Group No.	Course Code	Course Title	UNIQUE CODE
1	20CSE13	Advanced Design of RC Structures.	201CV001
1	20CGT12	Sub-surface Investigations and Ground Improvement Techniques	201CV002
1	20CWM13	Advanced Waste Water Treatment Engineering	201CV003
1	20CEE14	Solid Waste Engineering and Management	201CV004
1	20WRM13	Water Resources System Planning and Management	201CV005
1	20CCT12	Construction Project and Managements	201CV006
1	20CEM14	Construction Equipments and Management	201CV007
1	20CIM15	Advances in Pre-stressed Concrete	201CV008
1	20CTE13	Pavement Materials	201CV009
1	20CHT15	Traffic Engineering and Management	201CV010
1	20CTM11	Applied Statistics for Highway Engineering	201CV011
1	20CSE14	Mechanics of Deformable Bodies	201CV012
1	20CCS23	Structural Stability Analysis Classical & FE Approach	201CV013
1	20CCS334	Green Building Technology	201CV014
1	20WLM12	Surface Water Hydrology	201CV015
2	20CSE15	Structural Dynamics	202CV001
2	20CGT11	Forensic Geotechnical Engineering	202CV002
2	20CWM12	Water Pollution & Treatment Technology	202CV003
2	20CEE22	Atmospheric Environmental Pollution and Control	202CV004
2	20WRM14	Open Channel Hydraulics	202CV005
2	20CCT14	Advanced Construction Materials and Green Buildings	202CV006
2	20CEM243	Disaster Mitigation & Management	202CV007
2	20CIM23	Pre-fabricated Structures	202CV008
2	20CTE15	Urban Transport Planning	202CV009
2	20CHT23	Pavement Management System	202CV010
2	20CTM14	Soil Mechanics for Highway Engineers	202CV011
2	20CSE22	Finite Element Method of Analysis	202CV012
2	20CCS244	Structural Health Monitoring	202CV013
2	20CSE331	Fracture Mechanics Applied to Structural Engineering	202CV014
2	20CTE23	Geometric Design of Transportation Facilities	202CV015
3	20CSE21	Advanced Design of Steel Structures	203CV001
3	20CGT21	Reinforced Soil Structures	203CV002
3	20CWM14	Environmental Pollution and Control Management	203CV003
3	20CEE241	Environmental Geo Technology	203CV004
3	20WRM23	Watershed Conservation Management	203CV005
3	20CCT15	Mechanization in Construction	203CV006
3	20CEM244	Urban Hydrology, Storm Drainage and Management	203CV007
3	20CIM241	Construction Equipment and Safety Management	203CV008
3	20CTE21	Pavement Design and Analysis	203CV009
3	20CHT242	Design of Bridge and Grade Separated Structures	203CV010
3	20CTM241	Transportation Infrastructure Design	203CV011
3	20CSE242	Design of Precaste and Composite Structures	203CV012
3	20CCS253	Composite and Smart Materials	203CV013
3	20CSE31	Design of Bridges	203CV014
3	20WLM22	Ground Water Hydrology	203CV015
4	20CSE23	Earthquake Resistant Structures	204CV001

4	20CGT22	Soil Dynamics	204CV002
4	20CWM22	Industrial Effluent Treatment and Engineering	204CV003
4	20CEE31	Environmental Impact Assessment	204CV004
4	20WRM252	Climate Change and Adaption	204CV005
4	20CCT21	Construction Economics and Finance	204CV006
4	20CTM324	Railway Infrastructure Planning & Designing	204CV007
4	20CIM243	Ground Improvement Techniques	204CV008
4	20CTE31	Pavement Construction Technology	204CV009
4	20CHT254	Low Volume Roads Engineering	204CV010
4	20CTM31	Road Asset Management	204CV011
4	20CSE251	Design of Industrial Structures	204CV012
4	20CCS321	Structural Optimization – Theory and Computations	204CV013
4	20CCT251	Building Cost and Quality Management	204CV014
4	20WLM251	Irrigation Technology and Irrigation Water Management	204CV015

5	20CSE243	Advanced Concrete Technology	205CV001
5	20CGT23	Design of Deep Foundations	205CV002
5	20CWM241	Occupational Safety and Health Management	205CV003
5	20CEE242	Risk Assessment and Hazardous Waste Management	205CV004
5	20WRM31	Sediment Transport	205CV005
5	20CCT22	Pre Engineered Construction Technology	205CV006
5	20CEM31	Construction Quality and Safety Management	205CV007
5	20CIM332	Building Services and Maintenance	205CV008
5	20CTE322	Intelligent Transportation System	205CV009
5	20CHT31	Construction Planning & Economics	205CV010
5	20CTM321	Road Safety and Management	205CV011
5	20CSE252	Advances in Artificial Intelligence	205CV012
5	20CCS331	Design of Stack, Tower and Water Storage Structural Systems	205CV013
5	20CCT331	Energy and Buildings	205CV014
5	20WLM333	Global Warming and Climate change	205CV015

6	20CSE332	Design of Masonry Structures	206CV001
6	20CGT254	Soil Structure Interaction	206CV002
6	20CWM243	Aquatic Chemistry and Microbiology	206CV003
6	20CEE251	Water Resource Engineering and Applied Hydraulics	206CV004
6	20WRM322	Water Power and Dam Engineering	206CV005
6	20CCT31	Construction Contracts, Specification and Estimation	206CV006
6	20CEM241	Infrastructure for Smart City Planning	206CV007
6	20CIM334	Construction and Demolition Waste Management	206CV008
6	20CTE333	Pavement Evaluation and Management	206CV009
6	20CHT323	Special Problems in Road Construction	206CV010
6	20CTM333	Remote Sensing and GIS in Transport Planning	206CV011
6	20CSE254	Design of Tall Structures.	206CV012
6	20CCS12	Computational Structural Mechanics- Classical & FE Approach	206CV013
6	20CTM22	Advanced Traffic Engineering	206CV014
6	20WLM331	Ground Water Assessment, Development and Management	206CV015

Visvesvaraya Technological University, Belagavi.

Ph.D. Coursework Courses – 2020 in Civil Engineering.

(Group-1): 20CSE13 ADVANCED DESIGN OF RC STRUCTURES

Exam Hours: 3 hours	Exam Marks (Maximum): 100

Module-1

- Design of R C slabs by yield line method
- Design of flat slabs

Module-2

- Design of grid or coffered floors
- Design of continuous beams with redistribution of moments

Module-3

. Design of R C Chimneys

Module-4

- Design of R C silos
- Design of R C bunkers

Module-5

Formwork:
Introduction, Requirements of good formwork, Materials for forms, choice of formwork, Loads on formwork, Permissible stresses for timber, Design of formwork, Shuttering for columns, Shuttering for slabs and beams, Erection of Formwork, Action prior to and during concreting, Striking of forms. Recent developments in form work.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Unified Theory of Concrete Structures	Hsu T. T. C. and Mo Y. L.	John Wiley & Sons	2010
2	Limit design of reinforced concrete structures	Krishnamurthy, K.T., Gharpure S.C. and A.B. Kulkarni	Khanna Publishers	1985
3	Reinforced Concrete Design	Lin T Y and Burns N H	Wiley	2004
4	Reinforced Concrete Structures	Park & Paunlay	Wiley	2004
5	Comprehensive RCC Design	Punmia B.C, Ashok Kumar Jain and Arun Kumar Jain	Laxmi Publications, New Delhi	
6	Reinforced Concrete Structural Elements: Behaviour Analysis and Design	Purushothaman. P.	Tata McGraw-Hill	1986
7	Fundamentals of Reinforced Concrete	Sinha. N.C. and Roy S.K.	S. Chand and Company Limited, New Delhi	2003
8	Reinforced concrete Design	Unnikrishna Pillai and Devdas Menon	Tata McGraw Hill Publishers Company Ltd., New Delhi	2006
9	Limit State Design of Reinforced Concrete	Varghese P.C.	Prentice Hall of India	2007
10	Advanced Reinforced Concrete Design	Varghese P.C.	Prentice Hall of India, New Delhi	2000
11	Advanced Reinforced Concrete Design	Krishna Raju. N.	CBS Publishers & Distributors	
12	Reinforced Concrete Design	Pillai S. U. and Menon D.	Tata McGraw-Hill, 3rd Ed	1999
13	Relevant IS Code Books			
14	Reinforced Concrete, Vol-1 and Vol-2	Shah H. J	Charotar	8th Edition–2009 and 6th Edition–2012
	Design of Reinforced Concrete Structures	Gambhir M. L	PHI Pvt. Ltd, New Delhi	2008

(Group-1): 20CGT12	**SUB-SURFACE INVESTIGATIONS AND GROUND IMPROVEMENT TECHNIQUES**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

SITE INVESTIGATION:
Planning and experimental programme, investigations, exploration for preliminary design, exploration for detailed design, Geo-physical explorations, soundings, probings, boring, boring methods, excavation methods for explorations, ground water investigations, rock boring, miscellaneous exploratory techniques. Numerical problems

Module-2

SAMPLING AND IN-SITU FIELD TESTS: Types of samples, samplers, preservation, shipment and storage of samples, bore log, pore pressure measurements, core recovery, rock strength, rock quality designation
In-situ field testing and laboratory investigation of soils and rock, measurement techniques: SPT, SCPT, DCPT, pressure meter, dilatometer, plate load test. Numerical problems.

Module-3

DATA INTERPRETATION: Data interpretation for determination of engineering properties of soils and their application to geotechnical design, preparation of site investigation reports

Module-4

SITE IMPROVEMENT: General methods of stabilization – shallow and deep, factors governing suitable method, compaction.
Drainage: soil and filter permeability, filter criteria, drainage layout and pumping system, Pre-compression and consolidation: principles, sand drains, pore pressure distribution, electro-osmotic and chemical osmotic consolidation. Numerical problems

Module-5

STABILIZATION: Mechanical stabilization, lime, cement, bitumen, chemical etc. Grouting: Injection and principles,
grouting pressure criteria, grouting equipment, injection chemicals,
Thermal methods: heating and cooling effects on soils, equipment, Miscellaneous: moisture barriers and preventing techniques

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Engineering Principles of Ground Modifications	Hausmann	McGraw Hill	
2	Foundation Analysis and Design	J E Bowles	Tata McGraw Hill	
3	Subsurface Exploration and Sampling of Soils for Civil Engg. Purposes	Hvorslev M J		
4	Ground Improvement Techniques	P. Purushotham Raj		
5	Foundation Engineering	S P Brahma		
6	Soil Mechanics	T.W. Lambe and R.V. Whitman	John Wiley & Sons	1969
7	Geotechnical Engineering	Donold P	Coduto Phi Learning Private Limited, New Delhi	
8	Geotechnical Engineering	Shashi K. Gulathi & Manoj Datta. (4009)	Tata Mc Graw Hill	
9	Soil Mechanics and Foundation Engg	Muni Budhu (4010), 3rd Edition	John Wiely & Sons	
10	Soil Mechanics for Road Engineers	HMSO.		

(Group-1): 20CWM13	**ADVANCED WASTE WATER TREATMENT ENGINEERING**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction – Objectives of wastewater treatment system, Need for sanitation, classification of sewerage systems, dry weather and wet weather flow, factors affecting dry weather flow and wet weather flow, Design of sewers.
Characteristics of waste water and flow variations. Types of reactors and reactors analysis.

Module-2

Primary Treatment of wastewater- Flow chart on Community waste water treatment system, screenings, grit chamber, Oil and Grease removal, Aeration, Equalization basin, primary and secondary settling tanks and design.
Bio-kinetic coefficients– Definition, Significance in Biological treatment and their determination.

Module-3

Wastewater Treatment – Aerobic and Anaerobic treatment methods.
Theoretical principles and design considerations; **suspended growth system**- Conventional activated sludge process and its modifications.

Module-4

Sludge Processing – Separation - sludge thickeners, volume reduction, conditioning and digestion – aerobic and anaerobic.
Principles and design of stabilization ponds.
Nitrification and De-nitrification Processes, Phosphorous removal. Wastewater disinfection.

Module-5

Role of microorganisms in wastewater treatment - Degradation of Carbonaceous and Nitrogenous matter, high concentrated toxic pollutants.
Rural wastewater systems – Septic tanks, two-pit latrines, Eco-toilet, soak pits.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Wastewater Engineering - Treatment and Reuse	Metcalf and Eddy Inc., 4th Edition	Tata McGraw Hill Publishing Co. Ltd., New Delhi.	2003
2	Wastewater Treatment Concepts and Design Approach	Karia G.L., and Christian R.A.	Prentice Hall of India Pvt. Ltd., New Delhi.	2001
3	Water-wastewater Engineering	Fair G.M., Geyer J.G and Okun		
4	Wastewater Engineering - Treatment and Reuse	Metcalf and Eddy Inc., 4th Edition	Tata McGraw Hill Publishing Co. Ltd., New Delhi.	2003

(Group-1): 20CEE14	**SOLID WASTE ENGINEERING & MANAGEMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

I**ntroduction:** Sources and engineering classification, characterization, generation and quantification; Objectives, principles, functional elements of solid waste management system – Regulatory aspects of solid waste management, major problems. Environmental implications of open dumping, Construction debris – management &handling, E- Waste Management, Rag pickers and their role

Module-2

Waste Generation: Rate of generation, frequency, storage and refuse collection, physical and chemical composition, quantity of waste, engineering properties of waste, prediction, modeling concepts.

Collection, Segregation and Transport: Handling and segregation of wastes at source, Collection (primary & secondary) and storage of municipal solid wastes, collection equipment, transfer stations, collection route optimization and economics, regional concepts. System dynamics

Module-3

Waste Minimization: 4R: reduce, recover, recycle and reuse, case study, guidelines

Treatment Methods: Refuse processing technologies. Mechanical and thermal volume reduction. Biological and chemical techniques for energy and other resource recovery: composting, vermin composting, vermin gradation, fermentation. Incineration of solid wastes.

Module-4

Disposal Methods: Impacts of open dumping, site investigation and selection, sanitary land filling - Types, geotechnical considerations, design criteria and design, Liners - earthen, geo membrane, geo synthetics and geo textiles.

Operational aspects of MSW Landfills: Daily cover, leachate disposal, Ground Water monitoring, leachate and gas collection systems – Design, leachate treatment. Landfill Final Cap Design and Water Balance, Modeling (HELP–Hydraulic Evaluation of Landfill Performance), post-closure environmental monitoring; landfill remediation.

Module-5

Recent Developments in Solid Wastes Reuse and Disposal: Power Generation, Blending with construction materials and Best Management Practices (BMP). Community based waste management, Waste as a Resource concept, Public private partnership (PPP)

Role of various organizations in Solid Waste Management: Governmental, Non - Governmental, Citizen Forums.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Solid Waste Engineering Principles and Management Issues	Tchobanoglous G, Theissen H and Eliassen R.	McGraw Hill, New York	
2	Handbook of Solid Waste Disposal	Pavoni J. L.		
3	Environmental Engineering	Peavy, Rowe and Tchobanoglous	McGraw Hill	
4	SolidWaste Management		CPHEEO Manual	
5	Solid Waste Management		WHO Manual	
6	Management of Solid Wastes in Developing Countries	Flintoff F	WHO 4. Regional Publications, South East Asia, New Delhi	1976

(Group-1): 20WRM13	**WATER RESOURCES SYSTEMS PLANNING & MANAGEMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction: General Principles of Systems Analysis to Problems in Water Resources Engineering, Objectives of Water Resources Planning and Development, Nature of Water Resources Systems, Socio Economic Characteristics.

Module-2

Economic Analysis of Water Resources System: Principles of Engineering Economy, Capital, Interest and Interest Rates. Time Value of Money, Depreciation, Benefit Cost Evaluation, Discounting Techniques, Economic and Financial Evaluation, Socio-Economic Analysis.

