineering structure using software

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			2		3							1
CO2			2		3							1
CO3									3			1
Avg			2		3				3			1

Syllabus
Student should complete Part A and Part B

Part A
One planning projects are required to be completed from the following areas.

A. Neighbourhood Planning
The Project on NH includes study of housing layouts for different economic classes, different building forms, preparing lay-out plans of neighborhood incorporating field studies and familiarization with site development standards, zoning and subdivision regulations. Assessment of existing project, and preparation of housing plans and Neighborhood plans. The objective of this exercise is to evolve comprehensive housing development strategy for the selected city by studying city level and housing subsystem level aspects and estimating housing shortage; projecting housing need and demand and preparing alternative scenario's for housing development.

B. Development plan

Design portfolio in planning addresses evaluation and appraisal of Development Plan of one Major city/Mega City/Metropolitan Areas of India. Study shall cover assessment of objectives, carry out surveys, assess growth potentials, preparation of one land use plan of the development plan adopted, and is evaluated for the policy, planning design, implementation procedure and development controls regarding the land use. Do's and Dont's in professional Bodies

a. The students shall carry out preliminary assessment of the City through literature survey, data available on websites and other secondary sources.

b. Prepare detailed questionnaire for data collection during the field visits.

c. Visit one City to carry out surveys and data collection activities and thoroughly study the development plans, policies, implementation models, schemes etc.

d. Hold discussions with Government Authorities / Stakeholders

e. Carry out in depth appraisal of reports, & analysis of data collected and prepare appraisal report.

The studies need to be carried out mainly through primary data collection. A field visit to any Major or Mega town/city in India has to be made. The students are required to submit typed report (A-4, size papers, spiral bound, 2 copies) along with studio exhibits (imperial/ A1size drawing sheet) for the Design Portfolio Work. The work shall be carried by the team.

Part B

Students should get trained and developed skill in any one field and any one software / freeware of the following area or otherwise and submit the project work carried out using the software:

1	Project Management Software for Civil Engineering: MS Excel, Primavera, Microsoft Project (MS Project)
2	Software Required for 3d Modeling of Structure/Architecture: Autodesk 3ds Max, Autodesk Maya, Autocad Civil 3d, Sketchup, BIM
3	Software for Surveying: ARCGIS, Q GIS, DEM
4	Software in Water Resource Engineering: Hydrologic Modeling System (HEC-HMS), HEC-RAS (River Analysis System), StormCAD, Autodesk Storm and Sanitary Analysis, WaterCAD Bentley, EPANET (Software for water distribution systems), HydroCAD, SWMN

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Sem: II	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET201T	Subject: Design of High Rise Structures	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	Understand principles of tall buildings and its systems
2	Understand the loads on tall building
3	Analyze and design of tall structural building with shear wall
4	Learn ductile detailing for flexure
5	Analysis and design of multi storied buildings with bracing, masonry

Course Outcomes	
After completion of the course, students will be able to	
1	Plan tall buildings considering structural systems, fire rating, local considerations etc.
2	Evaluate loading for tall structures
3	Analyze and design of tall structural building with shear wall
4	Learn ductile detailing for flexure
5	Analysis and design of multi storied buildings with bracing, masonry

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2										
CO2	1	2										
CO3	1	2	2									
CO4	1	2										
CO5	1	2	2									
Avg	1	2	2									

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
UNIT NO. 1: **Principles of Planning of Tall Buildings**	9	-	1
Technological Planning, Mechanical systems, Fire rating, Local considerations, Structures elements, Types of structural systems for tall buildings, Shear Walls and their arrangement			
Unit No. 2: **Loads on Tall Buildings**	9	-	2

Gravity loads, Live loads, Wind loads and seismic loading, Code Provisions, Discussion of relevant codes of practices and loading standards, Fire Tender Loading,			
Unit No. 3: **Introduction of frame – shear wall buildings**	9	-	3
Introduction of frame – shear wall buildings, mathematical modeling of building with different structural system, analysis and design of shear walled buildings with ductile detailing as per IS 13920 – 2016			
Unit No. 4: **Ductile Detailing and Column Bracing**	9	-	4
Ductile reinforcement members subjected to flexure. Design of braced column using codal provisions.			
Unit No. 5: **Analysis and Design of Multi Storied Buildings**	9	-	5
Analysis and design of multi storied buildings with bracing and masonry in fills, beam – column jointed for ductile behaviors.			

References	
1	Agrawal P. and Shrikhande M., Earthquake Resistant Design Of Structure, Prentice Hall India, New Delhi, 4th Edition 2007
2	Veghese P. C., Advance Reinforced Concrete Design, Prentice Hall Of India, New Delhi, 2001
3	S. K. Duggal, Earthquake – Resistance Design Of Structure, Oxford University Press, Second Edition 2013
4	Bungale S. Taranath, Reinforced Concrete Design of Tall Building, First Edition Kindle Edition.
5	B. S. Taranath, Analysis and Design of Tall Buildings, Tata McGraw Hill Ltd.

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M. Tech. (Infrastructure Engineering & Technology)

Sem: II	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET202T	Subject: Geotechnical Investigations and Ground Improvement Technique	

Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	Introduce the various methods of determining geotechnical engineering properties soils
2	Introduce the application of engineering methods to ground improvement projects
3	Basic knowledge on various ground improvement techniques and their suitability for various types of soil conditions
4	The skills of implementation of geotechnical knowledge in field situations

Course Outcomes	
After completion of the course, students will be able to	
1	Analyze the need for ground improvement in weak and soft soils and understand dewatering
2	Analyze the need for ground improvement in weak and soft soils and understand dewatering
3	Decide on suitable stabilization and grouting method in soils to improve their performance
4	Apply appropriate method for strengthening foundation soil.
5	Use ground improvement techniques by geo-synthetics and soil reinforcement

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3		2								1
CO2	2	2		2								1
CO3	2	2		1								1
CO4	2	2		2								1
CO5	2	2		1								1
Avg	2	2.6		1.6								1

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
Internal assessment to be based on Class tests (15 marks) and assignment & Case studies covering various aspect of the course (15marks)	L	T	CO

Unit No. 1: **Geotechnical Investigations**	9	-	1
Methods of sub surface exploration, Factors controlling spacing and depth of bore holes, Spacing and depth of various Civil engineering structures, Indirect methods of exploration, Type of sampler and sampling methods, Laboratory investigation of soil, Field testing methods: Static cone penetration methods, Standard penetration test, Dynamic penetration test and plate load test			
Unit No. 2: **Ground Improvement and Dewatering**	9	-	2
Need and objectives of ground improvement, classification of ground modification techniques, trends in ground improvement, Engineering properties of soft, weak and compressible deposits Dewatering Techniques – Dewatering objective and necessity, Well points system, Freezing, Vacuum and electro osmotic methods			
Unit No. 3: **Stabilization and Grouting**	9	-	3
Stabilization: with admixtures like cement, lime, calcium chloride, fly ash and bitumen. Methods of soil improvement-lime stabilization Cement stabilization: Mechanism, amount, age and curing. Fly-ash - Lime Stabilization, Soil Bitumen Stabilization, injection; thermal, electrical and chemical methods **Grouting:** Materials of grouting, grouting techniques and control; purpose, functions, types of grouts; soil bentonite - cement mix; Emulsions & solutions; grout injection methods;			
Unit No. 4: **Improvement of Foundation Soils**	9	-	4
Ground Improvement in Granular Soil: In place densification by (i) Vibrofloatation (ii) Compaction pile (iii) Vibro Compaction Piles (iv) Dynamic Compaction (v) Blasting, Ground Improvement in Cohesive Soil: Compressibility of cohesive soil, ,(i) vertical and radial consolidation, (ii) preloading methods.			
Unit No. 5: **Geo-synthetics and Soil reinforcement**	9	-	5
Geo-synthetics: types, functions & Classification of geo-synthetics, Specific Applications: Bearing capacity improvement, reinforcement, **Soil reinforcement:** Reinforcing materials, concept of confinement, Soil nailing, Ground anchors and rock bolting			

References	
1	G. Ranjan and A S R Rao, Basic and Applied Soil Mechanics, New Age international Publisher
2	Manfred R. Hansmann, "Engineering principles of ground modification", McGraw Hill Publication
3	Robert M. Koerner, "Construction and Geotechnical methods in Foundation Engineering", McGraw- Hill Pub. Co., New York
4	Winterkornand Fang, "Foundation Engineering Hand Book" - Van Nostrand Rein hold Co., New York.
5	Aris C. Stamatopoulos & PanaghiotisC.Kotzios,"Soil Improvement by Preloading, John Wiley & Sons Inc. Canada.
6	P. Purushothama Rao, "Ground Improvement Techniques", Laxmi Publications.
7	Engineering with Geosynthetics G. V. Rao and G.V.S.S Raju Tata McGraw Hill Publication, New Delhi 2004

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M. Tech. (Infrastructure Engineering & Technology)

Sem: II	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET203T	Subject: Bridge Engineering and Water Retaining Structures	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	To study the importance and basic elements of bridge structure.
2	Acquaint with bridge substructure and superstructure.
3	To know prestresses construction and cable stayed bridges
4	Acquaint advanced bridge construction technique.
5	To know construction of water retaining structures

Course Outcomes	
After completion of the course, students will be able to	
1	To study typical loadings and specification of bridges.
2	To understand foundation and various type of construction technology adopted in Bridges.
3	To understand prestressed construction, its method and cable stayed bridges.
4	To understand composite construction, and multi level bridges construction
5	To understand construction of dam and weirs.