Module-3

Methods of Systems Analysis: Linear Programming Models, Simplex Method, Sensitivity Analysis, Dual Programming, Dynamic Programming Models, Classical Optimization Techniques, Non-linear Programming, Gradient Techniques, Genetic Algorithm, Stochastic Programming, Simulation, Search Techniques, Multi Objective Optimization

Module-4

Water Quantity Management: Surface Water Storage Requirements, Storage Capacity and Yield, Reservoir Design, Water Allocations for Water Supply, Irrigation, Hydropower and Flood Control, Reservoir Operations, Planning of an Irrigation System, Irrigation Scheduling, Groundwater management, Conjunctive Use of Surface and Subsurface Water Resources, Design of Water Conveyance and Distribution Systems.

Module-5

Water Quality Management: Water Quality Objectives and Standards, Water Quality Control Models, Flow Augmentation, Wastewater Transport Systems, River Water Quality Models and Lake Quality models. Legal Aspects of Water & Environment Systems: Principles of Law applied to Water Rights and Water Allocation, Water Laws, Environmental Protection Law, Environmental Constraints on water Resources Development.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Water Resources Systems Planning and Analysis	Loucks, D.P., Stedinger, J.R. and Haith, D.A.	Prentice Hall Inc. N York	1982
2	Water Resources Systems Planning and Management	Chaturvedi, M.C	Tata McGraw Hill Pub. Co., N Delhi	1987
3	Water Resources Systems	Hall. W.A. and Dracup, J.A.	Tata McGraw Hill Pub. N Delhi	1975
4	Economics of Water Resources Planning	James, L.D. and Lee	McGraw Hill Inc. N York	1975
5	Water Resources Development, Planning, Engineering and Economics	Kuiper, E	Buttersworth, London	1973
6	Systems Approach to Water Management	Biswas, A.K.	McGraw Hill Inc. N York	1976
7	Applied Water Resources System Planning	Major, D.C. and Lenton, R.L.	Prentice- Hall Inc, N.Jersey	1979
8	Operations Research	Taha h A	Prentice Hall of India, N Delhi.	1996

(Group-1): 20CCT12	**CONSTRUCTION PROJECT AND MANAGEMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction: Construction Projects- Concept, Project Categories, Characteristic of projects, project life cycle phase. Project Management- Project Management Function, Role of Project Manager.

Module-2

Project Feasibility Reports: Introduction, Significance in feasibility report- Technical analysis, Financial analysis, Economic analysis, Ecological analysis, Flow diagram for feasibility study of a project.

Project planning Scope: Planning Process, Objectives, Types of Project plans, Resource Planning Process.

Module-3

Scheduling: Introduction to software's in construction scheduling (MSP, Primavera, Construction manager), Project Monitoring & Controlling Bar Charts, Work Breakdown Structure, Time estimates, Applications of CPM and PERT, A- O-N Network-Logic and Precedence diagrams, advantages, Drawing A-O-N network from A-O-A network and related problems.

Module-4

Time Cost relationship: Direct and indirect cost, step in optimization of cost, related problem. Allocation of resources: Histogram, Resource smoothening, Resource leveling and related problem. Project updating using CPM network and related numerical problems.

Module-5

Resources: Scheduling, Monitoring and Updating. Line of Balance Scheduling. Resource Planning-Leveling and Allocation. Introduction to Building Information Model (BIM).

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Construction Project Management: Planning, Scheduling and Control	Chitkara, K.K	Tata McGraw-Hill Publishing Company, New Delhi	1998
2	Project Management	Choudhury S	McGraw-Hill Publishing Company, New Delhi	1988
3	Project Management for Construction– Fundamental Concepts for Owners, Engineers, Architects and Builders	Chris Hendrickson and Tung Au	Prentice Hall, Pittsburgh	2000
4	PERT and CPM	Srinath L.S	East West Press Pvt Ltd New Delhi	
5	Modern Construction Management	Frank Harris and Roland McCaffer	4th Ed. Blackwell Science Ltd.	

(Group-1): 20CEM14	**CONSTRUCTION EQUIPMENTS AND MANAGEMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Plants and Equipment for production of materials- Crushers, mixers, bituminous mixing plants, concrete mixing plants, transit mixers, advantages, choice, production rate calculation

Module-2

Construction Equipment – Operations, applications and performance of dozers, excavators, graders, compactors, pavers, haulers, crawler, wheel tractors, power shovels, pile driving equipments, hauling equipments, and drilling, blasting and tunneling equipment.

Module-3

Miscellaneous Equipments - Equipment for: Dredging, tunneling, dewatering. Equipment for flooring- dewatering and floors finishing. Sprayers, kerb casting equipment, screening equipment.

Module-4

Selection of Construction Equipment- Task considerations, cost considerations, engineering Considerations, equipment acquisition options.

Module-5

Management of Construction Equipment: Need for mechanization of construction–planning and financing construction plant and equipment–Owning and operating equipment versus hiring–planning for infrastructure mechanization equipment management–equipment maintenance and repair, log maintenance, safety during operation, economical life of equipment.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Construction Planning, Equipment and Methods	Peurifoy, R.L., Ledbette. W.B.	McGraw Hill Co.	
2	Civil Engineering Construction	Antil J.M.	McGraw Hill Book Co.	
3	Principles and Practice of Heavy Construction	Smith, R.C, Andres, C.K.	Prentice Hall	
4	Construction equipment	SC Sharma		
5	Construction Project Management: Panning, Scheduling and Control	Chitkara, K. K.	Tata McGraw Hill Publishing Company, New Delhi	1998

(Group-1): 20CIM15	**ADVANCES IN PRE-STRESSED CONCRETE**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction – 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.

SDA: Group activity – Simple model preparation: Tendons, anchorage, strand, pre- stress concrete element.

Module-2

Losses in Pre-stress

Purpose of calculating losses – Elastic loss; creep; shrinkage; relaxation; anchorage losses and Friction loss.

SDA: Understand reasons for losses in PSC structures through digital resources.

Module-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, Limit state of Serviceability–Stress (IS 1343-1987); Limit state of Collapse – Flexure and Shear (IS 1343-2012).

SDA: Calculation for the stresses and flexural moment carrying capacity of PT element as per IS 1343 using

Module-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 transfer bond length in pre-tensioned beams; 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.

SDA: Prepare calculation for the deflection (short and long term) of PT elements using appropriate tools.

Module-5

Special Topics

Detailing of Post-tensioned Beams and Slabs, Composite Construction of Pre- stressed and in-situ concrete; Pre-stressed Concrete Poles, Piles, Railway Sleepers – concepts; Construction Methodology of Bonded and Un-bonded PT Slabs.

SDA: Group activity to prepare detailing and quantities of materials for PT slab and PT beam using appropriate software tool or conventional methods.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Design of Pre-stressed Concrete Structures	T. Y. Lin	John Wiley & Sons, 3rd ed.	2010
2	Pre-stressed Concrete	N Krishna Raju	Tata McGraw Hill Publishing Co. Ltd, New Delhi, 6th ed.	2018
3	Pre-stressed Concrete	Raja Gopalan N	Narosa Publishing House, New Delhi, 2nd ed.	2010
4	Pre-stressed concrete	Pandit and Gupta	CBS	2009

Textbook/Reference Books				
Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
5	Fundamentals of Pre-stressed Concrete	Sinha N.C. & Roy	S. C & Co	1985
6	Fundamentals of pre-stressed concrete design		Precast/Pre-stressed Concrete Institute Manual ISBN-0-937040-02-9. IS: 1343-1987, IS: 1343-2012.	
7	Design Guide Post-Tensioned Concrete Floors	Sami Khan and Marin Williams	Butterworth-Heinemann Ltd., UK, ISBN: 0750616814	1995
8	Handbook on Precast Concrete Buildings		Indian Concrete Institute, Chennai	2016

(Group-1): 20CTE13	**PAVEMENT MATERIALS**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Basic road construction materials–types, source, functional, requirements and properties, tests and specifications for use in various components of road.

Basic soil properties, methods to determine strength of soil, Soil Compaction for use in fill and sub grade of roads, compaction studies in laboratory and field, properties of compacted soils.

Module-2

Aggregates–Origin, classification, equipments, properties. Tests and specifications on road aggregates for flexible and rigid pavements. Importance of aggregate gradation problems on Rothfutch's and Critical sieve methods and Shape factor in mix design.

Module-3

Bituminous binders– different types, properties and uses, physical tests on bitumen, Rheological and pavement performance related properties, Modified binders, ideal pavement binders, characteristics and applications in road construction, criteria for selection of different binders.

Bituminous mixes, types, requirements, properties, tests, Marshall Method of mix design, Criteria and super pave mix design, Additives & Modifiers in Bituminous mixes, problems on mix design.

Module-4

Portland cement and cement concrete for use in road works– Requirements, design of mix for CC pavement, use of additives, IRC specifications & Tests, joint filler and sealer materials.

Module-5

Soil stabilization– Principle, methods and tests, proportioning of materials and mix design, application of Roth fetch's method.

Marginal and waste materials in road construction, their properties and scope in road construction. Use of Fly-ash in road Embankment and cement concrete mixes, use of chemical stabilizers in road construction.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Highway Engineering	Khanna and Justo	Nem Chand and Bros., Roorkee	
2	Hot Mix Asphalt Materials, mixture design and construction	Freddy L Roberts, Prithvi S Kandhaletal	2nd Edition, National Asphalt Pavement Association Research and Education Foundation, Maryland, USA	
3	Bituminous materials in Road Construction		HMSO Publication	
4	Specifications for Roads and Bridges Works	MoRTH	Indian Roads Congress IS73, revised 2006, IS 2720, IS 2386, IS 1201 to 1220, IS 8887-1995, IS 217-1986	
5	Compaction of earth work and subrade		State of art, special report 3, IRC, HRB, 1999 IRC: 51-1992, 63-1976, 74–1979, 88-1984, Indian Roads Congress. IRCSP: 53–2002, IRCSP: 58–2000, Indian Roads Congress.	

Textbook/Reference Books				
Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
6	Guidelines for use of Geo textiles in Road Pavements and Associated works		Indian Roads Congress	2002
7	Highway Materials Testing	Khanna and Justo	Nem Chand and Bros., Roorkee	
8	Soil Mechanics for Road Engineers		HMSO Publication	
9	Highway Hand Book	FAW	NUS, Singapore	
10	Standard Data Book on Highway Technology		P.G Examination of VTU	

(Group-1): 20CHT15	**TRAFFIC ENGINEERING AND MANAGEMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Traffic Studies & Analysis: Scope, traffic elements-Characteristics-vehicle, road user :and road - Traffic studies-speed & delay, traffic volume, O & D, parking and accidents-Sample size, study methodology - Data analysis & inferences.

Module-2

Traffic Flow Analysis: Macroscopic, Microscopic & Mesoscopic approach–Types of Flow-Traffic stream characteristics–Space–Time diagram–Relationship between speed, flow & density-Level of service & capacity analysis–Shockwave theory.

Module-3

Intersection Design: Types of intersections - Conflict diagrams –Control hierarchy- Design of rotaries & at-grade intersections – Signal design - Grade separated intersections & their warrants.

Module-4

Geometric Design : Cross sections–Sight distances–Super elevation–Horizontal & vertical alignments–Safety considerations

Road Safety Audit : Global & Local perspective–Road safety issues–Road safety programmes–Types of RSA, planning, design, construction & operation stage audits – Methodology – Road safety audit measures

Module-5

Traffic Regulation & Traffic Safety Management : Speed, vehicle, parking, enforcement regulations-Mixed traffic regulation - Management techniques, one-way, tidal flow, turning restrictions etc.–Transportation System Management Process–TSM planning & Strategies

Use of software: PTV VISSIM / VISUM (Traffic Flow Simulations), SIDRA (intersections), etc.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Traffic Engineering and Transportation Planning	Kadiyali L.R.	Khanna Publication,New Delhi	
2	Traffic and Highway Engineering	Nicholas J. Garber, Lester A. Hoel	Third Edition Thompson Learning	
3	Highway, Traffic Analysis and Design	Salter R J and Hounsell NB	Macmillan Press Ltd., London	
4	Traffic Engineering	Matson T M, Smith W S , Hurd F W	McGraw Hill Book Co, NY, USA	
5	Traffic Flow Theory and Control	Drew D R	McGraw Hill Book Co, NY, USA	
6	Traffic System Analysis of Engineers and Planners	Wohl and Martin	McGraw Hill Book Co, New York, USA	
7	Traffic Flow Fundamentals	May, A.D.	Prentice – Hall, Inc., New Jersey	1990
8	Highways-Traffic Planning & Engineering	O'Flaherty C A	Edward Arnold, UK	

9	Traffic Engineering	Pignataro	John wiley & sons. Nicholas J Garber, Lester A Hoel	
10	Traffic & Highway Engineering		Third edition, IRC: SP 43 1994 and other Relevant IRC codes	
11	Highway Engineering	S.K. Khanna, C.E.G Justo and A. Veeraragavan	Nem Chand and Bros., Roorkee. Revised 10^{th} Edition.	
12	Indian Highway		Capacity Manual (Indo-HCM) CSIR, New Delhi, 2012-2017	

(Group-1): 20CTM11 APPLIED STATISTICS FOR HIGHWAY ENGINEERING	
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction to statistical methods, scope aim and limitations, sample, attribute and types of data, sources and collection of data. Accuracy of data.
Representation and summarizing data. Frequency distribution, histogram and frequency curves. O give curve, Measure of central tendency–arithmetic mean, median and mode dispersion-range, standard deviation, variance and co-efficient of variation, skewness and kurtosis.

Module-2

Introduction to probability & statistics for Traffic Engineering Design– Introduction, Random variables and statistical measures: arithmetic mean, measures of dispersion, basic laws of probability, probability laws for discrete random variables: binomialand Poisson distribution, probability laws for continuous random variables: normal distribution, Poisson distribution

Module-3

Sampling Techniques– objective, basics of sampling, advantages of sampling, sampling techniques, sampling distributions–sampling distribution of the sample mean, central limit theorem, chisquare, t and F– distributions. Sampling error, sample size and design.

Module-4

Statistical decisions–point estimation, properties of parameters, Testing of Hypothesis–Type I and II errors.
Tests of significance–tests for mean and variance. Tests for proportions.

Module-5

Chi-square test of goodness of fit, student's t test, Confidence interval.
Curve fitting by the method of least squares, Linear correlation & regression, multiple linear regression. Analysis of variance
Use of soft-wares in statistical analysis–MATLAB, MINITAB

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Statistics–Principles and methods	Johnson Rand G Bhattacharya	John Wiley &sons, Newyork	1985
2	Traffic Engineering	L. R Kadiyali	Khanna Publishers, NewDelhi	
3	Introduction to statistics	Medhi	New Age Pub, New Delhi	
4	Probability Statistics & Decisions for Civil Engineers	Benjamin Jack Rand Cornell C Allin	McGraw Hill Co.	
5	Basic Statistics	Agarwal, B. L	3rd Edition, New Age Pub. New Delhi	
6	Traffic System Analysis	Martin Wohl, Brian V Martin	McGrawHill Series	

(Group-1): 20CSE14	**MECHANICS OF DEFORMABLE BODIES**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Theory of Elasticity: Introduction: Definition of stress and strain and strain at a point, components of stress and strain at appoint of Cartesian and polar coordinates. Constitutive relations, equilibrium equations, compatibility equations and boundary conditions in 2-D and 3-D cases.

Module-2

Transformation of stress and strain at a point, Principal stresses and principal strains, invariants ofstress and strain, hydrostatic and deviatric stress, spherical and deviatric strains max. shear strain.

Module-3

Plane stress and plane strain: Airy's stress function approach to 2-D problems of elasticity, simple problems of bending of beams. Solution of axisym metric problems, stress concentration due to the presence of a circular hole in plates.

Module-4

Elementary problems of elasticity in three dimensions, stretching of a prismatic bar by its own weight, twist of circular shafts, torsion of non-circular sections, membrane analogy, Propagation of waves in solid media. Applications of finite difference equations in elasticity.

Module-5

Theory of Plasticity: Stress – strain diagram in simple tension, perfectly elastic, Rigid – Perfectly plastic, Linear work – hardening, Elastic Perfectly plastic, Elastic Linear work hardening materials, Failure theories, yield conditions, stress – space representation of yield criteria through Westergard stress space, Tresca and Von-Mises criteria of yielding

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Theory of Elasticity	Timoshenko & Goodier	McGraw Hill	
2	Advanced Mechanics of Solids	Srinath L. S.	10th print, Tata McGraw Hill Publishing company, New Delhi	1994
3	Theory of Elasticity	Sadhu Singh	Khanna Publishers	
4	Theory of Elasticity	Verma P.D.S	Vikas Publishing Pvt. Ltd	
5	Plasticity for Structural Engineers	Chenn W.P and Hendry D.J	Springer Verlag	
6	Continuum Mechanics Fundamentals	Valliappan C	Oxford IBH Publishing Co. Ltd.	
7	Applied Stress Analysis	Sadhu Singh	Khanna Publishers	
8	Theory of Elasticity	Xi Lu	John Wiley	

(Group-1): 20CCS23 STRUCTURAL STABILITY ANALYSIS – CLASSICAL AND FE APPROACH

Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Beam column: Differential equation. Beam column subjected to (i) lateral concentrated load, (ii) several concentrated loads, (iii) continuous lateral load. Application of trigonometric series. Euler's formulation using fourth order differential equation for pinned- pinned, fixed-fixed, fixed-free and fixed-pinned columns.

Module-2

Buckling of frames and continuous beams. Elastic Energy method: Approximate calculation of critical loads for a cantilever, Exact critical load for hinged-hinged column using energy approach. Buckling of bar on elastic foundation, Buckling of cantilever column under distributed loads. Determination of critical loads by successive approximation, Bars with varying cross section, Effect of shear force on critical load. Columns subjected to pulsating forces.

Module-3

Stability analysis by finite element approach: Derivation of shape functions for a two noded Bernoulli-Euler beam element (lateral and translational DOF)–element stiffness and Element geometric stiffness matrices–Assembled stiffness and geometric stiffness matrices for a discretised column with different boundary conditions–Evaluation of critical loads for a discretised (two elements) column (both ends built-in). Algorithm to generate geometric stiffness matrix for four noded and eight noded isoparametric plate elements, Buckling of pin jointed frames (maximum of two active DOF)-symmetrical single bay Portal frame.

Module-4

Lateral buckling of beams: Differential equation–pure bending–cantilever beam with tip load–simply supported beam of I section subjected to central concentrated load. Pure Torsion of thin – walled bars of open cross section. Non–uniform Torsion of thin–walled bars of open cross section

Module-5

Expression for strain energy in plate bending with in plate forces (linear and non – linear): Buckling of simply supported rectangular plate– uniaxial load and biaxial load. Buckling of uniformly compressed rectangular plate simply supported along two opposite sides perpendicular to the direction of compression and having various edge condition along the other two sides.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Theory of Elastic Stability	Timoshenko, S.P. and Gere, J.M.	2nd Ed., McGraw Hill Book Co., New York	1961
2	Fundamentals of Structural Stability	Simitses, G.J. and Hodges, D.H.	Butterworth & Heinemann	2006
3	Stability Analysis and Design of Structures	Gambhir, M.L.	Springer	2009
4	Elements of Matrix and Stability Analysis of Structures	Manicka Selvam, V.K.	6th Ed., Khanna Publishers, New Delhi	2004
5	Advanced Mechanics of Solids	Srinath, L.S.	3rd Ed., Tata McGraw-Hill Publishing Co. Ltd., New Delhi	2017
6	Computational Structural Mechanics	Rajashekaran. S	Prentice-Hall, India	2001
7	Dynamics of Structures	Ray W Clough and J Penzien	2nd Edition, McGraw-Hill, New Delhi	1968

(Group-1): 20CCS334	**GREEN BUILDING TECHNOLOGY**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Overview of the significance of energy use and energy processes in building - Indoor activities and environmental control-Internal and external factors on energy use and the attributes of the factors-Characteristics of energy use and its management-Macro aspect of energy use in dwellings and its implications.

Module-2

Indoor environmental requirement and management-Thermal comfort-Ventilation and air quality–Air-conditioning requirement-Visual perception-Illumination requirement-Auditory requirement.

Module-3

Climate, solar radiation and their influences-Sun-earth relationship and the energy balance on the earth's surface-Climate, wind, solar radiation, and temperature-Sun shading and solar radiation on surfaces-Energy impact on the shape and orientation of buildings.

Module-4

End-use, energy utilization and requirements-Lighting and day lighting - End-use energy requirements-Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non steady heat transfer through the glazed window and the wall-Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer

Module-5

Energy management options-Energy audit and energy targeting-Technological options for energy management. Building rating systems.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Natural Hazards	Bryant Edwards	Cambridge University Press, U.K.	2005
2	National Building Code of India, Vol. 1 and 2		Bureau of Indian Standards	2016
3	Disaster Management	Carter, W. Nick	Asian Development Bank, Manila	1991
4	Disaster Mitigation Experiences and Reflections	Sahni, Pardeep, Medury Uma and Dhameja Alka	Prentice Hall of India, New Delhi	2002
5	Hand book of Green Building Design and Construction	Sam Kubba	LEED, BREEAM and Green Globes	2012
6	Sustainable Construction: Green Building Design and Delivery	Charles J Kibbart	J Wiley and Sons	2016

(Group-1): 20WLM12	**SURFACE WATER HYDROLOGY**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction: Scope and importance of hydrology, Hydrologic cycle, Global and India's Water resources, Applications of hydrology.

Watershed Concept: Catchment, Topographic and Ground water divide, Description of the catchment, demarking a catchment, stream patterns. Location of rain-gauges and optimum number of rain-gauges, Analysis of rainfall data, Rainfall mass curve and hyetograph, Intensity-Duration analysis, Intensity-Frequency-Duration analysis, Depth-Area-Duration analysis, Double mass curve.

Module-2

Abstractions from precipitation: Evaporation-Process, Measurement, Empirical equations and Estimation by Water budget method and Energy budget method.

Evapo-transpiration-AET & PET, Estimation by Penman's equation, Reference Crop Evapo-transpiration by Blaney Criddle formula.

Infiltration-Process, Factor affecting infiltration, Measurement, Horton's equation and Philip's equation. Infiltration indices.

Module-3

Runoff:-Process, Factors affecting runoff, API, Basin yield, Curve number method, water budgeting.

Correlation, Regression analysis-simple linear and Multiple linear regression, Curvilinear regression.

Classification of models, Model formulation, Lumped parameter conceptual models, Physically based models, Model performance testing.

Module-4

Hydrograph and its features, Methods of hydrograph separation, Unit hydrograph and its derivation, Unit hydrographs from complex storms and for various durations, S-curve hydrograph and its uses, Synthetic unit hydrograph.

Module-5

Flood: Design flood and its estimation- Rational method, Frequency analysis Gumbel's and Log-Pearson's type III distribution, Selection of design return period.

Flood routing- Reservoir routing: Modified Pul's method, Goodrich method, Channel routing- Prism and Wedge storage, Muskingum method.

Flood control: Structural and Non-structural measures.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Engineering Hydrology	Subramanya K	Tata McGraw Hill	1998
2	A text book of Hydrology	Jaya Rami Reddy, P	Laxmi Publications	2009
3	Principles of Hydrology	Putty, M. R.Y.	I.K. Int. Publishing House, New Delhi	2010
4	Hydrology for Engineers	Linsley R K, Kohler and Paulhus	McGraw Hill, NY, USA	1958
5	Applied Hydrology	Mutreja, K. N.	Tata McGraw Hill Pub. Co., New Delhi, India	1986
6	Handbook of Applied Hydrology	Chow, V.T.	McGraw Hill, NY	1964

(Group-2): 20CSE15	**STRUCTURAL DYNAMICS**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction: Introduction to Dynamic problems in Civil Engineering, Concept of degrees of freedom, D'Alembert's principle, principle of virtual displacement and energy principles.

Dynamics of Single degree-of-freedom systems: Mathematical models of Single-degree-of-freedom systems system, Free vibration response of damped and undamped systems including methods for evaluation of damping.

Module-2

Response of Single-degree-of-freedom systems to harmonic loading including support motion, vibration isolation, transmissibility.

Numerical methods applied to Single-degree-of-freedom systems – Duhamel integral.

Principle of vibration measuring instruments–seismometerand accelerometer.

Module-3

Dynamics of Multi-degree freedom systems: Mathematical models of multi-degree-of-freedom systems, Shear building concept, free vibration of undamped multi-degree-of-freedom systems–Natural frequencies and mode shapes–Orthogonality of modes.

Module-4

Response of Shear buildings for harmonic loading without damping using normal mode approach. Response of Shear buildings for forced vibration for harmonic loading with damping using normal mode approach.

Module-5

Approximate methods: Rayleigh's method, Dunkarley's method, Stodola's method.

Dynamics of Continuous systems: Flexural vibration of beams with different end conditions.

Stiffness matrix, mass matrix (lumped and consistent).

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Dynamics of Structures – "Theory and Application to Earthquake Engineering	Anil K. Chopra	2nd ed., PearsonEducation	
2	Earthquake Resistant Design of Building Structures	Vinod Hosur	WILEY (India)	
3	Vibrations, structural dynamics	M. Mukhopadhaya	Oxford IBH	
4	Structural Dynamics	Mario Paz	CBS publishers	
5	Structural Dynamics	Clough & Penzien	TMH	
6	Vibration Problems in Engineering	Timoshenko S,	Van-Nostrand Co.	

(Group-2): 20CGT11 FORENSIC GEOTECHNICAL ENGINEERING

Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Earth and Rock fill Dams: General features, Selection of site; Merits and demerits of the earth and rock fill dams, Classification of earth dams, Causes of failure, Safe design criteria. Instrumentation in earth dams: Pore pressure measurements, Settlement gauges, Stress measurements, Seismic measurements.

Failures, Damages and Protection of Earth Dams: Nature and importance of failure, piping through embankment and foundations, Methods of seepage control through embankments and foundations, Design Criteria for filters.

Module-2

Embankment Construction: Equipment for excavating, hauling, spreading, blending, compacting and separating oversized rocks and cobbles, construction procedures and quality control of impervious and semi-pervious embankment sections, handling dry and wet materials, construction problems caused by fines, construction procedures of hard and soft rock fill embankments, field test on rock fill embankments, slope treatment and rip-rap.

Module-3

Slope Stability Analysis: Types of Failure: Failure surfaces - Planar surfaces, Circular surfaces, Non-circular surfaces, Limit equilibrium methods, Total stress analysis versus effective Stress analysis, Use of Bishop's pore pressure parameters, Short term and Long term stability in slopes. Taylor Charts.

Special Design problems and details**:** Design considerations in earthquake, ground movements, earthquake intensity scales, periods and amplitudes of ground motion, influence of foundation material, earthquake waves, slope stability analysis during earthquake as per BIS, problems in loose sand, soft clay and silt foundation.

Module-4

Method of Slices, Effect of Tension Cracks, Vertical Cuts. Bishop's Analysis, Bishop and Morgenstern Analysis, Non-circular Failure Surfaces: Janbu Analysis, Sliding Block Analysis, Introduction to Seismic stability, Stabilization of slopes: Soil reinforcement (geosynthetics/soil nailing/micro piles etc), soil treatment (cement/lime treatment), surface protection (vegetation/erosion control mats/shotcrete).

Module-5

Slope Protection and Rockfill Dams: Stabilization of slopes: Soil reinforcement (geosynthetics/soil nailing/micro piles etc), soil treatment (cement/lime treatment), surface protection (vegetation/erosion control mats/shotcrete). Requirements of compacted rockfill, Shear strength of rockfill, Rockfill mixtures, Rockfill embankments, Earth-core Rockfill dams, Stability, Upstream & Downstream slopes

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Earth and earth-rock dams	Sherard J L, Woodward R J, Gizienski S F and Clevenger W A	John Wiley & Sons, NY	
2	Earth and rockfill dam engineering	Sowers G P and Sally H L	Asia Publishing House, New Delhi	
3	Engineering for Dams	Creager W P, Justin J D and Hinds J	John Wiley & Sons, NY	
4	Earth and Earth-Rock Dams	Sherard, Woodward, Gizienski and Clevenger	John Wiley &. Sons	1963
5	Earth and Rockfill Dams	Bharat Singh and Sharma, H. D.		1999
6	Indian storage resources with earthen dams	Strange W L	R&FN Spon Ltd., London	

(Group-2): 20CWM12 WATER POLLUTION AND TREATMENT TECHNOLOGY

Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction: Objectives and necessity for Treatment of water. Water pollution, Sources of water pollution and control methods. Point and non-point sources of water pollution. Ground water pollution and its characteristics. Water Borne diseases and control. Characteristics of water.

Analysis for quality of water: Drinking water quality standards as per BIS & WHO guidelines. Importance of Bacteriological examination of water, Plate Count Test and MPN Test. Problems on determination of E-coli using MPN equation.

Module-2

Water Purification System: Flow Diagram on overall water supply Project. Various types of Unit flow diagrams used on Water Treatment System. Water Intake Structures and their classifications.

Purification of water: Water Aeration, Importance and limitations. Gas Transfer two film model; Water in Air system and Air in Water system with their types. Significance of Dissolved Oxygen in Water. Principles of Sedimentation Process and Separation of Solids. Design Criteria and design of Sedimentation tank in the removal of Discrete particles.

Module-3

Coagulation and Flocculation: Coagulation and Flocculation process of water. Theory of Coagulation and Principle. Types of Coagulants used with their merits and demerits. Coagulants chemical reaction with water. Coagulant Aids, Chemical feeding system. Determination of Optimum Coagulant Dosage using Flocculator. Numerical design problems on estimation of Coagulants.

Module-4

Water Filtration Process– Basic principles and theory on Filtration. Classification of sand filters used in treatment of water. Operational system and Operational troubles and troubleshooting method used in SSF and RSF in treatment of water. Design criteria used and Design of Slow and Rapid Sand Filters required for water treatment plant.

Module-5

Water Disinfection Process – Sterilization and Disinfection. Methods of disinfection and their suitability. Theory of Disinfection, characteristics of a good disinfectant. Forms of Chlorination, Chemical reactions, Break point Chlorination. Determination of Chlorine Demand of water. Estimation of quantity of Chlorine and Bleaching powder required for treatment of water.

Miscellaneous Treatment of water- Hardness of water and significance. Numerical problems on determination of Hardness in water sample and Studies on effect of hardness. Fluoridation and De fluoridation techniques.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Water supply Engineering Vol- I	Fair, G.M., Geyer J.C and Okun	John Wiley Publications	1969
2	Physico - Chemical Processes for Water Quality Control	Weber W.J.		1975
3	Water Supply and Treatment Engineering	CPHEEO Manual	GOI- Publications, New Delhi	2003
4	Environmental Engineering	Peavy, H.S., Rowe and Tchobonoglous, G.	McGraw Hill	1985
5	Water Supply and Pollution Control	PHI Learning, New Delhi		2009
6	Environmental Engineering and Science	Clair N. Sawyer, Perry L. McCarty and Gene F. Parkin	McGraw Hill Education Pvt. Ltd, New Delhi	2014

(Group-2): 20CEE22 ATMOSPHERIC ENVIRONMENTAL POLLUTION AND CONTROL

Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction: Definition of Air Pollution, sources, characterization and classification of atmospheric pollutants, air pollution episodes.
Effects of air **pollutants** on human health, vegetation, animals and materials and monuments. Composition and structure of the atmosphere; Visibility and other related atmospheric characteristics.

Module-2

Meteorology: Wind circulation, solar radiation, lapse rates, atmospheric stability conditions, wind velocity profile, Maximum Mixing Depth, Temperature Inversions, plume behaviour, Wind rose diagram, general characteristics of stack emissions, heat island effect. **Monitoring of particulate matter:** Respirable, non-respirable and nano-particulate matter. Monitoring of gaseous pollutants–CO, CO2, Hydrocarbons, SOX and NOX, photochemical oxidants. Monitoring equipment and sampling devices–stack sampling (Isokinetic sampling), air samplers, gas exhaust analyzer. Air Pollution Index.