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	3		2								
CO2	1	3										
CO3	1	3		2								
CO4	1	3										
CO5	1	3		2								
Avg	1	3		2								

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	
Unit No.1 General	8	-	1
Introduction to Bridges: Basic Elements of a Bridge. **Types of bridges and grade separated structures**: standard			

specifications for road bridges and grade separated structures to fulfill traffic, Structural and Hydraulic design requirements. **RE Panel Structures** - functions and applications, reinforced retaining walls, construction methods, benefits.			
Unit No.2 Substructure & Superstructure	10	-	2
Substructure:-Types of bridge foundation, open and pile foundation, excavation methods **Bridge Deck**:- General principle and methods of bridge deck analysis (No Problem), Structural forms and behaviour, Decks Construction methods, Different types of superstructure (RCC, PSC, Segmental construction), Effects of Differential settlement of supports. **T-beam and Box girder deck slab construction**: Slab type, T beam and box-girder bridges, Launching of girder, Span lengths -deck and stiffening system.			
Unit No.3 Prestressed Construction and Cable Stayed Bridge	9	-	3
Economics of reinforced concrete superstructure, pre-stressed concrete superstructure, Introduction to Precast segmental construction for long-span bridges, cables and their profiling, deck section, soffit surface, deflection and pre-camber, expansion joint, bearings, aesthetics. Cable-stayed bridge construction – Construction methods, cable configuration, towers, multi span cable stayed bridges, stay Tendons, aerodynamic stability.			
Unit No.4 Advanced Bridge Construction	9	-	4
Steel concrete composite construction: theory of composite structures, Introduction to steel - concrete - steel sandwich construction. **Multi-level Bridges:** 2 level, 3 level bridges, case studies			
Unit No. 5 Water Retaining Structures	9	-	5
Dam Construction:- Activity scheduling, stages of construction, river training, cofferdam and caissons **Weir:** Introduction, Need, Type, Plan and Design Philosophy, Case Studies			

References	
1	Victor. D. J, "Essentials of Bridge Engineering", Oxford IBH
2	Ponnuswamy. S, "Bridge Engineering", Tata McGraw Hill
3	Raina V. K. "Concrete Bridge practice", Tata McGraw Hill Publishing Co.
4	Derrick Beckett, "An Introduction to Structural Design of Concrete Bridges",Surry University Press, Oxford Shire.
5	Fleming. W.G.K., et al., "Piling Engineering", Surrey University Press, London.
6	PWD Handbook
7	CWC guidelines
8	Irrigation Manual

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
FACULTY OF SCIENCE &TECHNOLOGY
M. Tech. (Infrastructure Engineering & Technology)

Sem: II	Total Hours Distribution per Week		
Total Credit: 02	Lecture: 2 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET204T	Subject: New Construction Material and Technique	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	To enable the student understand the different advanced materials of construction and their application.
2	On completion of this course the students will have the knowledge of modern construction materials to be used in the field
3	To give an experience in the implementation of new technology concepts which are applied in field of Advanced construction.

Course Outcomes	
After completion of the course, students will be able to	
1	Understand the mechanism behind the behavior/performance of a particular material individually as well as in combination
2	Knowledge of the recent advances in materials used for structural and non-structural elements of a building
3	to keep pace with the industry and make them more industry-ready product.
4	Employ recent advancement in construction techniques.

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1				3		1					2
CO2	1				3		1					2
CO3	1		1		3		1					3
CO4	1		1		3		1					3
Avg	1		1		3		1					2.5

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
Unit No. 1: **Modern Construction Materials**	8	-	1
Types of structural steels, special steel, alloy steel, REBAR, stainless steel, light gauge steel, Ferrocement, material and			

properties, fibers and composites, Architectural use and Aesthetics of composites, Adhesives and sealants, Structural elastomeric bearings and resilient seating, Moisture barriers, Glass facade, materials and techniques, Use of titanium dioxide, transparent Aluminum.			
Unit No. 2: **Use of Waste Material and Polymer**	9	-	2
Material composition and properties, production, storage, distribution, testing, acceptance criteria, applications, limitations of use, economic consideration, and recent development related to the following materials to be studied: Fly Ash, coal ash, Blast furnace slag, Red mud, Waste glass, Rice husk, Structural Plastics and Composites Polymer Membranes-Coatings-Adhesives, Non - Weathering Materials Flooring And Facade Materials- Glazed Brick, Photo Catalytic Cement, Composite Fiber			
Unit No. 3: **New Construction Materials**	8	-	3
Transparent concrete, Float Concrete, Foam concrete, , Bendable Concrete, concrete canvas, Self Healing concrete, Sensi tile, Electrified Wood, Flexicomb, RichLite, Carbon fiber, Liquid Granite Low E-glass film, transparent Aluminium, Paper Insulation, Solar Pannel Roofing tile,			
Unit No. 4: **New Construction techniques**	8	-	4
Augmented reality in construction, Raised Access Flooring, Thin joint Masonry, Kinetic Footfall Energy Harvesting, 3D printed Building, precast foundation, Twin wall technology, Precast cladding Panel Techniques of construction for continuous concreting operation in tall buildings of various shapes and varying sections Launching techniques - Slip form techniques, suspended form work - erection techniques of tall structures.			

References	
1	S. K. Sharma, Civil Engineering Construction Materials. Khanna Book Publications, 2019
2	P. Purushothama Raj , Building Construction Materials and Techniques, Pearson, 2016
3	Bruntley L. R, Building Materials Technology Structural Performance & Environmental Impact, , McGraw Hill Inc Construction Technology, Vol I - IV, R Chudley, Longman Group Construction Ltd
4	Materials for Civil and Construction Engineers, Mamlouk and Zaniewski, Pearson
5	Ashby, M. F. and Jones, Engineering Materials: An introduction to Properties, applications and designs
6	J. Patrick Powers, Arthur B. Corwin, Paul C. Schmall, Walter E. Kaeck, "Construction Dewatering and Groundwater Control: New Methods and Applications", ISBN: 978-0-471-47943-7, Wiley & Sons, Inc., 3rd Edition.
7	Atev. S.S., "Construction Technology", Mir Publisher
8	The Complete Book on Construction Materials , NPCS Board of Consultants, Engineers

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M. Tech. (Infrastructure Engineering & Technology)

Sem: II	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET205T	Subject: Research Methodology	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	To understand significance of research
2	To know research methodology and technique for defining research problem
3	To gain knowledge of hypothesis
4	To explore various optimization methods for research
5	To write a technical research paper

Course Outcomes	
After completion of the course, students will be able to	
1	Understand some concepts of research its methodologies
2	Identify appropriate research topics and define appropriate research problem and parameters
3	Identify, explain, compare, and prepare the key elements of a research proposal/report
4	Describe sampling methods, measurement scales and instruments, and appropriate uses of each.
5	Demonstrate how educational research contributes to the objectives of your master program and to your specific career aspirations

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1			1	1	1		1	1		1
CO2	2	1	2	1	1	1	1		1	1		1
CO3	2	1	2	1	2	1	1	1	1	1	1	2
CO4	2	1	1	1	2	1		1	3		1	3
CO5	1	1			2	2	1		1	3		3
Avg	1.6	1	1.67	1	1.6	1.2	1	1	1.33	1.5	1	2

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
Unit No. 1:	9	-	1
What is Research?, How to do Research? The Objective of Research, Motivation in Research, Types of Research, Various Research Approaches, Significance of Research.			
Unit No. 2:	9	-	2
Research Methods, What is Research Methodology, Research Process, What is Research Problem, Various Components of Research Problem, How to Identify the Research Problem, Steps involved in formulation of Research Problem, Necessity and Techniques involved in Defining Research Problem, Feasibility Check.			
Unit No. 3:	9	-	3
What is Hypothesis?, its Characteristics, Examples and Types, Hypothesis Testing, Concepts and Procedure of Hypothesis Testing. Data Collection, Methods of data collection, Primary Data, Secondary Data, Analysis of data, Simple regression, Multiple regression, linear and non linear correlation and regression .			
Unit No. 4:	9	-	4
Optimization, Principle, linear programming technique, simplex method, evolutionary programming techniques. Model analysis of structures, direct and indirect method, dimensionless terms and their significance, structural similitude's, optimization of model.			
Unit No. 5:	9	-	5
Research Paper and its contents, Choice on topic, Method of writing research paper, Plagiarism including rules of plagiarism			

References

1	Research Methodology- Methods and Techniques: Kothari C.K. (2004), 2/e, New Age International, New Delhi 2. 3. 4. 5.
2	Simulation Modeling and Analysis, 2nd ed.: Law, A. M., and W. D. Kelton, 1991, McGraw Hill
3	Applied Statistics & Probability for Engineers: Montgomery, Douglas C. & Runger, George C. (2007), 3/e, (Wiley India)
4	Research Methods: A Modular Approach: 2nd edition, Sherri L. Jackson, Wadsworth Cengage Learngin, Belmont, USA
5	Schaum's Quick Guide to Writing Great Research Papers: Laurie Rozakis, 2nd edition, McGraw Hill, New York, USA.

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Sem: II	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET206T Program Elective III	Subject: Advance Foundation Engineering	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	Design and settlement determination of a shallow foundation.
2	Design of deep foundation i.e., piles based on settlement & bearing capacity criteria
3	To impart importance of well foundation, drilled pier and caisson.
4	To know apparent earth pressure diagrams in design of sheet piles & braced cuts.
5	Design of foundations in Expansive soils and collapsible soil

Course Outcomes	
After completion of the course, students will be able to	
1	Analyze the bearing capacity and settlement of shallow foundations
2	Analyze and design pile foundations.
3	Analyze well foundation and construct drilled pier & caisson
4	Analyze and design sheet piles and cofferdams.
5	Understand the concept of foundations in expansive and collapsible soils.

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	3	1								
CO2	2	2	3	1								
CO3	2	3	2	3		1						
CO4	2	2	3	1		1						
CO5	2	2	1	2		1						
Avg	2	2.2	2.4	1.33		1						

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
UNIT NO. 1: **Shallow Foundation:**	9	-	1
I.S. Code method of bearing capacity, bearing capacity in multi			

layered soil, Bearing capacity evaluation from Standard Penetration test and Plate load test. Elastic and Consolidation Settlements, Settlement analysis in cohesionless soils, Permissible settlements as per IS 1904-1978, Raft Foundation: Settlement and Bearing Capacity analysis, Analysis of flexible and rigid raft as per IS 2950.			
Unit No. 2: **Deep foundations**	9	-	2
Pile foundation: Types, load capacity- dynamic formulae, static formula; pile load tests,Vertical load test, lateral load test, Cyclic load test; settlement of piles and pile groups, negative skin friction on single pile and pile groups; laterally loaded piles - Broom's Analysis, IS Code method; Under reamed piles – Load capacity, design and construction			
Unit No. 3: **Well Foundations:**	9	-	3
Well Foundations: Introduction, Different shapes and characteristics of wells. Components of well foundation. Forces acting on well foundation. Sinking of wells. Causes and remedies of tilts and shifts. Design aspects of Components of well foundation Drilled Piers & Caissons: Introduction, construction procedure, advantages and disadvantages of drilled pier.			
Unit No. 4: **Sheet piles & Cofferdams:**	9	-	4
Sheet piles & Cofferdams: Cantilever sheet piles and anchored bulkheads: Earth pressure diagram, determination of depth of embedment in sands and clays, timbering of trenches, Earth pressure diagrams, forces in struts. Cofferdams: Types and construction methods.			
Unit No. 5: **Foundations in Expansive and Collapsible soil**	9	-	5
Foundations in Expansive soils: problems in Expansive soils, Mechanism of swelling, swell pressure and swelling potential, Heave Foundation practices: Sand cushion, CNS technique, under–reamed pile Foundations, Stone pile, anchor technique, stabilization of expansive soils. Foundations on Collapsible Soils: Origin and occurrence, Identification, Sampling and Testing, Preventive and Remedial measures			

References	
1	Principles of Foundation Engineering B. M Das Thomson Brooks/Cole
2	Foundation Analysis and Design J. E. Bowles McGraw-Hill Book Company
3	Analysis and design of Substructures, Swami Saran, Oxford & IBH Publications Pvt. Ltd.
4	Pile Foundation Analysis and Design H.G. Poulos, and E. H. Davis, John Wiley and Sons, New York.
5	Design of Foundation Systems (1992) N.P.Kurien: Principles & Practices, Narosa, New Delhi
6	Foundation Engineering Hand Book (1990), H. F. Winterkorn and H Y Fang Galgotia Book source

RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR

FACULTY OF SCIENCE &TECHNOLOGY

M. Tech. (Infrastructure Engineering & Technology)

Sem: II	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET206T Program Elective III	Subject: Pre-stressed Concrete Structures	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	Understand basic concepts of pre-stressing systems and methods
2	Understand the different types of losses in pre-stressing and its assessment
3	Understand analysis and design of pre-stressed concrete elements (members)
4	Understand deflection, crack and serviceability
5	Understand composite construction

Course Outcomes	
After completion of the course, students will be able to	
1	Identify various pre-stressed structural elements
2	Apply analytical skills to evaluate performance of pre-stressed structural elements
3	Analyze pre-stressed structural elements with various considerations
4	Design and detail pre-stressed structural elements for various loading conditions

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2											
CO2	2	2	1									
CO3	2	3	3									
CO4	2		3									
CO5	2	2	1									
Avg	2	2.33	2									

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
UNIT NO. 1: **Introduction**	9	-	1
Theory, Behaviour and Materials Introduction: Basic concept of pre-stressing (including advantages and disadvantages), Basic			

Definitions; Pre-stressing methods - Thermo elastic, chemical , Electrical; Material Properties - Concrete and Pre-stressing steel; Pre-stressing Systems - Pre-tensioning and Post-tension systems.			
Unit No. 2: **Losses in Pre-stress**	8	-	2
Purpose of calculating losses – Elastic loss, creep, shrinkage, relaxation and anchorage losses; Friction loss in pre-stress, Force variation diagram in friction loss.			
Unit No. 3: **Analysis and Design**	10	-	3
Analysis and Design For Flexure Analysis of stresses by stress method, force method and load balancing method; Pre-Basic assumptions for calculating flexural stresses, permissible stresses in steel and concrete as per IS 1343 Code; Design of sections of Type II and Type III Post-tensioned (PT) Beams/slabs;Check for strength limit based on IS 1343; Layout of cables in PT -beams/slabs.			
Unit No. 4: **Deflection and Design of Anchorage Zone**	9	-	4
Deflection and Design of Anchorage Zone, Factors influencing deflections – Short term deflections of un-cracked members; Prediction of long term deflections due to creep and shrinkage; Check for serviceability limit state of deflection, estimation of crack width. Determination of anchorage zone stresses in post-tensioned beams by Magnel's method, Guyon's method and IS 1343 method; design of anchorage zone reinforcement, Check for transfer bond length in pre-tensioned beams.			
Unit No. 5: **Special Structures**	9	-	5
Continuous beams - concepts; Composite Construction of Pre-stressed and in situ Concrete; Pre-stressed Concrete Poles, Pre-stressed Concrete Pavement, Piles Sleepers –concepts; Construction of Pre-stressed Concrete Structures.			

References	
1	T. Y. Lin, "Design of Pre-stressed Concrete Structures", John Wiley & Sons, 3E, 2010.
2	N Krishna Raju, "Pre-stressed Concrete", Tata McGraw Hill Publishing Co. Ltd, New Dehi, 6E, 2018.
3	Raja Gopalan N, "Pre-stressed Concrete", Narosa Publishing House, New Delhi, 2E, 2010.
4	Pandit and Gupta, "Pre-stressed concrete", CBS, 2009.
5	Sinha N.C. & Roy, "Fundamentals of Pre-stressed Concrete", S. C & Co, 1985.
6	6. Precast/Pre-stressed Concrete Institute Manual, "Fundamentals of pre-stressed concrete design", ISBN-0-937040-02-9
7	IS: 1343-1987, IS: 1343-2012
8	Srinath. L.S., Advanced Mechanics of Solids, Tata Mc Graw Hill Publishing Co ltd., New Delhi
9	S. Ramamrutham, "Prestressed concrete", Dhanpat Rai & Sons, Delhi

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FACULTY OF SCIENCE &TECHNOLOGY
M. Tech. (Infrastructure Engineering & Technology)

Sem: II	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET206T Program Elective III	Subject: Infrastructure Construction Technology	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	To introduce the various types of formwork and tall structure construction technique
2	To introduce the various construction methods and equipment's
3	To gain basic knowledge on various sub structure techniques
4	To acquire the knowledge of different super structure
5	To know top down construction and strengthening technique

Course Outcomes	
After completion of the course, students will be able to	
1	Design the formwork for beam, column, slab elements and understand construction technique for high rise structures
2	Understand the basic constructional methods and equipment's
3	Construct different sub structures
4	Apply knowledge in super structure construction
5	Understand top and bottom constructions and strengthening technique

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3	3		1							
CO2	2	2	1		1							
CO3	2	1	1		1							
CO4	2	1	1		1							
CO5	2	1	1		1							
Avg	2	1.6	1.4		1							

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
Unit No. 1: **Design of Formwork**	9	-	1
Basic Concepts in Formwork design - Beam formulae: Allowable stresses, Deflection, Bending, Lateral stability, Shear, Bearing; Design of Wall forms; Slab forms; Beam forms; Column forms.			