Module-3

Pollutants' dispersion models: Point, line and areal sources models. Box model, Gaussian plume dispersion model – for point source (with and without reflection), Gaussian dispersion coefficient, Determination of ground level concentrations. Infinite line source Gaussian model. Plume rise and effective stack height calculations.

Module-4

Air Pollution Control Equipment: Mechanisms, Control equipment for particulate matter–gravity settling chambers, centrifugal collectors, wet collectors, scrubbers, fabric filters, electrostatic precipitator (ESP)-Design principles and criteria with design **Control Equipment for gaseous pollutants**–adsorption, absorption, condensation and combustion. Design principles.

Module-5

Indoor Air Pollution: Sources, indoor air contaminants, effects and control. air changes per hour (ACH), IAQ Standards
Noise - sources, measurements, effects and occupational hazards.
Standards, Noise mapping, Noise attenuation equations and methods, prediction equations, control measures, Legal aspects of noise

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Environmental pollution control engineering	C.S Rao	New age international publishers	2006
2	Air Pollution	M. N Rao and H. V. N Rao.	Tata McGraw-Hill Publishing Company Limited, New Delhi.	1999
3	Air Pollution	Wark, K., Warner, C.F., and Davis, W.T		1998
4	Air Pollution Control Theory	Crawford, M.	TATA McGraw Hill.	1980
5	Environmental Engineering	Howard S. Peavy, Donald R. Rowe and George Technobanoglous	McGraw Hill International Publications.	2017
6	Environmental Engineering and Science	Clair N. Sawyer, Perry L. McCarty and Gene F. Parkin	McGraw Hill Education Pvt. Ltd, New Delhi	2014
7	Air Pollution Vol I, II, III.	Stern, A.C.		
8	Air Pollution: The Effects of Air Pollution	Stern, A. C.	3rd- Edition, Academic Press	1977

(Group-2): 20WRM14	**OPEN CHANNEL HYDRAULICS**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Basic Concepts of Free Surface Flow, classification of flow, velocity & pressure distribution. Conservation laws, continuity equation, momentum equation, Specific energy, Application of momentum & energy equation, Channel transition, Hydraulic jump. Critical flow.

Module-2

Uniform flow: flow resistance, equation of flow resistance, compound channel, Computation of normal flow depth.

Module-3

Gradually varied flow, Governing equation, classification of water surface profiles, and computation of GVF. Unsteady Rapidly Varied Flow. Application of conservation laws. Positive and Negative Surges. Moving hydraulic Jump, Spillways, Energy dissipaters.
Critical slope and limit slope.

Module-4

Hydraulics of Mobile bed channel, Initiation of Motion of sediment, Critical analysis of Shield's diagram, Bed forms, and Predication of bed form. Sediment load: Suspended load, Bed load, total bed material load, measurement and estimation of sediment load. Design of Stable Channels: Regime and Tractive force Methods.

Module-5

Introduction to Bridge Hydraulics: Water ways, Afflux, Scour: Local scour, abutment scour, Indian practice of design for scour.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Open Channel Hydraulics	Chow, V.T.	McGraw Hill. N York	1979
2	Open Channel Flow	Henderson	McMillan Pub. London	1966
3	Flow in Open Channels	Subramanya, K	Tata McGraw Hill Pub.	1996
4	Mechanics of Sediment Transportation and Alluvial Stream Problems	Grade and Ranga Raju, K.G.	Wiley Eastern, N Delhi	1980
5	Open – Channel Flow	Chaudhry M.H.	Prentice Hall of India, N Delhi	1994
6	Open Channel Hydraulics	French, R.H.	McGraw Hill Pub Co., N York	1986
7	Bridge Hydraulics	Hamill L.	E & FN Spon, London	1999

(Group-2): 20CCT14	**ADVANCED CONSTRUCTION MATERIALS AND GREEN BUILDINGS**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction: Energy in building materials, Environmental issues concerned to building materials, Embodied energy and life-cycle energy, Global warming and construction industry, Green concepts in buildings, Green building ratings IGBC and LEED manuals–mandatory requirements, Rainwater harvesting & solar passive architecture. Environmental friendly and cost effective building technologies, Requirements for buildings of different climatic regions.

Module-2

Alternative Building Materials: Lime, Pozzolana cements, Raw materials, Manufacturing process, Properties and uses. Fibers-metal and synthetic, Properties and applications. Fiber reinforced plastics, Matrix materials, Fibers organic and synthetic, Properties and applications. Building materials from agro and industrial wastes, Types of agro wastes, Types of industrial and mine wastes, Properties and applications. Masonry blocks using industrial wastes.
Construction and demolition wastes

Module-3

Special Concretes: Definition & Introduction, General properties, Advantages, Disadvantages, Applications, High density concrete, Shrinkage compensating concrete, Mass concrete, Roller compacted concrete. Light weight concrete, High strength concrete, Ultra-high strength concrete (reactive powder concrete), High workability concrete/Self compacting concrete, Fiber reinforced concrete, Polymer-concrete composites.

Module-4

Introduction and definition of Sustainability. Carbon cycle and role of construction material such as concrete and steel, etc. CO2 contribution from cement and other construction materials. Control of energy use in building, ECBC code, codes in neighboring tropical countries, features of LEED and TERI Griha ratings, Performance ratings of green buildings.

Module-5

Non-renewable sources of energy and Environmental aspects – energy norm, coal, oil , natural gas, Nuclear energy, Global temperature, Green house effects, global warming. Acid rain - Causes, effects and control methods. Regional impacts of temperature change.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Alternative Building Materials and Technologies	K. S. Jagadish, B. V. Venkatarama Reddy and KS Nanjunda Rao	New Age International Publishers	
2	Concrete Technology	Gambhir M. L.	McGraw Hill Education	2006
3	Concrete Technology	Shetty M.S.	S. Chand and Company Ltd. Delhi	2003
4	Building Materials	M. L. Gambhir	Neha Jamwal, Tata McGraw Hill Publ	
5	Sustainable Construction: Green Building Design and delivery	C. J. Kibert	3rd Ed., John Wiley, Hoboken, New Jersey	2008
6	Building Materials in Developing Countries	RJS Spence and DJ Cook	Wiley pub.	
7	Concrete- Microstructure, Properties and Materials	Mehta. P. K., and Paulo J.M. Monteiro	(Indian Ed., Indian Concrete Institute), McGraw Hill. National Building Code 2005, Part 0-10, Bureau ofIndian Standards	
8	Living in the Environment: Principles, Connections and Solutions	G.T. Miller Jr.	14th Ed., Brooks Cole, Pacific Grove, California, Washington DC,	April 1989 & 2004

(Group-2): 20CEM243 DISASTER MITIGATION & MANAGEMENT	
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction To Disasters Definition: Disaster, Hazard, Vulnerability, Resilience, Risks–Disasters: Types Of Disasters–Earthquake, Landslide, Flood, Drought, Fire Etc–Classification, Causes, Impacts Including Social, Economic, Political, Environmental, Health, Psychosocial, Etc.-Differential Impacts-In Terms Of Caste, Class, Gender, Age, Location, Disability–Global Trends In Disasters: Urban Disasters, Pandemics, Complex Emergencies, Climate Change-Dos And Don'ts During Various Types Of Disasters.

Module-2

Approaches To Disaster Risk Reduction Disaster Risk Reduction Strategies, Disaster Cycle, Phases of Disaster, Preparedness Plans, Action Plans and Procedures, Early warning Systems Models in disaster preparedness, Components of Disaster Relief-(Water, food, sanitation, shelter, Health and Waste Management), Community based DRR, Structural non structural measures in DRR, Factors affecting Vulnerabilities, , Mainstreaming disaster risk reduction in development, Undertaking risk and vulnerability assessments, Policies for Disaster Preparedness Programs, Preparedness Planning, Roles and Responsibilities, Public Awareness and Warnings, Rehabilitation measures and long term reconstruction.

Module-3

Inter-Relationship Between Disasters And Development Factors Affecting Vulnerabilities, Differential Impacts, Impact Of Development Projects Such As Dams, Embankments, Changes In Land-Use Etc.- Climate Change Adaptation- IPCC Scenario And Scenarios In The Context Of India–Relevance Of Indigenous Knowledge, Appropriate Technology And Local Resource

Module-4

Disaster Risk Management In India Hazard And Vulnerability Profile Of India, Components Of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional Arrangements (Mitigation, Response And Preparedness, Disaster Management Act and Policy–Other Related Policies, Plans, Programmes And Legislation–Role Of GIS And Information Technology Components In Preparedness, Risk Assessment, Response And Recovery Phases Of Disaster–Disaster Damage Assessment.

Module-5

Disaster Management: Applications And Case Studies Cases Studies : Bhopal Gas Disaster, Gujarat Earth Quake, Orissa Super-cyclone, south India Tsunami, Bihar floods, Plague Surat, Landslide in North East, Heat waves of AP& Orissa, 278 Cold waves in UP. Bengal famine, best practices in disaster management, Local Knowledge Appropriate Technology and local Responses, Indigenous Knowledge, Development projects in India (dams, SEZ) and their impacts.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Environmental Geography	R.B.Singh (Ed)	Heritage Publishers, New Delhi	
2	Environmental Geography	Savinder Singh	Prayag Pustak Bhawan	
3	The Environment as Hazards	Kates B .I & White G.F	oxford, New York	
4	Disaster Management	R.B. Singh (Ed)	Rawat Publication, New Delhi	
5	Disaster Management	H.K. Gupta (Ed)	Universities Press, India	
6	Disaster Management in Hills	Dr. Satender	Concept Publishing Co., New Delhi	

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
7	Action Plan For Earthquake, Disaster, Mitigation	A.S. Arya	(V.K. Sharma (Ed) Disaster Management IIPA Publication New Delhi	
8	An overview on Natural & Manmade Disaster & their Reduction	R.K. Bhandani	CSIR, New Delhi	
9	Manuals on Natural Disaster management in India	M.C. Gupta	National Centre for Disaster Management, IIPA, New Delhi	
10	Disaster Mitigation Experiences & Reflections	Pardeep Sahni, Alka Dhameja and Uma Medury		
11	Disaster Management Report	Department of Agriculture and Cooperation, Govt. of India.		

(Group-2): 20CIM23	**PREFABRICATED STRUCTURES**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Basic Definitions - Types of prefabrication-prefabrication systems and structural schemes-Prefabricated Elements–columns, beams, floor, roof, footing and wall panels.
SDA: Group activity - Prepare simple models on elements like slab, beam, and column to understand their behavior in prefab structures.

Module-2

Functional Design Principles: Modular coordination–Standardization-Disuniting, Diversity of prefabricates–Material properties-Production–Transportation–Erection-Codal provisions-Lateral load resistance-Location and types of shear walls.
SDA: Prepare simple building plan (prefab structure) using modular coordinate system.

Module-3

Precast concrete Floors: Types of floor slabs–flooring arrangements, limit state Serviceability–Deflection, limit state of flexure-Ultimate strength calculations in shear and flexure.
SDA: Prepare detailing of conventional slab, flat slab using appropriate tools.

Module-4

Precast concrete Beams: Introduction-Types of beams–non composite and composite beams - design and detailing of R C precast non composite beams.
Walls: Types of wall panels - load bearing wall-stability of wall panels–construction procedure of pre-cast walls.
Different Types of joints-their behavior and design–Leak prevention, Joint sealants.
SDA: Prepare the detailing of conventional beams and column manually through sketches/appropriate software tools.

Module-5

Components of Industrial Building (Single-Storey) - Purlins, Principle Rafter, Roof Truss, Gantry Girders, Corbel, Column, Bracings.
Precast Reinforced Concrete Truss–General, Requirement for Design of Truss, Reinforcement as per IS: 3201-1988, Construction Sequence.
Purlins–Design Procedure only.
Pre–Cast Columns–Design Procedure only.
Corbel- General Consideration as per IS-456:2000, Initial Dimensioning of Corbels as per BS 8110, Design of Corbel - Step by Step Procedure as per BS 8110.
SDA: Visit to nearby site or pre-cast plant.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Precast concrete design and Applications	Hass, A. M.	Applied Science Publishers	1983
2	Handbook on Precast concrete for buildings		ICI Bulletin 02, Indian Concrete Institute	2016
3	National Building Code of India		BIS, New Delhi	2016
4	Precast concrete structures	Kim S Elliott	Butterworth Heinemann Publications, ISBN-0750650842, 2002	
5	Precast Concrete Structures	Hubert Bachmann and Alfred Steinle	Berlin: Ernst & Sohn, ISBN: 978-3433029602, 2011.	

(Group-2): 20CTE15	**URBAN TRANSPORT PLANNING**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Urban Transportation Problems & Policy: Urban transportation Issues, Travel Characteristics, Evolution of Planning Process, Supply and Demand – Systems approach; NUTP, Recommendations of 12th FYP and NTDP

Travel Demand Modelling: Trends, Overall Planning process, Long term - Short term planning, Demand Function, Independent Variables, Travel Attributes, Assumptions in Demand Estimation, Sequential, and Simultaneous Approaches, Aggregate and Disaggregate Techniques, Tour based models, and Activity based models.

Module-2

Data Collection and Inventories: Collection of data – Organization of surveys and Analysis, Study Area, Zoning, Types and Sources of Data, Road Side Interviews, Home Interview Surveys, Commercial Vehicle Surveys, Sampling Techniques, Expansion Factors, Accuracy Checks, Use of Secondary Sources, Economic data–Income– Population– Employment– Vehicle Ownership

Trip Generation Models: UTPS Approach, Trip Generation Analysis: Zonal Models, Category Analysis. Household Models, Trip Attraction models, Commercial Trip Rates.

Module-3

Trip Distribution Models: Trip Distribution: Growth Factor Methods, Gravity Models, Opportunity Models, Time Function Iteration Models.

Mode Split Analysis:
Mode Choice Behavior, Competing Modes, Mode Split Curves, Models and Probabilistic Approaches–Logit Model

Module-4

Traffic Assignment Techniques:
Diversion Curves, Basic Elements of Transport Networks, Coding, Route Properties, Path Building Criteria, Skimming Tree, All-or-Nothing Assignment, Capacity Restraint Techniques, Reallocation of Assigned Volumes, Equilibrium Assignment, Multipath Assignment Technique.

Module-5

Corridor Identification-Plan preparation and evaluation: Master plans, Selection of Corridor, Corridor Identification, Corridor deficiency Analysis; TOD; Travel Forecasts to Evaluate Alternative Improvements, Impacts of New Development on Transportation Facilities; Pivot Point Analysis, Environmental and Energy Analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Transportation Engineering: An Introduction	C. JotinKhisty and B. Kent Lall	3rd Edition, Pearson	2016
2	Transportation Engineering and Planning	C.S. Papacostas and P.D. Prevedouros	Third Edition, Prentice Hall of India Pvt. Ltd.	2015
3	Principles of Urban Transport Systems Planning	Hutchinson, B.G.	McGraw Hill	1974
4	Modelling Transport	Juan de Dios Ortuzar and Luis G. Willumsen	4th Edition, JohnWiley and Sons	2011
5	Transportation Planning Handbook	Michael D. Meyer	Fourth Edition, Institute of Transportation Engineers, John Wiley & Sons Inc.	2016

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
6	Urban Transportation Planning: A decision oriented Approach	Michael D. Meyor and Eric J. Miller	Second Edition, McGraw Hill	2001
7	Introduction to Transportation Planning	Michael J. Bruton	UCL Press, London, UK	2000

(Group-2): 20CHT23	**PAVEMENT MANAGEMENT SYSTEM**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction: Components & principals of pavement management systems, pavement maintenance measures, planning investment, research management. Pavement Management Data Needs, Inventory Data Needs

Characterizing Pavement performance: Serviceability Performance concept, Pavement Roughness, Equipment for evaluating roughness, Universal roughness standard, Calibration needs, relating roughness to serviceability, Applications of Roughness data

Evaluation of Pavement Structural Capacity - Nondestructive measurement and analysis, Destructive structural evaluation, Structural Capacity Index concepts, Network versus Project level applications of structural capacity evaluation

Module-2

Evaluation of Pavement Surface distress condition surveys – purpose, methods- manual and automated, types of distress, distress survey procedures, equipment used

Evaluation of Pavement Safety: skid resistance evaluation - basic concepts , importance of surface texture, methods of measuring skid resistance, friction management in Pavement Management, Combined measures of Pavement Quality, Data Base Management, **Present status of Pavement networks** – Performance measures, Strategic level pavement management, state of road network in terms of IRI, in terms of Asset value.