Unit No. 2: **Various construction methods & Equipment**	9	-	2
Trenchless technology, Drilling, Blasting, Dewatering, Finishing items, painting, flooring, brick works. Types of Earthwork Equipment, Tractors, Motor Graders, Scrapers, Front end waders, tamping rollers, smooth wheel rollers, pneumatic tyred rollers, Earth Movers Equipment for Dredging, Trenching, Forklifts and Related Equipment, Portable Material Bins, Conveyors.			
Unit No. 3: **Sub Structure Construction**	9	-	3
Under Water Construction of diaphragm walls and basement, Tunneling techniques -Tunnel technique by advance planning and equipment in geologically adverse condition, piling techniques, driving well and caisson, Box jacking, Pipe Jacking, cofferdam sinking, cable anchoring and grouting, Large reservoir construction with membranes and Earth system, well points			
Unit No. 4**: Super Structure Construction**	9	-	4
Concrete paving technology, construction techniques for continuous concreting operation in Tall buildings, Vacuum Dewatering of concrete flooring, Launching Techniques, Launching techniques for heavy decks in situ pre-stressing in high rise structures, , Construction sequences in cooling towers, Silos, Chimney, Sky scrapers, bow string bridges, cable stayed bridges,			
Unit No. 5: **Top and down construction Methods**	9	-	5
General construction sequence for Building tower constructions. Construction procedure of lattice towers and rigging of transmission line structures. Common Strengthening Techniques: Mud Jacking grout through slab foundation - micro piling for strengthening floor - under pinning. Explosives and its classification. Sequence in demolition and dismantling.			

	References
1	Roy Chudley and Roger Geeno,"Advanced Construction Technology" Latest Edition, 2005.
2	Sankar S. K. And Saraswati .S, "Construction Technology", Oxford University Press, New Delhi, 2008.
3	J. Singh, "Heavy Constructon-Planning, Equipment and Methods", Oxford & IBH Publishing Co. Pvt 1993.
4	Peurifoy, Robert L., Schexnayder, Clifford J., Shapira, Aviad & Schmitt, Robert L., (2011), "Construction Planning, Equipment, and Methods"*, 8th ed., McGraw-Hill.
5	Chew Yit Lin, Michael, "Construction Technology for Tall Buildings", Singapore University Press, World Scientific, Hong Kong,
6	Harris, F.C., "Modern Construction Equipment and Methods, Longman Scientific & Technical, 1994".
7	Austin, C.K., Formwork for Concrete, Cleaver -Hume Press Ltd., London, 1996.
8	Hurd, M.K., Formwork for Concrete, Special Publication No.4, ACI, Detroit, 1996.

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M. Tech. (Infrastructure Engineering & Technology)

Sem: II	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET206T Program Elective III	Subject: Building Services and Engineering	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	The course will provide students the knowledge regarding various building services, NBC etc
2	The course will provide students the knowledge regarding the various vertical communication modes
3	The course will provide students the knowledge of Fire protection requirements for multi storied buildings
4	The course will provide students the knowledge of water supply & sanitation
5	The course will provide students the knowledge of light, ventilation & acoustics

Course Outcomes	
After completion of the course, students will be able to	
1	Understand necessity of building services and National Building Codes (NBC)
2	Apply knowledge of vertical communication in building construction
3	Apply fire safety system in residential & public buildings
4	Apply knowledge of plumbing system in domestic & commercial buildings
5	Understand & execute the concept of light, ventilation & acoustics

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		3				3	2					1
CO2		3				3	2					1
CO3		3				3	2					1
CO4		3				3	2					1
CO5		3				3	2					1
Avg		3				3	2					1

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
UNIT NO. 1: **Overview of Building Services**	9	-	1
Introduction to building services, classification of buildings as per national building code	1		
Necessity of building services, functional requirements of building,	1		
Different types of building services ie. HVAC (Heating, Ventilation, Air Conditioning),	2		
Escalators and lifts, fire safety, protection and control, plumbing services	2		
Rain water harvesting, solar water heating system	1		
Lighting, acoustics, sound insulation and electrical installations	1		
Unit No. 2: **Modes of Vertical Communication**	9	-	2
Objectives & modes of vertical communication in building	1		
Lifts: Different types of lifts and its uses, component parts of lift, lift well, travel, pit, hoist way, machine, buffer, door locks, suspended rope, lift car, landing door, call indicators, call push etc., design provisions for basic size calculation of space enclosure to accommodate lift services, safety measures	3		
Escalators: Different types of escalators & uses, components of escalators, design provision for basic size calculation of space enclosure to accommodate escalator services, safety measures	2		
Ramp: Necessity, design consideration, gradient calculation, layout & special features required for physically handicapped and elder people.	3		
Unit No. 3: **Fire Safety**	9	-	3
Fire protection requirements for multi-storied building, causes of fire in building, fire detecting and various extinguishing system, working principle of various fire protection systems.	3		
Safety against fire in residential and public buildings (multi-storied building), National Building Code provision for fire safety, fire resisting materials and their properties,	3		
Fire resistant construction, procedures for carrying out fire safety inspections of existing building, provisions for evacuation.	3		
Unit No. 4: **Water Supply & Sanitation Services**	9	-	4
Importance of plumbing, AHJ (Authority Having Jurisdiction) approval, plumbing terminology and fixtures: Terms used in plumbing, different types of plumbing fixtures, shapes/sizes, capacities, situation and location where used, Traps, Interceptors	3		
Domestic and commercial Hot water and water supply system for multi-storied buildings, Swimming pools-Design criteria, Springboards, pressure filters for recirculation, maintenance,	3		
Plumbing system for Drainage: phenomenon, types such as one pipe, two pipe system, different pipe materials, Anti siphon & vent piping	3		

- Installation, pipe joints, fitting, hanger supports, valves used in plumbing & their sustainability External drainage system in building.			
Unit No. 5: **Lighting, Ventilation and Acoustics**	9	-	5
Concept of lighting, types of lighting (natural & artificial), factors influencing the brightness of room, selection of artificial lighting, installation of light (direct, half- direct, indirect, half- indirect and direct-indirect), types of light control (manual switch, remote switch, timer, and photo-electric switch), types of lamps (incandescent, tungsten halogen and electric discharge) lamp selection as per room sizes	4		
Concept of ventilation, necessity and types, overview of air conditioning system for building.	2		
Building Acoustics, objectives, acoustic control in a building, acoustic material (porous absorber and cavity resonator)	3		

	References
1	National Building code, Part 1,4,8,9 Bureau of Indian standard, New Delhi
2	IS 12183 (Part 1):1987 Code of Practice for Plumbing in Multistoried buildings, Bureau of Indian standard, New Delhi
3	2008 Uniform Plumbing Code- India (UPC-1) Bureau of Indian standard, New Delhi
4	Plumbing Design & practice Code, McGraw-Hill, New Delhi ISBN-9780074620694
5	The A to Z of Practical Building Construction and its Management, Satya Prakashan, New Delhi ISBN-13:978-8176849692
6	Fire Services in India: History, Detection, Protection, Management by Bag S.P., Mittal Publications, New Delhi 8170995981
7	Principles of Fire Safety Engineering: Understanding Fire and Fire Protection by Akhil Kumar Das PHI Learning Pvt Ltd, New Delhi, 2014, ISBN-9788120350380
8	Acoustical designing in Architecture, by V .O.Kusen & C.M.Harris, John.Wiley&Son
9	Acoustic designing & practice, by R.L.Suri, Asia Publishing House.
10	Architecture acoustics, by Anita Lawrence.
11	Thermal Performance of Building by J.P Van Stratten, Elsvier Publishing Co.
12	Functional requirement of building (other than Industrial Building) ,BIS Handbook
13	A text book on Building services, R.Udyakumar, Eswar Press, Chennai

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FACULTY OF SCIENCE &TECHNOLOGY
M. Tech. (Infrastructure Engineering & Technology)

Sem: II	Total Hours Distribution per Week		
Total Credit: 01	Lecture: 0 Hrs	Tutorial: 0 Hrs	Practical (P) : 2 Hrs
Subject Code	PGIET207P	Subject: Advanced Communication Skills Lab	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
25 Marks	25 Marks	25Marks	-

Course Objectives	
1	Improving the students skill to communicate and respond in different socio-cultural and professional context
2	Communicating ideas relevantly and coherently in writing
3	Getting ready for industry

Course Outcomes	
After completion of the course, students will be able	
1	To communicate and write technical papers, report etc.
2	To develop presentation skills and corporate skills
3	To get ready for jobs in industry

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1								3		3		1
CO2								3		3		1
CO3								3		3		1
Avg								3		3		1

Syllabus

Details of Topic
Following Activities to be conducted:
1: Communicating Competency
• Reading comprehension – Techniques-Book review • Listening comprehension- Video talks – Eminent speeches • Verbal competency – Vocabulary- Spotting errors- Aptitude test
2: Technical Writing
• Essential of writing – Technical paper / report writing- concise writing • Administrative / Business Documentation – Circular Writing- Meeting-Agenda – Minutes Resolutions • Project Writing – Framing Outline – Finding Problem – Documentation - Citation
3: Presentation Skills

• Oral presentation – Public speaking – Paper & Seminar Presentation • Digital presentation – Power Point- Video Presentation – Poster presentation • Stage Dynamics- Body language – Para language
4: Corporate Skills
• Etiquettes – Dress- Dining – Net Etiquettes • Telephonic skills - Mobile Etiquettes • Soft Skills: Intra –Inter Personal Skills
5: Interview Skills
• Before interview- Curriculum vitae/Resume- Covering letter-Email writing • During interview: G. D.- Mock Interviews – Psychometric Tests – Follow up • After Interview – Excelling in Profession – Team Spirit – Work culture

References	
1	Rizvi, M. Ashrif. Effective Technical Communication. New Delhi: Tata McGraw Hill, 2005
2	Essential Communication Skills by Shalini Agrawal
3	Professional Communication Skills by A. K. Jain, Dr. P. Bhatiya and Dr. A. M. Shiekh, S. Chand Publisher
4	Raman, Meenakshi & Sharma Sangeeta. Technical Communication Principles and Practice, 2nd Edition, New Delhi: Oxford University Press, 2011
5	Bovee, Courtland L.; Thill, John V.& Chaturvedi, Mukesh. Business Communication Today, 9th Edition. New Delhi: Dorling Kindersley (India) Pvt. Ltd. Pearson. 2011
6	Soft Skills- Know Yourself and Know the World, Dr. K. Alex, Chand Publications, 3rd Edition, 2014
7	Word Power Made Handy, Shalini Verma, S Chand Publications, 2011
8	K-VAN SOLUTIONS-Advanced communication Lab software

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FACULTY OF SCIENCE &TECHNOLOGY
M. Tech. (Infrastructure Engineering & Technology)

Sem: II	Total Hours Distribution per Week		
Total Credit: 01	Lecture: 0 Hrs	Tutorial: 0 Hrs	Practical (P) : 2 Hrs
Subject Code	PGIET208P	Subject: Skill Training-2	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
25 Marks	25 Marks	25 Marks	-

Course Objectives	
1	To know the preparation of DPR for any infrastructure projects and sustainable development planning
2	Understand various software of geotechnical engineering, structural analysis and design, road designing and analysis
3	Analyze and Design civil engineering structure

Course Outcomes	
After completion of the course, students will be able	
1	To prepare a DPR for any infrastructure project
2	To understand sustainable development planning and smart cities infrastructure
3	To use modern tools to develop skills in geotechnical engineering, structural analysis and design, road designing and analysis

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1			2		3							1
CO2			2		3							1
CO3									3			1
Avg			2		3				3			1

Syllabus
Student should complete Part A and Part B

Part A

One planning projects are required to be completed from the following areas.

A. Preparation of DPR of any Infrastructure
B. Sustainable Environmental Planning.
C. Smart Cities Infrastructure & Services
D. Structural auditing for any Infrastructure

Students should undertake the work as per following guidelines:

a. Undertake studies and surveys for Site selection, site analysis, technical feasibility studies, for formulating the project and design of selected area / project.

b. Undertake studies to assess management, financial feasibility, Cost Benefit Analysis of Project, Social and Economic Impacts of Various Projects,

c. Identify bottle-necks, and prepare proposals suitable for implementation of Projects in consultation with Planning Authority and Stake Holders. The studies need to be carried out mainly through secondary sources.

d A field visit to any town/city in India has to be made.

e The students are required to submit typed report (A-4, size papers, spiral bound, 2 copies) along with studio exhibits (imperial/ A1size drawing sheet) for both the projects.

f The work shall be carried by the project team and to be presented

PART B

Students should get trained and developed skill in any one field and any one software / freeware of the following area or otherwise and submit the project work carried out using the software:

1	Software Required for Geo-Technical Work: GeoStudio, Geo5, FLAC3D, PLAXIS, EDUSHAKE, STADD Foundation
2	Software Required for Structural Analysis: SAFE, SAP2000, ABAQUS, ANSYS, FEAST
3	Software for Road Designing & Analysis: MX –Road, Bently Road Network, AutoCAD Civil 3D , OPEN ROADS, KENPAVE and HDM-4 (Management and applications)
4	Software Required for Structural Analysis and Design: STAAD Pro, ETABS, Revit Structure, Midas Gen

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Sem: II	Total Hours Distribution per Week		
Total Credit: 01	Lecture: 0 Hrs	Tutorial: 0 Hrs	Practical (P) : 2 Hrs
Subject Code	PGIET209P	Subject: Design of High Rise Structures Lab	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
25Marks	25 Marks	25 Marks	-

Course Objectives	
1	The objective of the course is to give awareness of practical application of various theoretical concepts.
2	The objective of the course is to enhanced the skills by using software in the field of Civil Engineering

Course Outcomes	
After completion of the course, students will be able to	
1	Understand organizational skills & professional practices
2	Interpret the communication skills of organizational members with each other
3	Analyze the structural problems by using STADD.PRO
4	Design the structural members by using STADD.PRO

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1					3				2	2		1
CO2					3				2	2		1
CO3					3				2	2		1
CO4					3				2	2		1
CO5					3				2	2		1
Avg					3				2	2		1

Syllabus

STAAD PRO is structural analysis and designing software which is used by civil engineers to analyse and design the structure. It helps to reduce the calculations of Shear Force, Bending Moment and deflection of structure.

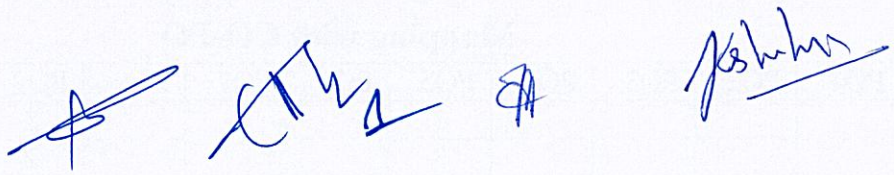
Minimum any Six Practical's to be performed from the list as below

1. Practical Based on: Overview of Structural Analysis and Design, Introduction of STAAD. Pro V8i, STAAD Editor, Creating a New Project in STAAD.Pro, Units, Model Generation,

Creating Nodes & Members, Select Menu, Insert Node, Add Beam, Modeling Methods, Long and Short Method Practice, Modeling Practice, Working On Examples.

2. Practical Based on: Support Specification, Member Property Specification, And Material Specification. Loading, Analyzing. Understanding Units, Working on examples, Understanding Material Properties, Understanding Various Types of Loads, and Implementing Loads.
3. Practical Based on : Performing Analysis, Pre Analysis Print, Post Analysis Print, Area Load, Floor Load.
4. Practical Based on: Wind Load Generation, Load Combination & Auto Load Combinations, Repeat Load Cases, Concrete Design.
5. Practical Based on : Concrete Column Design, Concrete Beam Design, Slab Design.
6. Using a software application, analyse and design a continuous beam. Compare the design outputs of software applications with those of manual calculations.
7. Using a software application, analyse and design of frame. Compare the design outputs of software applications with those of manual calculations.
8. Using a software application, design the Isolated footing of the frame. Compare the design outputs of software applications with those of manual calculations.
9. Using a software application, analyse and design of multi storied frame. Subjected to dead load, live load and wind load.
10. Study and review of IS 456, SP16 and SP34.

Student have to submit maximum four experiments on above contents (Selection of contents made by concern faculty) in 8 weeks. Proposed amendment is "STAAD Pro V8i or Any Other Equivalent Software may also be used for performing the same activities.