Module-3

Determining Present and future needs and priority programming of rehabilitation and maintenance – Establishing criteria, prediction models for pavement deterioration, determining needs, Rehabilitation & Maintenance alternatives and priority programming, **Structural design and economic analysis –** MEPDG process for pavement design, Economic evaluation of alternative pavement design strategies and selection of optimal strategy, Implementation of pavement management system.

Module-4

Design alternatives and Selection: Design objectives and constraints, basic structural response models, physical design inputs, alternate pavement design strategies and economic evaluation, reliability concepts in pavement engineering, life cycles costing, analysis of alternate pavement strategies based on distress and performance, case studies and Problems.

Module-5

Expert systems and Pavement Management: Role of computers in pavement management, applications of expert systems for managing pavements, expert system for pavement evaluation and rehabilitation, knowledge–based expert systems, case studies. Implementation of Pavement Management Systems.

Use of softwares: HDM-4/dTIMS.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Pavement Asset Management	Ralph Hass, W. Ronald Hudson with Lyne Cowe Falls	Scrivener Publisher, copyright	2015
2	Modern Pavement Management	Ralph Hass, W. Ronald Hudson. W. R., Zaniewisti .J.	Krieger Publishing Company, Florida	1994
3	Managing Pavement Managing Pavement		Proceedings of North American Conference	
4	Structural Design of Asphalt Pavements	Juan de Dios Ortuzar and Luis G. Willumsen	Proceedings of International Conference, NCHRP, TRR and TRB Special Reports	

(Group-2): 20CTM14	**SOIL MECHANICS FOR HIGHWAY ENGINEERS**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction to Soil and their Engineering Properties: Functions of Sub grades oil, Influence of soil properties on design and performance of pavement, embankments and foundations. Laboratoryand field tests for the soil classification, methods of soil classification useful for highway, Importance of cohesion, plasticity and volume change of soils. Frost action in soils- factors, mechanics, depth of frost penetration, measures to decrease the damaging effects.

Module-2

Strength of Soils: Stress-strain relationships under different types of loadings- incremental, sustained and repeated loading, time dependent deformations.
Soil Water: Movement of water in soil, gravitational water, held water, soil moisture movements, soil suction and soil vapour.
Soil Compaction: Introduction, Lab Tests, Factors affecting, Structure & Engg behavior of compacted cohesive oil, Field compaction specifications, Field compaction control, Different types of Equipments used for compaction, their choice.

Module-3

Soil Investigations: Soil survey sin highway projects. Methods of soil exploration–boring, geo physical methods, disturbed and undisturbed sampling. Investigations on detrimental matters -organic matters, sulphate sand carbonates.
Permeability of soil: Darcy's Law, Validity, Soil- water system, Types, Determination of permeability, problems.

Module-4

Highway Drainage: Introduction, Importance, Surface drainage, Sub surface drainage, methods, Design of sub surface drainage system, Road construction in water logged areas, Landslides–definition, classifies, factors producing.

Module-5

Stability of slopes: Introduction, Types, Different methods of analysis of slopes for Ø u + 0 & C- Ø soil, Location of most critical circle, Earth dam slopes stability, Taylor's stability number. Effect of Earthquake Force, problems on above.
Reinforced Earth structures Introduction, Components, advantages, types of stability– external, Internal, (No problems), Geo textiles–types, Functions, their uses in road embankments and railway works, other uses.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Basic and Applied soil Mechanics	Gopal Ranjan, A S R Rao	New Age International Publishers	
2	Soil Mechanics & Foundation Engg	Dr. B. C. Punmia, Ashok Kumar Jain, Arun KumarJain	Laxmi Publications(P)Ltd,16th edition	
3	Highway Engg	S. K. Khanna	C.E.G. Justo, 5thedition	
4	Soil Mechanics & Foundation Engg	K. R. Arora	Standard Publishers Distributors	
5	Soil Mechanics for road Engineers		HMSO, London. IRC–Relevant Codes	

(Group-2): 20CSE22	**FINITE ELEMENT METHOD OF ANALYSIS**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Basic concepts of elasticity, Kinematic and Static variables for various types of structural problems, approximate methods of structural analysis–Rayleigh–Ritz method, Finite difference method, Finite element method. Variation method and minimization of Energy approach of element formulation, Principles of finite element method, advantages and disadvantages, Finite element procedure, Finite elements used for one, two and three dimensional problems, C0, C1 and C2 type elements, Element aspect ratio, Mesh refinement vs. higher order elements, Numbering of nodes to minimize bandwidth.

Module-2

Nodal displacement parameters, Convergence criterion, Compatibility requirements, Geometric invariance, Shape function, Polynomial form of displacement function, Generalized and Natural coordinates, Lagrangian interpolation function, shape functions for one, two &three dimensional elements.

Module-3

soparametric elements, Internal nodes and higher order elements, Serendipity and Lagrangian family of Finite Elements, Sub-parametric and Super- parametric elements, Condensation of internal nodes, Jacobian transformation Matrix, Development of strain-displacement matrix and stiffness matrix, consistent load vector, numerical integration.

Module-4

Application of Finite Element Method for the analysis of one & two dimensional problems: Analysis of plane trusses and beams, Application to plane stress/strain, Axisymmetric problems using CST and Quadrilateral Elements

Module-5

Application to Plates and Shells, Non-linearity: material, geometric and combined non- linearity, Techniques for Non-linear Analysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	The Finite Element Method for Solid and Structural Mechanics	Zeinkeiwich, O.C. and Tayler, R.L.	Butterworth-Heinemann	2013
2	Finite Element Analysis: Theory and programming	Krishnamoorthy, C. S.	Tata McGraw Hill Publishing Co. Ltd.	2017
3	Introduction to the Finite Element Method: A Numerical method for Engineering Analysis	Desai, C., and Abel, J. F.	East West Press Pvt. Ltd.	1972
4	Concepts and applications of Finite Element Analysis	Cook, R.D., Malkas, D.S. and Plesha., M.E.	John Wiley and Sons	2007
5	An Introduction to Finite Element Methods	Reddy, J.	McGraw Hill Co.	2013
6	Finite Element Procedures in Engineering Analysis	Bathe K J	PrenticeHall	
7	Energy and Finite Element Methods in Structural Mechanics	Shames, I. H and Dym, C. J.	McGraw Hill, New York	1985

(Group-2): 20CCS244	**STRUCTURAL HEALTH MONITORING**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction to Structural Health Monitoring Definition of structural health monitoring (SHM), Motivation for SHM, SHM as a way of making materials and structures smart, SHM and biomimetics, Process and pre-usage monitoring as a part of SHM, SHM as a part of system management, Passive and active SHM,NDE, SHM and NDECS, Variety and multi disciplinarity: the most remarkable characters of SHM, Birth of the SHM Community.

Module-2

Vibration-Based Techniques for SHM Basic vibration concepts for SHM, Local and global methods, Damage diagnosis as an inverse problem, Model-based damage assessment, Mathematical description of structural systems with damage, General dynamic behavior, Statespace description of mechanical systems, Modeling of damaged structural elements, Linking experimental and analytical data, Modal Assurance Criterion (MAC) for mode pairing, Modal Scaling Factor (MSF), Co-ordinate Modal Assurance Criterion (COMAC), Damping, Expansion and reduction, Updating of the initial model, Damage localization and quantification, Change of the flexibility matrix, Change of the stiffness matrix, Strain- energy-based indicator methods and curvature modes, MECE error localization technique, Static displacement method, Inverse eigen sensitivity method, Modal force residual method, Kinetic and strain energy-based sensitivity methods, Forced vibrations and frequency response functions, Solution of the equation system, Regularization, Parameter subset selection, Other solution methods, Variances of the parameters, Neural network approach to SHM, The basic idea of neural networks, Neural networks in damage detection, localization and quantification, Multi-layer Perceptron (MLP), A simulation example, Description of the structure, Application of damage indicator methods, Application of the modal force residual method and inverse eigen sensitivity method, Application of the kinetic and modal strain energy methods, Application of the Multi- Layer Perceptron neural network, Time-domain damage detection methods for linear systems, Parity equation method, Kalman filters, AR and ARX models, Damage identification in non-linear systems, Extended Kalman filter, Localization of damage using filter banks, A simulation study on a beam with opening and closing crack, Applications, I-40 bridge, Steelquake structure, Application of the Z24 bridge, Detection of delamination in a CFRP plate with stiffeners.

Module-3

Fiber-Optic Sensors Classification of fiber-optic sensors, Intensity-based sensors, Phase modulated optical fiber sensors, or interferometers, Wavelength based sensors, or Fiber Bragg Gratings (FBG), The fiber Bragg grating as a strain and temperature sensor, Response of the FBG to uniaxial uniform strain fields, Sensitivity of the FBG to temperature, Response of the FBG to a non-uniform uniaxial strain field, Response of the FBG to transverse stresses, Photo- elasticity in a plane stress state, Structures with embedded fiber Bragg gratings, Orientation of the optical fiber optic with respect to the reinforcement fibers, Ingress/egress from the laminate, Fiber Bragg gratings as damage sensors for composites, Measurement of strain and stress variations, Measurement of spectral perturbations associated with internal stress release resulting from damage spread, Examples of applications in aeronautics and civil engineering, Stiffened panels with embedded fiber Bragg gratings, Concrete beam repair.

Module-4

SHM with Piezoelectric Sensors The use of embedded sensors as acoustic emission (AE) detectors, Experimental results and conventional analysis of acoustic emission signals, Algorithms for damage localization, Algorithms for damage characterization, Available industrial AE systems, New concepts in acoustic emission, State-the-art and main trends in piezoelectric transducer-based acousto-ultrasonic SHM research, Lamb wave structure interrogation, Sensor technology, Tested structures (mainly metallic or composite parts), Acousto-ultrasonic signal and data reduction methods, The full implementation of SHM of localized damage with guided waves in composite materials, Available industrial acousto ultrasonic systems with piezoelectric sensors, Electromechanical impedance, E/M impedance for defect detection in metallic and composite parts, The piezoelectric implant method applied to the evaluation and monitoring of visco elastic properties.

Module-5

SHM Using Electrical Resistance Composite damage, Electrical resistance of unloaded composite, Percolation concept, Anisotropic conduction properties in continuous fiber reinforced polymer, Influence of temperature, Composite strain and damage monitoring by electrical resistance, 0° unidirectional laminates, Multidirectional laminates, Randomly distributed fiber reinforced polymers, Damage localization. Low Frequency Electromagnetic Techniques Theoretical considerations on electromagnetic theory, Maxwell‘s equations, Dipole radiation, Surface impedance, Diffraction by a circular aperture, Eddy currents, Polarization of dielectrics, Applications to the NDE/NDT domain, Dielectric materials, Conductive materials, Hybrid method, Signal processing, Time- frequency transforms, The continuous wavelet transform, The discrete wavelet transform, Multi resolution, Denoising, Application to the SHM domain, General principles, Magnetic method, Electric method, Hybrid method.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Structural Health Monitoring	Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes	Wiley ISTE	2006
2	Health monitoring of structural materials and components- Methods with Applications	Douglas E Adams	John Wiley and Sons	2007
3	Structural Health Monitoring and Intelligent Infrastructure, Vol-1	J. P. Ou, H. Li and Z. D. Duan	Taylor and Francis Group, London, U.K	2006
4	Structural Health Monitoring with Wafer Active sensors, smart materials and structures	Victor Giurglutiu	Gandhi and Thomson	2007
5	Structural Health Monitoring: current status and perspective	Fu Kuo Chang	CRC Press, Inc.	1997

(Group-2): 20CSE331 FRACTURE MECHANICS APPLIED TO STRUCTURAL ENGINEERING

Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Stress concentration in elastic materials

Theory of stress concentration in elastic materials, stress concentration factors around circular and elliptic holes. Influence of ratio of radii on stress concentration factor in elliptic hole.

Module-2

Linear Elastic Fracture mechanics

Modeling a crack as a flat elliptic hole by Inglis and the limitations of the model, Griffith theory of brittle fracture Theories of linear elastic fracture mechanics, stress intensity factors, Irwin's definition. Fracture toughness KIc, KIIc, KIIIc & corresponding values of GC.

Module-3

Elasto-plastic fracture mechanics

Crack-tip plasticity in metals. Irwin's modification for elasto-plastic material.
J integral, CMOD, CTOD. Mixed mode problems and evaluation of critical fracture parameters.

Module-4

Fracture of Concrete

Limitations of theories of linear elastic fracture mechanics in concrete, Review of concrete behaviour in tension and compression.
Kaplan's experiments, concept of fracture energy, definition of a quasi-brittle material, concept of softening.

Module-5

Advanced concepts in fracture behavior of concrete

Definition of fracture energy by RILEM, Influence of size on fracture behavior, Bazant's size effect law.
Size dependent & independent fracture energies. Application of fracture mechanics in design of concrete structures.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Theory of Elasticity	Timoshenko & Goodier	McGraw Hill	
2	Continuum Mechanics Fundamentals	Valliappan S.	Oxford IBH, ND. New Delhi	1982
3	Elementary Engineering Fracture Mechanics	Broek, D.	4th edition, Martinus Nijhoff	1987
4	Fracture Mechanics-Fundamentals and Applications	T. L. Anderson	CRC press	
5	Advanced Mechanics of Solids	Srinath L.S.	10th print, Tata McGraw Hill Publishing company, New Delhi	1994
6	Fracture mechanics and structural concrete	Bhushan L Karihaloo	John Wiley & Sons Inc	
7	Fracture and Size Effect in Concrete and Other Quasibrittle Materials	Zdenek P. Bazant, Jaime Planas	CRC press	

(Group-2): 20CTE23	**GEOMETRIC DESIGN OF TRANSPORTATION FACILITIES**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction: Classification of rural highways and urban roads. Objectives and requirements of highway geometric design
Design Controls: Topography, vehicle characteristics and design vehicle, driver characteristics, speed, traffic flow and capacity, levels of service, pedestrian and other facilities, environmental factors

Module-2

Design Elements: Sight distances-types, analysis, factors affecting, measurements,
Horizontal alignment-design considerations, stability at curves, super elevation, widening, transition curves; curvature at intersections, vertical alignment-grades, ramps, design of summit and valley curves, combination of vertical and horizontal alignment, express ways, IRC standards and guidelines for design problems

Module-3

Cross Section Elements: Right of way and width considerations, roadway, shoulders, kerbs, traffic barriers, medians, Pavement surface characteristics-types, cross slope, skid resistance, unevenness.

Module-4

Design Considerations: Design considerations for rural and urban arterials, freeways and other rural and urban roads-design speeds, volumes, levels of service and other design considerations.

Module-5

Design of Inter sections & Parking lots: Characteristics and design considerations of at-grade inter sections; Different types of islands, channelization; median openings; Rotary intersections; Grade separations and interchanges-types, warrants, adaptability and design details; ramps. Computer applications for intersection and inter change design.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Highway Engineering	Khanna S. K and Justo,C.E.G. Justo	Nem Chandand Bros.	
2	Planning and Design Guide: At-Grade Intersections'	Jack E Leishand Associates	Illinios	
3	A Policy on Geometric Design of Highways and Streets'	AASHTO	American Association of State Highway and Transportation Officials, Washington D.C.	
4	Roads in Urban Areas	DSIR	HMSO, London, Relevant IRC publications	

(Group-3): 20CSE21	**ADVANCED DESIGN OF STEEL STRUCTURES**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Laterally Unrestrained Beams:
Lateral Buckling of Beams, Factors affecting lateral stability, IS 800 code provisions, Design Approach. Lateral buckling strength of Cantilever beams, continuous beams, beams with continuous and discrete lateral restraints, Mono-symmetric and non-uniform beams–Design Examples. Concepts of-Shear Center, Warping, Uniform and Non-Uniform torsion.