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Sem: III	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET301T- Program Elective IV	Subject: Intelligent Building and Smart Cities	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	The course will provide students the knowledge of intelligent buildings
2	The course will provide students the knowledge of energy management in services
3	The course will provide students the knowledge of different smart material for construction
4	The course will provide students the knowledge of smart cities
5	The course will provide students the knowledge of economic, social & cultural aspects of smart cities

Course Outcomes	
After completion of the course, students will be able to	
1	Understand necessity of intelligent buildings/ smart buildings
2	Apply knowledge of energy management in building construction services
3	Select proper smart material in construction
4	Acquaint knowledge on smart cities planning and development
5	Understand economic, social & cultural aspects of smart cities

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	3				3	3					1
CO2	2	3				3	3					1
CO3	2	3				3	3					1
CO4	2	3				3	3					1
CO5	2	3				3	3					1
Avg	2	3				3	3					1

1 Low 2 Medium 3 High

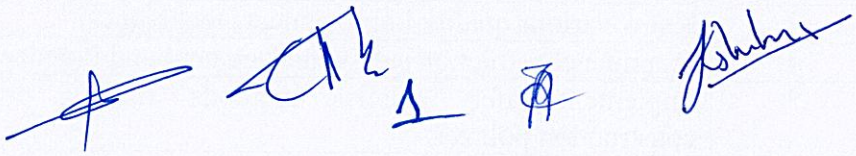
Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
UNIT NO. 1: **Intelligent Buildings:**	9	-	1
Concept, Definition, intelligent Architecture and structure,			

evaluation of intelligent buildings			
IB assessment criteria – intelligent homes, Natural building design consideration			
Energy efficient design strategies - Contextual factors - Longevity and process Assessment			
Renewable energy sources and design- Advanced building Technologies - Smart buildings.			
Unit No. 2: **ENERGY MANAGEMENT IN SERVICES :**	9	-	2
Energy in building design - Energy efficient and environment friendly building	2		
Thermal phenomena - thermal comfort Indoor Air quality - passive heating and cooling systems, Energy Analysis - Active HVAC systems	2		
Preliminary Investigation - Energy audit - Types of energy audit	2		
Energy flow diagram - Energy consumption/ Unit production – Identification of wastage -Priority of conservative measures - Maintenance of management programme	3		
Unit No. 3: **SMART MATERIALS IN CONSTRUCTION**	9	-	3
Smart material concept, advantages, smart materials such as self-cleaning concrete, self-healing coating, transparent concrete, carbon fiber reinforced concrete, microbial concrete, shape memory alloy, transparent aluminum, carbon fibers, smart glass, thermo-wood cladding, solar shingles, Magnetorheological liquids, Light Emitting Cement			
Unit No. 4: **INTRODUCTION TO SMART CITIES:**	9	-	4
Introduction to city planning, Concept, Principle stakeholders, key trends in smart cities developments	3		
Understanding smart cities, Dimension of smart cities, Global Standards and performance benchmarks, Practice codes	3		
Smart city planning and development, Financing smart cities development, Governance of smart cities	3		
Unit No. 5: **ECONOMIC, SOCIAL & CULTURAL ASPECTS OF SMART CITIES & MISSION INDIA:**	9	-	5
Concept of city economy, urban governance and smart city	3		
Smart city concepts in slum area development, Historic core regeneration/ preservation and smart city	3		
Urban projects in India-JNNURM, Smart city mission, Detailed case studies with focus on technology as enabling mechanism	3		

References	
1	S. Wang, *Intelligent Buildings and Building Automation*, Taylor & Francis, Spon Press, 1st ed., 2010.
2	Albert Ting-Pat So, and W. L. Chan, Intelligent Building Systems, Springer, Kluwer Academic Publishers group, 1999.
3	James Sinopoli,"Advanced Technology for Smart Buildings",Artech House, 2016
4	James Kachadorian,"Passive Solar House: The Complete Guide to Heating and Cooling Your Home" Chelsea Green Publishing; Revised and expanded second edition

	edition,2006
5	James M. Sinopoli, Smart Buildings Systems for Architects, Owners and Builders Publisher: Butterworth-Heinemann, 2009
6	Jo Beall (1997); "A city for all: valuing differences and working with diversity"; Zed books limited, London (ISBN: 1-85649-477-2)
7	UN-Habitat; "Inclusive and sustainable urban planning: a guide for municipalities"; Volume 3: Urban Development Planning (2007); United Nations Human Settlements Programme (ISBN: 978- 92-1-132024-4)
8	Arup Mitra; "Insights into inclusive growth, employment and wellbeing in India"; Springer (2013), New Delhi (ISBN: 978-81-322-0655-2)
9	William J. V. Neill (2004); "Urban Planning and cultural identity"; Routledge, London (ISBN: 0- 415-19747-3)
10	John S. Pipkin, Mark E. La Gory, Judith R. Balu (Editors); "Remaking the city: Social science perspective on urban design"; State University of New York Press, Albany (ISBN: 0-87395-678-8)
11	Giffinger, Rudolf; Christian Fertner; Hans Kramar; Robert Kalasek; Nataša Pichler-Milanovic; Evert Meijers (2007). "Smart cities – Ranking of European medium-sized cities". Smart Cities. Vienna: Centre of Regional Science
12	"Draft Concept Note on Smart City Scheme". Government of India - Ministry of Urban Development (http://indiansmartcities.in/downloads/CONCEPT_NOTE_-3.12.2014__REVISED_AND_LATEST_.pdf)
13	"Smart Materials in Construction Technology", Jay Patel and Aditi Goyal, https://ieeexplore.ieee.org/document/8537256
14	"Smart Materials And Adaptive Building Envelopes As An Approach For Reducing Energy Consumption In Egypt: A Literature Review", Samar Awad Abdelhamed Soliman, Ibrahim Elsayed Maarouf Ibrahim & Mai Mohamed Abdo Ibrahim, https://www.witpress.com/Secure/elibrary/papers/SC22/SC22002FU1.pdf



RASHTRASANT TUKADOJI MAHARAJ NAGPUR UNIVERSITY, NAGPUR
FACULTY OF SCIENCE &TECHNOLOGY
M. Tech. (Infrastructure Engineering & Technology)

Sem: III	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET301T- Program Elective IV	Subject: Quality Control & Safety in Construction	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	Understand and evaluate safety management principles in construction
2	Understand and analyse quality circle (QC) concepts for possible implementation to solve construction productivity and quality problems entitled "How to manage productivity quality?"
3	Good basic practices for quality system and progress for quality assurance and quality improvement for construction companies

Course Outcomes	
After completion of the course, students will be able to	
1	Apply control concepts for improving the quality of construction.
2	Maintain the records of quality assurance processes and audits.
3	Know various quality improvements techniques.
4	Examine construction safety management and Practice safety in construction operations.
5	Implement safety policies, methods, training provided on any ISO approved construction policies.

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1		1			1					1	2
CO2	1		1			1					1	2
CO3	1		1			1					1	2
CO4	1		3			3					1	2
CO5	1		3			3					1	2
Avg	1		1.8			1.8					1	2

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
UNIT NO. 1: Quality Management	9	-	1

Introduction. , Definitions and objectives. Factor influencing construction quality, Responsibilities and authority. Quality plan, Quality Management Guidelines & Quality circles, Concept of Quality Audit, Importance of Quality Control in Construction, Measure taken for Improving Quality of Construction, Challenges faced on Construction project due to Globalization, Best Quality Construction Projects			
Unit No. 2: Quality Systems	8	-	2
Introduction. Quality system standard. ISO 9000 family of standards & requirements. Preparing Quality System Documents Quality related training. Implementing a Quality system. Bench-marking quality. Design of Quality manuals, checklist and inspection reports.			
Unit No. 3: Quality Assurance, Control and Improvement	10	-	3
Objectives. Difference between Quality Control and Quality assurance. Regularity agent, owner, design, contract and construction-oriented objectives & methods. Techniques and needs of QA/QC. Different aspects of quality. Appraisals, Factors influencing construction quality.	5		
Quality Improvement Techniques Selection of new materials Influence of drawing, detailing, specifications & standardization. Bid Preparation. Construction activity, environmental safety, social and environmental factors. Natural causes and speed of construction. Life cycle costing. Value engineering and value analysis.	5		
Unit No. 4: Construction Safety Management and operations	9	-	4
Construction Safety Management Role of top management. Duties & responsibilities of various officers on site.. Responsibilities of general employees. Safety committee. Safety training, Safety campaign.	5		
Safety in construction operations - Safety on various construction sites viz. buildings, dams, Tunnels, bridges, roads, Safety at various stages of construction. Prevention of accidents. Safety measures.	4		
Unit No. 5: Safety in use of Construction equipments and Policies	9	-	5
Safety in Use of Construction Equipment's -Safety while operating construction equipment's. e.g. Vehicles, cranes, hoists and lifts Safety of scaffolding and working platforms. Safety while using electrical appliances and explosives used.	4		
Study of Safety Policies - Study of safety policies, methods, equipment and training provided On any ISO approved construction company. Safety in office, working on sites of high rise construction.	5		

References	
1	James, J.O' Brian, Construction Inspection Handbook – Quality Assurance and Quality Control, Van No strand, New York, 1989.
2	Mantri Handook- A to Z of Construction- Mantri Publication.
3	Kwaku, A., Tena, Jose, M. Guevara, Fundamentals of Construction Management and Organisation, Reston Publishing Co., Inc., Virginia, 1985.
4	Juran Frank, J.M. and Gryna, F.M. Quality Planning and Analysis, Tata McGraw Hill,

	1993
5	Hutchins.G, ISO 9000, Viva Books, New Delhi, 2000
6	Rumane, Abdul Razzak (2011) "Quality Management in Construction Projects", ISBN: 9781439838723 464p.
7	Clarkson H. Oglesby, Productivity Improvement in Construction, McGraw-Hill, 1989.
8	John L. Ashford, The Management of Quality in Construction, E & F.N.Spon, New York, 1989.
9	Steven McCabe, Quality Improvement Techniques in Construction, Addison Wesley Longman Ltd, England. 1998.
10	Jimmy W. Hinze, Construction Safety, Prentice Hall Inc., 1997.
11	Richard J. Coble, Jimmie Hinze and Theo C. Haupt, Construction Safety and Health Management, Prentice Hall Inc., 2001.

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Sem: III	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET301T- Program Elective IV	Subject: Structural Health Monitoring	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	Learn the fundamentals of structural health
2	Study of structural health monitoring aspects
3	Learn the structural health monitoring using static field testing
4	Study the structural health monitoring using dynamic field testing
5	Study repair and rehabilitation of structures

Course Outcomes	
After completion of the course, students will be able to	
1	Understand concepts of structural health
2	Understand various structural health monitoring aspects
3	Learn the structural health monitoring using static field testing.
4	Understand the structural health monitoring using dynamic field testing.
5	Understand concepts of repair and rehabilitation of structures

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2		1		1						
CO2	2	3		1		1						
CO3	2	3		1		1						
CO4	2	3		1		1						
CO5	2	2		1		1						
Avg	2.2	2.6		1		1						

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
Unit No. 1: **Structural Health**	9	-	1
Factors affecting Health of Structures, Causes of Distress, Regular Maintenance			
Unit No. 2: **Structural Health Monitoring**	9	-	2

Concepts, Various Measures, Structural Safety in Alteration. Structural Audit: Assessment of Health of Structure, Collapse and Investigation, Investigation Management, SHM Procedures.			
Unit No. 3: **Static Field Testing**	9	-	3
Types of Static Tests, Simulation and Loading Methods, sensor systems and hardware requirements, Static Response Measurement.			
Unit No. 4: **Dynamic Field Testing**	9	-	4
Types of Dynamic Field Test, Stress History Data, Dynamic Response Methods, Hardware for Remote Data Acquisition Systems, Remote Structural Health Monitoring.			
Unit No. 5: **Introduction to Repairs and Rehabilitations of Structures**	9	-	5
Case Studies (Site Visits), piezo–electric materials and other smart materials, electro–mechanical impedance (EMI) technique, adaptations of EMI technique.			

References	
1	Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, Structural Health Monitoring, Wiley ISTE, 2006.
2	Douglas E Adams, Health Monitoring of Structural Materials and Components Methods with Applications, John Wiley and Sons, 2007.
3	J.P. Ou, H.Li and Z.D. Duan, Structural Health Monitoring and Intelligent Infrastructure, Vol-1, Taylor and Francis Group, London, U.K, 2006.
4	Victor Giurglutiu, Structural Health Monitoring with Wafer Active Sensors, Academic Press Inc, 2007.
5	Smart Materials and Structures, Gandhi and Thompson
6	Structural Health Monitoring: Current Status and Perspectives, Fu Ko Chang

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Sem: III	Total Hours Distribution per Week		
Total Credit: 03	Lecture: 3 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET301T Program Elective IV	Subject: Mass Transportation System	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	To know various mass transportation characteristics
2	To plan urban mass transportation system
3	To know metro railway construction
4	To analyze and understand operational and management issues
5	To know various modern transportation systems

Course Outcomes	
After completion of the course, students will be able to	
1	Understand various mass transportation characteristics
2	Design the planning for the Urban Mass Transportation Systems.
3	To plan metro railway, its station and depot system
4	Analyze the operational and management issues in mass transportation systems
5	Plan various modern transportation system

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		2	1									1
CO2		2	3		2							1
CO3		2	3		1							1
CO4		3	2									1
CO5		1	1		3							1
Avg		2	2		2							1

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
Unit No. 1: History and role of Transit	9	-	1
Recent Trends Mass Transportation Characteristics. Demand characteristics, Spatial, Temporal and Behavioural Characteristics of			

Transportation Demand.			
Unit No. 2: Urban Mass Transportation Planning	9	-	2
Demand Surveys, Estimation and Demand Projection, Four Stages of Planning. Performance Evaluation of Mass Transport System, Structure of Decision Making, Evaluation and Selection Methods, Selection Procedures, Economic Evaluation Methods			
Unit No. 3: **Metro Rail Construction**	9	-	3
Metro Planning & Selection Metro Act, Metro Planning and Selection, Metro Track Construction, Metro Rolling Stock, Tunnel Ventilation systems; Air conditioning for stations and buildings; Fire control systems; Lifts and Escalators **Metro Station and Depot** Metro Depots, Stations, Metro Maintenance, Facilities required at Metro railway Stations,			
Unit No. 4: Operational and Management Issues	9	-	4
Fleet Management, Reserved Bus Lanes, Signal Preemption, Dial-a-Bus, Vehicle Monitoring and Control System, Modal Coordination, Special Studies, Underground Transportation, Para transit, Rail Transit, Case Studies			
Unit No. 5: Transportation Systems	9	-	5
Mass Rapid Transit System (MRTS), Light rail transit (LRT), Street Car, Sky Train, and other Multiple modes, Behaviour Analysis, Multinomial and nested logit modals, Revealed and Stated Preference, Parking facilities, Operation Strategy.			

References	
1	Vuchic V.R., Urban Public Transportation System and Technology, Prentice Hall, Inc. Englewood Cliffs, New Jersey, (1981).
2	Agarwal M.K., Urban Transportation in India, INAE, Allied Publishers Ltd., (1996).
3	Grey G.E. & Hoel , L. A., Public Transportation, Prentice Hall, Englewood Cliffs, N.J. (1992).
4	Ceder, A.,Public Transit Planning and Operation: Theory, Modeling and Practice, B-H Elsevier Ltd., MA, 2007
5	Papacostas C.S. and Prevedouros, P.D., Transportation Engineering & Planning, PHI, New Delhi,2002
6	Vukan, R. Vuchic, Urban Transit: Operations, Planning and Economics, John –Wiley & Sons, New Jersey, 2005
7	Sarkar P., Maitry V., Joshi G.J., Transportation Planning –Principles, Practices & Policies,PHI,New Delhi (2014)
8	Kadiyali L. R. , Traffic Engineering and Transport Planning, Khanna Publication, 9th Edition, (1999)
9	M. Ramachandran "Metro Rail Projects in India" Oxford University Press 2011.
10	M. M. Agrawal, Sudhir Chandra and K. K. Miglani "Metro Rail in India for Urban Mobility" Prabha & Co. 2021
11	Detailed Project Reports of Various Metro Projects in India –By Delhi Metro Rail Corporation

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M. Tech. (Infrastructure Engineering & Technology)
Open Elective

Sem: III	Total Hours Distribution per Week		
Total Credit: 04	Lecture: 4 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET302T- Open Elective I	Subject: Disaster Management and Mitigation	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	To acquire the knowledge of disaster and hazards
2	To know various natural disaster
3	To understand man made disaster
4	To know pre and post preparedness for the disaster
5	To understand various disaster mitigation techniques

Course Outcomes	
After completion of the course, students will be able to	
1	Understanding foundations of hazards, disasters and associated natural / social phenomena
2	Familiarity with disaster management theory (cycle, phases)
3	Understand and study the manmade disaster
4	Humanitarian Assistance before and after disaster
5	Technological innovations in Disaster Risk Reduction: Advantages and problems

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1			1	1	1		1	1		1
CO2	1	1			1	1	1		1	1		1
CO3	1	1			1	1	1		1			1
CO4	1	1			1	2	1		3			2
CO5	1	1	1	2	2	2	1		1	1		3
Avg	1	1	1	2	1.2	1.4	1		1.33	1		1.6

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
UNIT NO. 1: **Introduction to Disaster**	9	-	1

Meaning, Nature, Importance of Hazard, Risk, Vulnerability and Disaster-Dimensions & Scope of Disaster Management-India's Key Hazards - Vulnerabilities - National disaster management framework - Disaster Management Cycle			
Unit No. 2: **Natural Disasters**	9	-	2
Natural Disasters- Meaning and nature of natural disaster; their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, Heat and cold waves, Climatic change: global warming, Sea level rise, ozone depletion.			
Unit No. 3: **Anthropogenic Disasters**	9	-	3
Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation and industrial waste water pollution.			
Unit No. 4: **Approaches in Disaster Management**	9	-	4
Pre- disaster stage (preparedness) - Preparing hazard zonation maps, Predictability/ forecasting & warning - Preparing disaster preparedness plan - Land use zoning - Preparedness through Information, education. Emergency Stage - Rescue training for search & operation - Immediate relief - Assessment surveys. Post Disaster stage - Rehabilitation - Social Aspect - Economic Aspect and Environmental Aspect.			
Unit No. 5: **Disaster Mitigation**	9	-	5
Meteorological observatory - Seismological observatory - Hydrology Laboratory and Industrial Safety inspectorate. Technology in Disaster Management-Emergency Management Systems (EMS) in the Disaster Management Cycle -Remote Sensing and Geographic Information Systems(GIS) in Disaster Management			