Module-2

Beam- Columns in Frames:
Behaviour of Short and Long Beam-Columns, Effects of Slenderness Ratio and Axial Force on Modes of Failure, Biaxial bending, Strength of Beam Columns, Sway and Non-Sway Frames, Strength and Stability of rigid jointed frames, Effective Length of Columns, Methods in IS 800-Examples

Module-3

Steel Beams with Web Openings:
Shape of the web openings, practical guide lines, and Force distribution and failure patterns. Analysis of beams with perforated thin and thick webs, Design of laterally restrained castellated beams for given sectional properties.
Vierendeel girders (design for given analysis results)

Module-4

Cold formed steel sections:
Techniques and properties, Advantages, Typical profiles, Stiffened and un stiffened elements, Local buckling effects, effective section properties, IS 801& 811 code provisions- numerical examples, beam design, column design.

Module-5

Fire resistance:
Fire resistance level, Period of Structural Adequacy, Properties of steel with temperature, Limiting Steel temperature, Protected and unprotected members, Methods of fire protection, Fire resistance Ratings. Numerical Examples.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Design of Steel Structures	N. Subramanian	Oxford, IBH	
2	Design of Steel Structures	Duggal, S. K.	TataMcGraw-Hill,	
3	IS 800: 2007, IS 801-2010 , IS 811-1987			
4	BS5950 Part-8			
5	INSDAG Teaching Resource Chapter 11 to 20: www.steel-insdag.org			
6	SP 6 (5)			1980

(Group-3): 20CGT21	**REINFORCED SOIL STRUCTURES**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Historical background: Introduction to reinforced soil structures, comparison with reinforced cement concrete structures.
Reinforced Earth: Principles, concepts and Mechanisms of reinforced earth

Module-2

Materials used, properties, laboratory testing and constructional details, metallic strips, metallic grids, geo textiles, geo grids, geo membranes and geo composites, their functions and design principles

Module-3

Geo textiles: Introduction, design methods, function and mechanism, geo textile properties and test methods – physical, mechanical and hydraulic properties, construction methods and techniques using geo textiles

Module-4

Design applications of reinforced soil structures in pavements, embankments, slopes, retaining walls and foundations, reinforced soil structures for soil erosion control problems, geo synthetic clay liners

Module-5

Design applications of reinforced soil structures : Slopes, Soil Nailing ,Case studies of reinforced soil structures, discussion on current literature and design problems

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Designing with Geo synthetics	Koerner R H	Prentice Hall Inc.	1994
2	Reinforcements and Soil Structures	Jones, CJEP	Butterworth Publications	1996
3	Membranes in ground engineering	Rankilor, P R	John Wiley & Sons	1985
4	Soil Reinforcement with Geo textiles	Jewel R A	CIRIA	1996
5	Geo textiles hand book	Ingold J S and Miller K S	Thomas Telford Ltd.	1988

(Group-3): 20CWM14	**ENVIRONMENTAL POLLUTION AND CONTROL MANAGEMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction: Environmental Pollution and Sources, types of pollution and their Global, regional and local environmental effects.
Air Pollution: Classifications and sources of air pollutants. Secondary pollutants and formation of Photo-chemical Smog, PAN, PBN, Acid rain; Atmospheric Diffusion and Plume Behaviour, Effects of air pollutants on plants.

Module-2

Water Pollution: Sources of water and their contamination, Types of pollutants, Industrial effluents- pulp and paper mills, Sugar, Distillery, Domestic wastes, Effluents from water treatment plants. Eutrophication – causes, effects and control measures.
Soil pollution: Plants as soil pollution indicators, Formation of salts in soils,Causes of soil pollution, Effects of Fungicides and weedicides on soil components and pollution. Different kinds of synthetic fertilizers (N, P, K), their toxicity and Environmental effects, control of soil pollution.

Module-3

Radioactive Pollution: Types of radiations (Alpha, Beta, Gamma), Units of radioactivity, Sources of radioactive material in environment, Biological impact and health hazards associated with radiation, control of Radioactive pollution. Fate and movement of radioactive material in environment.
Heavy Metal Pollution: Sources of heavy metals, Accumulation of heavy metals in abiotic environment and biotic components, Bioaccumulation, Bio-magnification, Toxic effects (Lead, Mercury, Arsenic).

Module-4

Noise Pollution: Basic properties of sound, Units, Sources of Noise Pollution, Effects of noise pollution, Measurement of sound. Measures to control noise pollution in industries-automotive type silencers, vibration isolation, damping, lagging. Protection of personnel–ear plugs, ear muffs, helmets, isolation.
Thermal pollution: Definition and Sources, effects of thermal pollution–physical, chemical, biological, control of thermal pollution.

Module-5

Oil pollution: introduction, major oil spills in the world, fate and movement of oil after spillage - spreading, evaporation, emulsification, dispersion, dissolution, sedimentation, biodegradation. Effects and control of oil pollution, Remote sensing in water quality monitoring.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Environmental Chemistry and Pollution Control	S. S. Dara	S. Chand and Co Ltd., New Delhi	
2	Environmental Protection and Pollution Control Manual	Jones, CJEP	Karnataka State Pollution Central Board	
3	Environmental Chemistry	B.K. Sharma and H. Kaur		
4	Handbook of Environmental Health and Safety – principle and Practices, Vol. II	Jewel R A	CIRIA	1996

(Group-3): 20CEE241	**ENVIRONMENTAL GEO-TECHNOLOGY**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Soil- Pollutant Interaction:

Introduction to geo environmental engineering–environmental cycle–sources, production and classification of waste–causes of soil pollution–factors governing soil-pollutant interaction-Physicochemical behavior and modelling -failures of foundations due to pollutants stations, collection route optimization and economics, regional concepts. System dynamics

Module-2

Characterization, Stabilization and Disposal Safe disposal of waste–site selection for landfills–characterization of land fill sites–waste characterization–stability of landfills–current practice of waste disposal- passive contaminant system-Hazardous waste control and storage system–mechanism of stabilization - solidification of wastes–micro and macro encapsulation–absorption, adsorption, precipitation- detoxification–organic and inorganic stabilization. Biological and chemical techniques for energy and other resource recovery: composting, vermin composting, vermin gradation, fermentation. Incineration of solid wastes. control measures.

Soil pollution: Plants as soil pollution indicators, Formation of salts in soils, Causes of soil pollution, Effects of Fungicides and weedicides on soil components and pollution. Different kinds of synthetic fertilizers (N, P, K), their toxicity and Environmental effects, control of soil pollution.

Module-3

Transport of Contaminants:

Contaminant transport in sub surface–advection–diffusion–dispersion–governing equations–contaminant transformation–sorption–biodegradation–ion exchange –precipitation–hydrological consideration in land fill design–ground water pollution – bearing capacity of compacted fills – pollution of aquifers by mixing of liquid waste –protecting aquifers.

Module-4

Detection and Testing Methods

Methodology-review of current soil testing concepts–Proposed approach for characterization and identification of contaminated ground soil for engineering purposes

Module-5

Remediation of Contaminated Soils:

Rational approach to evaluate and remediate contaminated sites – monitored natural attenuation–exsitu and insitu remediation–solidification, bio–remediation, incineration, soil washing, electro kinetics, soil heating, verification, bio venting – Ground water remediation – pump and treat, air sparging, reactive well- application of geo synthetics in solid waste management – rigid or flexible liners.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Geotechnical practice for waste disposal	Daniel, B.E.	Chapman and Hall, London	1993
2	Introduction to Environmental Geo technology	Fang, H.Y.	CRC press New York	1997
3	Hazardous Waste Management	Wentz, C.A.	McGraw Hill, Singapore	1989
4	Hazardous Waste Management	Lagrega M.d., Bukingham P.L. and Evans J.C.	McGraw Hill, Inc. Singapore	1994

(Group-3): 20WRM23	**WATERSHED CONSERVATION AND MANAGEMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction: Watershed – Definition and Classification – Components- Basic factors influencing watershed development – Codification - Watershed delineation – Characteristics of watershed: size, shape, physiography, slope, climate, drainage, land use, vegetation, geology and soils, hydrology and hydrogeology – Socio - economic characteristics.

Module-2

Soil conservation measures: Types of Erosion – Water and Wind Erosion: Causes, Factors, Effects and Control– Estimation of Soil Erosion- Soil Loss Models- Sedimentation - Soil Conservation Practices: Vegetative and Mechanical.

Module-3

Water harvesting and conservation: Types of storage Structures-Water yield from Catchments-Losses of stored water-Water Conservations Methods-Water harvesting methods and Techniques-Rainwater Harvesting-Catchment, Harvesting structures, Roof water harvesting- Soil Moisture Conservation-Check Dams-Artificial Recharge-Farm Ponds-Percolation tanks.

Module-4

Watershed management: Project Proposal Formulation-Watershed Development Plan Entry Point Activities–Estimation–Watershed Economics-Agro forestry–Grassland Management–Wasteland Management–Watershed Approach in Government Programmes–Developing Collaborative know how–People's Participation–Evaluation of Watershed Management

Module-5

Watershed management plan: Methodology of planning a watershed management, identification of watershed problems, socio-economic issues - application of Remote Sensing and GIS in watershed management.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Watershed Management	Dhuruva Narayana.V. V, Sastry. G and Patnaik. U. S	Publications and information division, Indian Council of Agriculture Research, New Delhi	1990
2	Soil and Water Conservation Engineering	Gelnn O. Schwab	John Wiley and sons, New York	1981
3	Hydrology and Soil Conservation engineering	Ghanashyam Das	Prentice Hall of India Private Limited, New Delhi	2000
4	Watershed Management in India	Murthy J.V.S	Wiley Eastern Limited, New Delhi	1995
5	Soil and Water Conservation Engineering	Suresh R	Standard Publishers	
6	Watershed Management	Tideman E.M.	Omega Scientific Publishers, New Delhi	1996

(Group-3): 20CCT15	**MECHANIZATION IN CONSTRUCTION**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction to mechanization: Definition, advantages and limitations of mechanization, Indian scenario and Global scenario.
Mechanization through construction equipment: Equipment cost, Machine Power, Production cycle - Dozers, scrapers, excavators, Finishing equipment, Trucks and Hauling equipment, Hoisting equipment, Draglines and Clamshells.

Module-2

Mechanization in aggregate manufacturing: Flow chart of process of manufacturing of coarse aggregates, Different types of crushers used, process of screening and washing. Recycled aggregates: Types of recycled aggregates. Artificial aggregates: Types of artificial aggregates. Mechanization in concrete production (RMC plant):Flow chart of the process of concrete production. Methods of placing and compaction of concrete.

Module-3

Mechanization in rebar fabrication Mechanization through construction: formwork and scaffolding types, materials and design principles.

Module-4

Mechanization through construction methods/technologies: segmental construction of bridges/flyovers, box pushing technology for tunneling, trench-less technology. Pile Driving Equipments. Underground & under water construction (problems encountered, under water drilling, Blasting & grouting)

Module-5

Mechanization through construction methods of Drilling, Blasting and Tunneling Equipment : Definition of terms, bits, Jack hammers, Drifters, wagon drills, chisel drills, piston drills, blast hole drills, shot drills, diamond drills, tunneling equipment, selecting the drilling method equipment; selecting drilling pattern. Safety and Environmental issues in mechanization

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Construction Equipment and its Planning and Applications	Mahesh Varma	Metropolitan Book Co. (P) Ltd., New Delhi. India	
2	Construction Equipment and Management	Sharma S. C.	Khanna Publishers, Delhi	1988
3	ConstructionReview	Ghanashyam Das	Published by Civil Engineering and Construction Review, New Delhi	1991

(Group-3): 20CEM244	**URBAN HYDROLOGY, STORM DRAINAGE AND MANAGEMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Urban Hydrologic Process: Process of urbanization–Water in Urban ecosystem–Urban water subsystems–Urban hydrologic cycle. Impact of urbanization on urban runoff and stream flow quantity–Impact of urbanization on quality of runoff and stream flow – Erosion due to urban runoff.

Module-2

Storm water Modeling: Analysis of hydrologic changes due to urbanization- Approaches to study – Data collection and analysis–Probabilistic and statistical approaches. Modelling of urban water quantity–Types of models–Rainfall, Runoff modeling; urban watershed modeling (quantity)–Rational Method (or coefficient method), Runoff hydrograph, unit hydrographs–10 min synthetic unit hydrograph–Linear reservoir model (Viessman) – Chen and Shubinski model–QUURM Model–TVA model. Urban watershed modellingfor water quality of runoff and stream water quality.

Module-3

Urban Drainage Systems: Sanitary and combined sewer systems–components–Design considerations for fixing sewer capacity–Infiltration into and exfiltration from sewers-causes Infiltration inflow analysis–Field investigations–Control measures.

Design consideration of the components of the sewer systems–Performance of the sewer system both under dry weather flow condition and under storm water impact-Sewer sediment.

Module-4

Storm Water Management: Urban storm runoff quantity and quality management – Mitigation of damaging effects of urban storm runoff Structural and non-structural control measures – Storm water management models.

Module-5

Urban Drainage Systems Maintenance: Maintenance management of UDS and its subsystems–Drainage system–Storm drain conveyance system–Pump stations–Open channel–Illicit connections and discharges–Spill response–Other considerations (limitations and regulations).

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Storm water Hydrology and Drainage	Stephenson D	Elsevier Publications, 2nd Edition	1981
2	Urban Hydrology	Hall J. M	Elsevier Applied Science Publishing Company, 1st Edition	1984
3	Storm water Modelling	Overtens D.E. and Medows M. E.	Academic Press, 2nd Edition	1976
4	Urban Water Infrastructure Planning, Management, and Operations	Grigg, N.S	John Wiley & Sons, 2nd Edition	1986
5	Introduction to Hydrology	Viessman W.I., Knapp J.W., Lewis G.L. and Henbrough T.E.	Harper and Row Publishing Company, 2nd Edition	1977
6	Manual of Sewerage and Sewage Treatment		Ministry of works and Housing, Government of India	2006

(Group-3): 20CIM241 CONSTRUCTION EQUIPMENT AND SAFETY MANAGEMENT	
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Plants and Equipment for production of materials: Crushers, mixers, bituminous mixing plants, concrete mixing plants, advantages, choice,

Module-2

Construction Equipment: Operations, applications and performance of dozers, excavators, graders, compactors, pavers, haulers, crawler, wheel tractors, power shovels, Cranes, hauling equipment's.

Module-3

Selection of Construction Equipment: Task considerations, cost considerations, engineering considerations, equipment acquisition options, Maintenance of Equipment: Repairs, log maintenance, safety during operation, economical life of equipment

Module-4

Safety in Use of Construction equipment's: Human Factors in Construction Safety management Motivation: Management, Supervisors, Workers, Motivational schemes

Module-5

Safety Management: Role of first line supervisors, Role of middle managers, Role of workers, top management practices, safety audit, Safety in site preparation, Design, safety culture, Top Management, Company Activities and Safety-Safety Personnel, Sub-contractual Obligation-Project Coordination and Safety Procedures

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Construction Planning, Equipment and Methods	Peurifoy, R.L., Ledbette. W.B.	McGraw Hill Co.,	
2	Civil Engineering Construction	Antil J.M.	McGraw Hill Book Co.	
3	Construction equipment and its Management	S C Sharma	Khanna Publications	
4	Hand Book on Construction Safety Practices		SP 70, BIS	2001
5	Construction Safety	Jimmy W. Hinze	Prentice Hall Inc.	1997
6	Construction Safety and Health	Richard J. Coble, Jimmie Hinze and Theo C. Haupt		

(Group-3): 20CTE21	**PAVEMENT DESIGN AND ANALYSIS**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Road Pavements and pavement layers- types, functions, choice Factors affecting design and performance of flexible and rigid pavements–Pavement design factors, loads–axle load distribution, ESWL, EWL, VDF due to varying load sand CSA.

Module-2

Sub grade support-CBR and plate bearing tests, Resilient Modulus, fatigue tests, permanent deformation Pavement material Characteristics, climatic, drainage and environmental factors, their effects and evaluation. Factors affecting design and performance of airport pavements.