References	
1	Sharma.S.R, —Disaster management‖, A P H Publishers, 2011.
2	VenuGopalRao.K, —Geoinformatics for Disaster Management‖, Manglam Publishers and Distributors, 2010.
3	Singh.R.B, —Natural Hazards and Disaster Management: Vulnerability and Mitigation‖, Rawat Publications, 2006.
4	Gupta.H.K, —Disaster Management‖, University Press, India, 2003.
5	Gupta.M.C, —Manuals on Natural Disaster management in India‖, National Centre for Disaster Management,IIPA, New Delhi, 2001

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Sem: III	Total Hours Distribution per Week		
Total Credit: 04	Lecture: 4 Hrs	Tutorial: 0 Hrs	Practical (P) : 0 Hrs
Subject Code	PGIET302T- Open Elective I	Subject: Water Resources Management	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
30 Marks	70 Marks	50 Marks	3 Hours

Course Objectives	
1	To know various aspects of water resources systems
2	To know various computing technique to solve water resources problems
3	To understand flood management
4	To know basing level management
5	To analyses impact of water resources projects of environment

Course Outcomes	
After completion of the course, students will be able to	
1	Learn about economic aspects of water and get awareness about allocation of resources and financial analysis in the water sector
2	Introduce the basics of soft computing techniques and illustrate its application for solving various problems in water resources engineering
3	The appraisal and design of measures for mitigating and managing such risks (such as structures for flood protection /mitigation, flood and droughts policies/plans/mapping; forecasting and managing flood and drought emergencies)
4	Make effort for learning basin level water resources management with technical and social aspects and understand water demand for irrigation, domestic, industrial use.
5	Apply knowledge acquired to the process of environmental impact , social impact

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	1	1	1				1	1	1	1	2
CO2	2	1		1	1				1	1	1	2
CO3	2	1	1	1	1				1	1	1	2
CO4	2	1		1	1	1			1	1	1	2
CO5	2	1	1		1				1	1		2
Avg	2	1	1	1	1	1		1	1	1	1	2

1 Low 2 Medium 3 High

Syllabus

Details of Topic	Allotment of Hours		Mapped with CO Number
	L	T	CO
UNIT NO. 1: **Introduction**	9	-	1
World water resources, water resources in India, water as finite resource, variability of water in time & space, history of water resources development, water infrastructure-problems and perspectives, present institutional framework for water management. Water laws: Constitutional provisions, National Water Policy, riparian rights / ground water owner ship, prior appropriation, permit systems, acquisition and use of rights, scope for privatization. (3Hrs) Economics of water: Water as economic good, intrinsic value, principles of water pricing & water allocation, capital cost, opportunity cost, internal rate of return, benefit cost analysis, principles of planning and financing of water resources project			
Unit No. 2: **Probabilistic and statistical methods**	9	-	2
statistical parameters, mean, mode, median, standard deviation, curtosis, probability, random events, random variable, functions of random variables, moments and expectations, common probabilistic distributions (normal, lognormal, poission, extreme value, log-pearson etc.) estimation of parameters, goodness of fit tests, regression and correlation analysis. Systems engineering: Systems Engg. concepts, optimizing techniques, conventional (LP, NLP, DP…) and evolutionary (ANN, fuzzy logic, genetic algorithm), simulation, applications of soft computing techniques for water resources planning and management			
Unit No. 3**: Flood management**	9	-	3
Causes of floods, structural and non-structural measures, mitigation plan, flood damage assessment, use of geoinformatics, Drought management: types of droughts, severity index, drought forecasting, damage assessment, mitigation plan, use of geoinformatics.			
Unit No. 4**: Basin scale hydrology**	9	-	4
Estimation of surface water, estimation of ground water draft/ recharge import/ export of water (interbasin water transfer), recycling and reuse, storages. Demand and supply based management: Consumptive & non consumptive demands, irrigation demand estimation, water utilization, irrigation efficiency, water management in irrigation sector, demand estimation in hydro/thermal/nuclear power sector, estimation & forecasting of water demands of domestic & industrial sector, navigation and recreational water demands			
Unit No. 5: **Environmental management**	9	-	5
Protection of vital ecosystem, water requirements for			

environmental management, aquaculture, minimum flows, water quality management for various uses. Social impact of water resources development: direct/ indirect benefits, employment generation, industrial growth, agro-industry, enhanced living standards, education & health, co-operative movement, management of rehabilitation & resettlement, control of water logging, salinity, & siltation of storages.			

References	
1	Water Resources Systems Engg, D. P. Loucks, Prentice Hall
2	A. K. Biswas; Systems Approach to Water Management, McGraw Hill Book Co, New York.
3	Chaturvedi, M.C. —Water Resources Systems Planning and Management‖ Tata McGraw Hill
4	Water resources hand book; Larry W. Mays, McGraw International Edition
5	ANN in Hydrology; Govinda Raju & Ramachandra Rao; PHI
6	Handbook of Applied Hydrology‖ by Van Tee Chow- McGraw Hil

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FACULTY OF SCIENCE &TECHNOLOGY
M. Tech. (Infrastructure Engineering & Technology)

Sem: III	Total Hours Distribution per Week		
Total Credit: 13	Lecture: 0 Hrs	Tutorial: 0 Hrs	Practical (P) : 26Hrs per students /semester
Subject Code	PGIET303P	Subject: Dissertation Phase I	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
50 Marks	150 Marks	100 Marks	-

Course Outcomes	
After completion of the course, students will be able to	
1	Identify the problem reviewing the available literature
2	Develop solutions for problems using modern tools for sustainable development.
3	Demonstrate ethical and professional sustainability while working in a team and communicate effectively for the benefit of the society
4	Apply engineering and management principles through efficient handling of the project

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1								
CO2	3	3	3	2	3	1	2		3	3	2	3
CO3	3	3	3	1		1	1	3	2	3	1	3
CO4	3	1	3	2	1						1	2
Avg	3	2.5	2.5	1.5	2	1	1.5	3	2.5	3	1.33	2.7

1 Low 2 Medium 3 High

Syllabus

Student should also complete internship and present the report.

The project work shall be carried out individually. Students in consultation with the guide/co-guide (if any) in project shall pursue a literature survey and complete the preliminary requirements of the selected Project work. This will involve scientific research, design, collection and analysis of data, determining the solutions. Each student shall prepare a relevant introductory project document and present a seminar.

Minimum two presentations on the work done during the semester. The dissertation report shall be based on the work carried out in the semester and approved by respective guides. The same work will continue in successive semester as Dissertation Phase II.

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Sem: IV	Total Hours Distribution per Week		
Total Credit: 16	Lecture: 0 Hrs	Tutorial: 0 Hrs	Practical (P) : 40 Hrs per student /semester
Subject Code	PGIET401P	Subject: Dissertation Phase II	
Examination Scheme			
Internal marks	University	Minimum Passing Marks:	Examination Duration
200 Marks	200 Marks	200 Marks	-

Course Outcomes	
After completion of the course, students will be able to	
1	Apply appropriate methods and tools to solve the problem
2	Develop solutions for problems using modern tools for sustainable development.
3	Demonstrate ethical and professional sustainability while working in a team and communicate effectively for the benefit of the society
4	Apply engineering and management principles through efficient handling of the project

Mapping with CO-PO

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	1	1								
CO2	3	3	3	2	3	1	2		3	3	2	3
CO3	3	3	3	1		1	1	3	2	3	1	3
CO4	3	1	3	2	1						1	2
Avg	3	2.5	2.5	1.5	2	1	1.5	3	2.5	3	1.33	2.7

1 Low 2 Medium 3 High

Syllabus

Students in consultation with the guide/co-guide (if any shall continue to work of Dissertation phase -1 to complete the Project work. Mid semester presentation and pre-submission seminar at the end of semester should be conducted. Each student shall prepare project document and present a seminar.
Final Project work will be evaluated based on:

- Project problem definition
- Literature Survey
- Scope , Assumptions
- Project Plan
- Project Preparatory Work and Data Gathering
- Concepts and Methodology used
- Results and Discussion
- Project Presentation

1. Students have to publish a research paper in a UGC-CARE journal/International Conference of the research work done in the semester.
2. Students will have to submit a soft copy of their dissertation report along with the hard copies.