Module-3

Stresses and Deflection/strain in flexible pavements: Application of elastic theory, stresses, deflections/train sin single, two and three layer system, Application sin pavement design problems

Module-4

Flexible pavement design: Emperical, semi- empirical and theoretical design approaches, principle, advantages and application. Design steps by CBR method as per IRC, outline of other common design methods such as AASHTO and Asphalt Institute methods, Problems.

Module-5

Rigid pavement design: Determination of ESWL, EWL for dual and dual tandem wheel load sin Rigid pavements, General design principle, Stresses in rigid pavements, stresses due to wheel load sand temperature variations, design of cement concrete Pavements (joint sand slab thickness) as per I R C guidelines. Design features of CRCP, SFRC and ICBP, Problems.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Principles of Pavement Design	Yoder and Witczak	John Wiley and sons Inc (second edition)	1975
2	Design of functional pavements	Yang	McGraw Hill Book Co.	
3	Pavement Analysis	Huang	Elsevier Publications	
4	Design & Performance of Road Pavements	David Croney, Paul Croney	McGraw Hill Book Co.	
5	Modern Pavement Management	W. Ronald Hudson, Ralph Haasand Zeniswki	McGraw Hill and Co. IRC37-2001, IRC81-1997, IRC58–2002, IRC59–1976, IRC101-1988, Indian Roads Congress	
6	Highway Engineering	Khanna and Justo	Nem chand & Bros, Roorkee	

(Group-3): 20CHT242	**DESIGN OF BRIDGE AND GRADE SEPARATED STRUCTURES**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction to Bridges: Basic Elements of a Bridge.
Types of bridges and grade separated structures for highways, standard Specifications for road bridges and grade separated structures to fulfill traffic and Structural and Hydraulic design requirements.

Module-2

Bridge bearings- joints, approaches, construction and maintenance aspects.

Module-3

Basic design approaches of RCC, PSC and steel bridges superstructure. Types of bridges for IRC loading conditions

Module-4

General Design Considerations for grade separated structures and their choices, IRC Class AA Tracked and Wheeled Loading Analysis, Problems.

Module-5

Introduction to Construction Specification and quality control:
for foundations and substructures of bridges and Grade separated Interchanges–Types, warrants and Design standards. Concept of evaluation of existing bridge structures. Methods of rehabilitation and widening.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Essentials of bridge Engineering	D.Johnson Victor	Oxford, IBH publishing company	
2	Bridge Engineering	Ponnuswamy	McGraw Hill Publication	1989
3	Relevant IRC codes			
4	Design of Concrete Bridges	Vazirani Ratwani & M.G.Aswani	Khanna Publishers, New Delhi	
5	Design of Bridges	Dr. Krishna Raju	Oxford & IBH Publishing Company Limited	
6	Analysis and design of Bridges	M.A.Jayaram	Sapna Publishers, Bangalore	

(Group-3): 20CTM241	**TRANSPORTATION INFRASTRUCTURE DESIGN**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Functional Classification of Highway System; Design Controls–Topography, Driver characteristics, Vehicle Characteristics, Traffic, Capacity and Level of Service, Design Speed. Objectives of Geometric Design, Cross Section Elements: Design specifications; Pavement Surface characteristics–Skid Resistance, Road Roughness; Camber, Objectives, design standards. Specifications for hill roads.

Module-2

Horizontal Alignment of Roads: Sight Distances–Stopping Sight Distance, Overtaking Sight Distance and Intermediate Sight Distance; Objectives of horizontal curves; Super elevation; Extra- widening on Curves; Transition Curves–Objectives and Design. Transition Curve setting methods, Introduction to MX Roads software.

Module-3

Vertical Alignment of Roads: Gradients–Types of Gradients, Design Standards; Vertical Curves–Summit Curves, Valley Curves and Design criteria for Vertical Curves; Importance of Sight Distances for Horizontal and Vertical Curves; Combination of Vertical and Horizontal Curves–Grade Compensation.

Module-4

Geometric Design of Intersections: Types of Intersections; Design Principles for Intersections; Design of At-grade Intersections–Channelization, Objectives; Traffic Islands and Design standards; Rotary Intersection–Concept, Advantages and Disadvantages; Grade separated Interchanges – Types, warrants and Design standards.

Module-5

Miscellaneous Elements: Requirements of Pedestrians; Pedestrian facilities on Urban Roads; Cycle Tracks – Guidelines and Design standards; Bus bays–Types and Guide lines; Design of On-street and Off street Parking facilities–Guidelines for lay out Design, Traffic Signs and Markings.

Note: Computer Lab. using highway geometric design software for design of intersections, interchanges and parking lots to be carried out.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Principles and Practice of Highway Engineering	L. R. Kadiyali and N.B.Lal	Khanna	2007
2	A Policy on Geometric Design of Highways and Streets		AASHO, American Association of State Highway and Transportation Officials, Washington D.C.	
3	Highway Engineering	Khanna S.K. and Justo, C. E.G.	Nem Chand and Bros.	2000
4	Roads in Urban Areas	DSIR	HMSO, London	
5	Planning and Design Guide: At-Grade Intersections	Jack E Leishand Associates	Illinios	
6	Relevant IRC Codes & Publications			

(Group-3): 20CSE242 DESIGN OF PRECAST & COMPOSITE STRUCTURES

Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Concepts , components, Structural Systems andDesign of precast concrete floors
Need and types of precast construction, Modular coordination, Precast elements- Floor, Beams, Columns and walls. Structural Systems and connections.
Design of precast Concrete Floors:
Theoretical and Design Examples of Hollow core slabs,. Precast Concrete Planks, floor with composite toppings with and without props.

Module-2

Design of precast reinforced and pre-stressed Concrete beams
Theoretical and Design Examples of ITB – Full section precast, Semi Precast, propped and unpropped conditions. Design of RC Nibs

Module-3

Design of precast concrete columns and walls
Design of braced and unbraced columns with corbels subjected to pattern and full loading. Design of Corbels Design of RC walls subjected to Vertical, Horizontal loads and moments, Design of vertical ties and horizontal joints.

Module-4

Design of Precast Connections and Structural Integrity Beam bearing, Beam half Joint, Steel Inserts, Socket Connection, Structural integrity, Avoidance of progressive collapse, Design of Structural Ties.

Module-5

Design of Steel Concrete Composite Floors and Beams Composite Floors:
Profiled Sheeting with concrete topping, Design method, Bending and Shear Resistance of Composite Slabs, Serviceability Criteria, Design Example
Composite Beams:
Elastic Behaviour, Ultimate Load behavior of Composite beams, Stresses and deflection in service and vibration, Design Example of Simply Supported beams.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Precast Concrete – Design and applications	Hass A.M.	Applied Science	1983
2	Plant cast, Precast and Pre-stressed concrete	David Sheppard	McGraw Hill	1989
3	IS 15916-2011, IS 11447, IS6061–I and III	NBC – 2005 (Part I to Part VII)	BIS Publications, New Delhi	2005
4	Composite Structure of Steel and Concrete (Volume 1)	R.P. Johnson	Blackwell Scientific Publication (Second Edition), U.K.	1994
5	Code of Practice for Composite Construction in Structural Steel and Concrete	IS: 11384		1985
6	INSDAG Teaching Resource	Chapter 21 to 27: www.steel-insdag.org		

(Group-3): 20CCS253	**COMPOSITE AND SMART MATERIALS**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

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

Module-2

Anisotropic elasticity: Unidirectional and anisotropic lamina, thermo-mechanical properties, micro- mechanical analysis, classical composite lamination theory, Cross and angle–play laminates, symmetric, anti-symmetric and general asymmetric laminates, mechanical coupling, laminate stacking,

Module-3

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

Module-4

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

Module-5

Beam modeling with strain actuator, bending extension relation.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Mechanic of Composite Materials	Robart M Jones	McGraw Hill Publishing Co.	2015
2	Analysis and Performance of Fiber Composites	Bhagwan D Agarawal, and Lawrence J Brutman	John Willy and Sons	2006
3	Mechanics of composite materials and structures	Madujit Mukhopadyay	University Press	2004
4	Piezoelectric actuator modeling using MSC/NASTRAN and MATLAB	Mercedes C. Reaves and Lucas G. Horta	NASA/TM-2003-212651, Langley Research Center, Hampton, Virginia	2003
5	Lecture notes on Smart Structures	Inderjit h Chopra	Department of Aerospace Engg., University of Maryland	
6	Use of piezoelectric actuators elements of intelligent structures	Crawley E F. and deLuis J	A journal Vol 25, No 10, Pp 1373-1385	Oct 1987
7	Detailed models of piezo-ceramics actuation of beams	Ceawley E. and Anderson E	Ceawley E. and Anderson E	April 1989

(Group-3): 20CSE31	**DESIGN OF BRIDGES**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction & Design of Slab Culvert

Bridge Engineering and its development in past, Ideal site selection for Bridges, Bridge classifications, Forces acting on Bridge. Analysis for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles. Structural design of slab culvert using limit state method with reinforcement details.

Module-2

Box Culvert

Introduction to box culvert, advantage of structural continuity, Analysis for maximum BM and SF at critical sections using moment distribution method for various load combinations such as Dead, Surcharge, Soil, Water and Live load as per IRC class A, B, AA tracked and wheeled vehicles. Structural design of box culvert using limit state method with reinforcement details.

Module-3

T Beam Bridge

Components of T Beam Bridge, Load transfer mechanism, Proportioning the of Components, Analysis of **Slab** using **Pigeauds Method** for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles and design of **Slab** using limit state method with reinforcement details. Analysis of **Cross Girder** for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles and design of slab using limit state method with reinforcement details. Analysis of **Main Girder** using **Courbon's Method** for maximum BM and SF at critical sections for Dead and Live load as per IRC class A, B, AA tracked and wheeled vehicles and design of **Main Girder** using limit state method with reinforcement details.

Module-4

PSC Bridge

Introduction to Pre & Post Tensioning, Proportioning of Components, Analysis & Structural Design of Slab, Analysis of Main Girder Using **Courbon's Method** for IRC Class AA, Tracked vehicle, Calculations of Prestressing Force, Calculations of Stresses, Cable profile, Design of End Block, Detailing of Main Girder.

Module-5

Balanced Cantilever Bridge

Introduction & Proportioning of Components, Analysis of Main Girder Using **Courbon's Method** for IRC Class AA, Tracked vehicle Design of Simply Supported Portion, Cantilever Portion, Articulation, using limit state method with reinforcement details

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Essentials of Bridge Engineering	Dr D Johnson Victor	& IBH Publishing Co New Delhi	
2	Design of Bridges	Dr N Krishna Raju	Oxford & IBH Publishing Co New Delhi	
3	Principles and Practice of Bridge Engineering	S P Bindra	Dhanpat Rai & Sons New Delhi	
4	IRC 6-1966 Standard Specifications And Course Code Of Practice For Road Bridges Section II Loads and Stresses		The Indian Road Congress New Delhi	
5	IRC 21-1966 Standard Specifications And Course Code Of Practice For Road Bridges Section III Cement Concrete (Plain and reinforced)		The Indian Road Congress New Delhi	

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
6	IS 456-2000 Indian Standard Plain and Reinforced Concrete Course Code of Practice (Fourth Revision)		BIS New Delhi	
7	IS 1343 - Indian Standard Pre-stressed Concrete Course Code of Practice		BIS New Delhi	

(Group-3): 20WLM22	**GROUND WATER HYDROLOGY**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

General Water Balance, Regional Ground Water Balance, Distribution of Subsurface Water, Different Types of Aquifers, Heterogeneity and Anisotropy, Occurrence of Ground Water in Hydro Geological Formations, Structure and Types of Wells. –Problems on estimation of basic parameters.

Module-2

Governing Equation of Groundwater Flow in Aquifers. Derivation of General Differential Equations for Ground Water Flow, Regional Ground Water Problems, Governing Equations for Transient Flow Conditions.

Module-3

Models for Ground Water Analysis: Introduction, Major Applications of Groundwater Models, Numerical Modelling of Groundwater Systems, Groundwater Modelling by the Finite Difference (FD). –Problems.

Pollution of Groundwater: Hydrodynamic Dispersion of Pollutants in Groundwater Environment (Advection dispersion, Molecular diffusion) Optimization models for management of groundwater quantity and quality.

Module-4

Well Hydraulics: Analysis of Steady Radial Flow Towards a Well in a confined Aquifer, Dupuit Forcheimmer (DF) Theory of free Surface Flow For Steady Flow in Unconfined Aquifers, Analysis of Steady Radial Flow in Laterlly Stratified Phreatic Aquifers. Problems on well Hydraulics.

Module-5

Artificial Recharge: Spreading methods, Induced-recharge method, Recharge- well method, Subsurface dams, Wastewater discharge, Recharge by urban storm runoff, Case history.

Geophysical Methods in Groundwater Exploration, Introduction, Electrical Resistivity Method, Analytical Derivation for Resistivity in Vertical Electrical Sounding, Seismic Retraction Method, Determination of Aquifer Thickness, Geologic and Hydrologic methods, Hydrogeologic well logging, Tracer techniques.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Numerical Groundwater Hydrology	A. K. Rastogi	Penram International Publishing (India) Pvt.Ltd.	2007
2	Ground Water Hydrology	Todd D.K. & Mays, L.W.	3 Ed, Wiley	
3	Ground Water	Raghunath H.M.	New Age Publishers	2007

(Group-4): 20CSE23	**EARTHQUAKE RESISTANT STRUCTURES**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction to engineering seismology, Geological and tectonic features of India, Origin and propagation of seismic waves, characteristics of earthquake and its quantification–Magnitude and Intensity scales, seismic instruments. Earthquake Hazards in India, Earthquake Risk Evaluation and Mitigation. Structural behavior under gravity and seismic loads, Lateral load resisting structural systems, Requirements of efficient earthquake resistant structural system, damping devises, base isolation systems.

Module-2

The Response history and strong motion characteristics.
Response Spectrum – elastic and inelastic response spectra, tripartite (D-V-A) response spectrum, use of response spectrum in earthquake resistant design. Computation of seismic forces in multi-storied buildings – using procedures (Equivalent lateral force and dynamic analysis) as per IS- 1893.

Module-3

Structural Configuration for earthquake resistant design, Concept of plan irregularities and vertical irregularities, Soft storey, Torsion in buildings. Design provisions for these in IS-1893. Effect of infill masonry walls on frames, modeling concepts of infill masonry walls. Behaviour of masonry buildings during earthquakes, failure patterns, strength of masonry in shear and flexure, Slenderness concept of masonry walls, concepts for earthquake resistant masonry buildings – codal provisions.

Module-4

Design of Reinforced concrete buildings for earthquake resistance-Load combinations, Ductility and energy absorption in buildings. Confinement of concrete for ductility, design of columns and beams for ductility, ductile detailing provisions as per IS1893. Structural behavior, design and ductile detailing of shear walls.

Module-5

Seismic response control concepts – Seismic demand, seismic capacity, Overview of linear and nonlinear procedures of seismic analysis. Performance Based Seismic Engineering methodology, Seismic evaluation and retrofitting of structures.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Dynamics of Structures – Theory and Application to Earthquake Engineering- 2nd ed.	Anil K. Chopra	Pearson Education	
2	Earthquake Resistant Design of Building Structures	Vinod Hosur	WILEY (india)	
3	Earthquake Resistant Design of Structures	Duggal	Oxford University Press	
4	Earthquake resistant design of structures	Pankaj Agarwal, Manish Shrikande	PHI India	
5	IS – 1893 (Part I): 2002, IS – 13920: 1993, IS – 4326: 1993, IS-13828: 1993			
6	Design of Earthquake Resistant Buildings	Minoru Wakabayashi	McGraw Hill Pub.	
7	Seismic Design of Reinforced Concrete and Masonry Buildings	T Paulay and M J N Priestley	John Wiley and Sons	

(GROUP-4): 20CGT22	**SOIL DYNAMICS**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Theory of vibration–single degree, two degree and multi degree of freedom system. Free and forced vibration, transient response, resonance and its effects.

Module-2

Wave Propagation–theory and application to dynamic problems, dynamic soil properties- general, laboratory and field methods, factors affecting. Different properties, vibration inducing and measuring instruments.

Module-3

Shear strength and liquefaction of soils- stress, strain, strength characteristics of soils under dynamic loads. Factors affecting, resonance column test, triaxial test under dynamic loads. Liquefaction of soils and factors influencing liquefaction, dynamic earth pressure, retaining wall problems under dynamic loads.

Module-4

General principles of machine foundation design- introduction, design criteria, types and requirements of machine foundations, foundations for reciprocating machines, foundations for forge hammers, foundations for turbo generators.

Module-5

Vibration isolation–Introduction, mechanical isolators, isolation by artificial barriers, active and passive isolation, case histories of foundation of isolation.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Soil Dynamics and Machine Foundation (4010)	Swami Saran	Galgotia Publications Pvt. Ltd.	
2	Soil Dynamics	Prakash, S.	McGraw Hill Book Company	1981
3	Foundation for Machines Analysis and Design	Prakash S. and Puri V. K	John Wiley & Sons	1998
4	Vibration Analysis and Foundation Dynamics	Kameswara Rao, N. S. V.	Wheeler Publication Ltd.	1998
5	Vibrations of Soils and Foundations	Richart, F. E. Hall J. R and Woods R. D.	PrenticeHall Inc.	1970
6	Principles of Soil Dynamics (4002)	Das B. M.	PWS KENT publishing Company, Boston	

(GROUP-4): 20CWM22	**INDUSTRIAL EFFLUENT TREATMENT AND ENGINEERING**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Industrial Effluent Significance of industrial effluent treatment, Effects of Industrial Wastes on sewerage system and sewage treatment plants and receiving water bodies. Effects of waste additions on physical and chemical properties of soil.
Disposal Standards Effluent standards and receiving water quality standards – differences, steps for implementation. Disposal alternatives–methods, operating procedures, recommended standards.

Module-2

Industrial Waste Survey - Process flow charts for manufacturing of Sugar, Distillery, Paper & Pulp, Dairy industries, condition of waste stream, Material balance–procedure & significance, Sampling–Grab, Composite and integrated samples. Continuous monitoring–pH, Conductivity, Bio-monitoring.

Module-3

Pre-treatment of Industrial Wastewater–Volume reduction–methods and its significance, Strength reduction–methods and its significance, Neutralization, Equalization and Proportion, Removal of Organic and inorganic dissolved solids.

Module-4

Effluent Treatment for industries: Distillery, Sugar Industry, Pulp and paper, Cement Industry, Textile, Dairy Industry, Fertilizer, Pesticides and Pharmaceutical industries – flowchart with significance of each treatment unit.

Module-5

Design of complete treatment system & disposal of Effluents: Distillery, Diary, Sugar Paper and Pulp mill to meet PCB standards.
Treatment of Radio Active Wastes - Low activity and high activity radiation, application of radioactive techniques for wastewater treatment. **Bio-Remediation**.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Liquid Waste of industry theories, Practices and Treatment	Nemerow N.N.	Addison Willey New York	1971
2	Wastewater Engineering - Treatment and Reuse	Metcalf and Eddy Inc.	4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi	2003

(GROUP-4): 20CEE31	**ENVIRONMENTAL IMPACT ASSESSMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Environmental Legislation: Introduction & need, Constitution of India, Environmental Jurisprudence, National Environmental Policy, Environmental Tribunal (Green Tribunal) Legal framework Legislative act, rules, regulations notification and amendments

Module-2

Indian Environmental Acts: Environment (Protection) Act, 1986, Air & Water Acts. Biomedical Waste (Managing and Handling) Rules, 2011, Recycle Plastics (Manufacturing and Usage) Rules, 1999, Water Act, 1974, Air Act, 1981, Forest Act, 1927, Environmental Tribunal Authority, 1995. Wild Life Protection Act, 1972, Biodiversity Rules, 2004

Module-3

Environmental Impact Assessment: Definition, Objectives, Types – Rapid and Comprehensive EIA, EIS, FONSI. Step-by step procedure for conducting EIA and Limitations of EIA, Prevention of Significant Deterioration (PSD) Programme. Carrying capacity concept

Module-4

Attributes, Standards and Value functions: Public participation in EIA.
Environmental Management Plan (EMP) and Disaster Management Plan (DMP).

Module-5

EIA Case Studies–Thermal Power Plant, Mining, Fertilizer, Construction Projects, Air port, Water and Wastewater Treatment Plants

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Environmental Impact Assessment Methodologies	Anjaneyulu and Valli Manickam	BS Publications, Hyderabad	2010
2	Environmental Impact Assessment	Canter L.	McGraw Hill.	
3	Environmental Impact Analysis-A New Dimension in Decision Making	Jain R.K., Urban L.V., Stacey G.S.	Van Nostrand Reinhold	1977

(GROUP-4): 20WRM252	**CLIMATE CHANGE AND ADAPTATION**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Earth's Climate System**:** Introduction–Climate in the spotlight - The Earth's Climate Machine–Climate Classification–Global wind systems–Trade Wind Systems–Trade Winds and the Hadley Cell–The Weserlies–Cloud formation and Monsoon Rains–Storms and Hurricanes–The Hydrological Cycle–Global Ocean Circulation–EI Nino and its Effect–Solar Radiation–The Earth's Natural Green House Effect–Green House Gases and Global Warming–Carbon Cycle.

Module-2

Observed Changes and Its Causes: Observation of Climate Change–Changes in pattern of temperature, precipitation and sea level rise–Observed effects of Climate Changes–Patterns of Large Scale Variability–Drivers of Climate Change–Climate Sensitivity and Feedbacks–The Montreal Protocol–UNFCCC–IPCC–Evidences of Changes in Climate and Environment–on a Global Scale and in India – Climate Change modeling.

Module-3

Impacts Of Climate Change: Impacts of Climate Change on various sectors – Agriculture, Forestry and ECO system – Water resources – Human Health – Industry, Settlement and Society – Methods and Scenarios – Projected Impacts for different regions Uncertainties in the Projected Impacts of Climate Change – Risk of irreversible changes.

Module-4

Climate Change Adaptation and Mitigation Measures: Adaptation Strategy/options in various sectors – Water – Agriculture – Infrastructure and Settlement including coastal zones. Human Health – Tourism – Transport – Energy – Key Mitigation Technologies and practices – Energy supply – Transport – Buildings – Industry – Agriculture – Forestry– Carbon sequestration – Carbon Capture and Storage (CCS) – Waste (MSW & Biowaste, Biomedical, Industrial waste – International and Regional co-operation.

Module-5

Clean Technology and Energy: Clean Development Mechanism – Carbon Trading – Examples of future Clean Technology – Biodiesel – Natural Compost – Eco-friendly Plastic – Alternate Energy – Hydrogen – Bio-fuels – Solar Energy – Wind –Hydroelectric Power – Mitigation Efforts in India and Adaptation funding.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Al core Inconvenient Truth		video form	
2	Climate Change – An Indian Perspective	Dash Sushil Kumar	Cambridge University Press India Pvt. Ltd.	2007
3	IPCC Fifth Assessment Report		www.ipcc.ch	
4	Impacts of "Climate Change and Climate Variability on Hydrological Regimes	Jan C. van Dam	Cambridge University Press	2003

(GROUP-4): 20CCT21	**CONSTRUCTION ECONOMICS AND FINANCE**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Economics; Definition and importance and scope Finance: Definition and scope, Sources of finance, Financial Management; Meaning and Scope, Supply and Demand Mechanism, Time value of money, discounted cash flow, NPV, ROR, Problems

Module-2

Pricing; objectives, determinants, absorption, marginal costing. Financial analysis, Process of Decision making: Capital Budgeting, budgetary control, standard costing and variance, investment appraisal. Practical problems

Module-3

Quantifying alternatives for decision making; Bases of comparison, Incremental analysis, Benefit-Cost analysis, Capital budgeting; Profit, loss and Breakeven analysis, Practical Problems

Module-4

Working capital cycle, Working capital management, Financial statements; Balance sheet and its components, profit & loss account, fund flow statement. Financial ratios and their importance. Project appraisal, project yield, taxation and inflation

Module-5

Risk and uncertainty-SWOT analysis, Turnkey activities; cost control, performance budgeting. Equipment economics: Equipment costs, Ownership and operating costs, Buy/Rent/Lease options, Replacement analysis, depreciation and amortization.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Managerial Economics	Peterson, H.C., Lewis, W.C.	Prentice Hall of India Pvt. Ltd.	2001
2	Modern Macroeconomics	Parkin, M. & Bade R.	4th Edition, Prentice Hall	1996
3	Human Resources & Personnel Management	Werther & Davis	McGraw Hill	1996
4	Manpower planning	Edwards, John et.al.	John Wiley, New York	1983
5	Management control systems	Anthony, R.N. Govindrajan, V., Irwin	McGraw Hill Publications, 10th Edition	2000

(GROUP-4): 20CTM324	**RAILWAY INFRASTRUCTURE PLANNING AND DESIGNING**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Planning of railway network: Operational system, historical background, plans and developments, policy and standards, traffic forecasts and surveys, railway alignment, project appraisal and organization setups

Module-2

Component of railway track and rolling stock: Permanent way, forces acting on rails, function of rails, rail fixtures and fastenings, sleepers and ballast, rail joints, elements of junctions and layouts, types of traction, locomotives and other rolling stock, tractive effort and hauling power of locomotives.

Module-3

Geometric design of railway track, construction and maintenance:
Field investigation, right of way and formation, geometric design elements and standards, speeds computation, string lining of curves, grade compensation, railway cant and cant deficiency, traction, practice with examples. Special considerations and practices, track laying, inspection and maintenance, maintenance tools, maintenance of rail surface, track drainage, track circuited lengths, track tolerances, ballast confinement and track maintenance, renewal works.

Module-4

Signalling and interlocking: Objectives, classifications, signaling systems, mechanical and electrical signaling systems, systems for controlling train movement, interlocking, and modern signaling.
Railway accidents and safety: Cause of train accidents, types of collision and derailment, restoration of traffic, safety measures, disaster management, level crossing and related accidents, remedial measures.

Module-5

Railway Station and Yards: Site selection, facilities, classification, platforms, building areas, types of yards, sidings, foot over bridges and subways, loading gauge, end loading ramps, locomotive sheds, triangles, buffer stop, scotch block, derailing switch, sand hump, fouling mark.
High Speed Railways: Modernization of railways, effect of high speed track, vehicle performance on track, high speed ground transportation system, ballastless track, elevated railways, underground, and tube railways.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Indian Railway Track	Agarwal, M.M	Prabha & Co., New Delhi, India	1988
2	Railway Engineering	Chandra S. and M. Agrawal	Second Edition, Oxford University Press	2013
3	Practical Railway Engineering	Clifford F. Bonnett	2nd edition, imperial college press, London	2005
4	Text Book of Railway Engineering	Gupta, B.L.	Standard Publishers, New Delhi, India	1982
5	Railway Track Engineering	Mundrey, J. S.	Fourth Edition, TATA McGraw- Hill, New Delhi	2009
6	Principles of Railway Engineering	Rangwala, S. C.	Charotar Publishing House, Anand, India	2009
7	A text book of Railway Engineering	Saxena S.C. and S.P. Arora	Dhanpat Rai	2010
8	https://nptel.ac.in/courses/105107123/			
9	https://www.edx.org/course/railway-engineering-an-integral-approach-2			

(GROUP-4): 20CIM243 GROUND IMPROVEMENT TECHNIQUES	
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction - Need and objectives of ground improvement, classification of ground modification techniques, trends in ground improvement, Engineering properties of soft, weak and compressible deposits; Principles of treatment; Methods of compaction: Blasting, dynamic consolidation, pre-compression and compaction piles.

Module-2

Methods of dewatering: Open sumps and ditches, well point system, electro- osmosis, Vacuum dewatering wells; pre-loading without and with sand drains, strip drains and rope drains.
Stabilization: With admixtures like cement, lime, calcium chloride, fly ash and bitumen. Methods of soil improvement-lime stabilization and injection; thermal, electrical and chemical methods.

Module-3

Soil reinforcement: Reinforcing materials, concept of confinement, Gabbion walls; Dynamic consolidation, Vibro flotation, Pre-consolidation with vertical drains, Granular piles, Soil nailing, Anchors & Thermal methods.

Module-4

Improvement of Foundation Soils:
(a) Improvement of granular soils: Terms used to describe degree of compactness – relative density, density ratio and degree of compaction; Methods-Vibration at ground surface, factors influencing roller compaction; deep dynamic compaction, vibro-compaction impact at depth.
(b) Improvement of cohesive soils: Preloading, or dewatering, methods of installing: sand drains, drain wicks, electrical and thermal methods.

Module-5

Grouting: Materials of grouting, grouting techniques and control; purpose, functions, types of grouts; soil bentonite - cement mix; Emulsions & solutions; grout injection methods; Geo-synthetics: types, functions & Classification of geo-textiles. Specific Applications: Bearing capacity improvement, reinforcement, Retaining walls, embankment etc.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Engineering principles of ground modification	Manfred R. Hansmann ISBN: 978-0070272798	McGraw Hill pub. Co., New York	1991
2	Construction and Geotechnical methods in Foundation Engineering	Robert M. Koerner ISBN: 978-0070352452	McGraw- Hill Pub. Co., New York	1984
3	Foundation Engineering Hand Book	Winterkornand Fang	Van Nostrand Rein hold Co., New York	1975
4	Soil Improvement by Preloading	Aris C. Stamatopoulos & Panaghiotis, C.Kotzios ISBN: 978-0471815938	John Wiley & Sons Inc. Canada	1985
5	Ground Improvement Techniques	P. Purushothama Rao ISBN: 978-8131805947	2e, Laxmi Publications	2016

(GROUP-4): 20CTE31	**PAVEMENT CONSTRUCTION TECHNOLOGY**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Importance of surveys and investigations, Guidelines for alignment and route location, Use of aerial photographs and remote sensing technology, Conventional ground survey techniques, Types of drawings, Estimates, Project reports, Project Cost Forecasting, Cost Optimization and Resources Planning, Tendering and Contracting, Laws of Contracts, Subcontracts, Potential Problems, Post Contract Problems, Documents, Conditions, Arbitration, Special Features of International Contracts. Human Resource Management, Resource Management and Inventory: Basic concepts, labor requirements and productivity.

Module-2

Road construction equipment–different types of excavators, graders, soil compactors/ rollers, pavers and other equipment for construction of different pavement layers– their uses and choice. Problem on equipment usage charges; Pre-construction survey sand marking on ground-Specifications and steps for the construction of road formation in embankment and cut, construction steps for granular sub-base, quality control tests.

Module-3

Different types of granular base course–WMM, CRM, WBM; specifications, construction method and quality control tests. Different types of bituminous layers for binder and surface courses; their specifications (as per IRC and MORTH); construction method and quality control tests.

Module-4

Different types of sub-base and base course for cement concrete (CC) pavement and construction method. Construction of cement concrete (PQC) pavements joints quality control during construction. Construction details of inter locking concrete block pavements

Module-5

Principle of construction planning, application of CPM and PERT, Problems, Road maintenance works–day to day and periodic maintenance works of various components of road works and road furniture

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Construction Planning, Equipment and Methods	Peurifoy R. L.	McGraw Hill Publishers, New York	2000
2	Construction Equipment and its Management	S. C. Sharma	Khanna Publishers, New Delhi	1988
3	Asphalt Technology and Construction Practices		The Asphalt Institute, Maryland, USA	1997
4	Relevant IS, IRC, AASHTO and MoRTH Publications			

(GROUP-4): 20CHT254	**LOW VOLUME ROADS ENGINEERING**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction to Low-Volume Roads (LVR). Significance of LVR, Definition, Design Environments. Planning of rural road, planning data base, concept of network planning Rural roads plan, guidelines laid down in recent 20 year plans and in PMGSY Road alignment and surveys, governing factors for route selection Factors controlling alignment; obligatory points, traffic, geometric designs, economy, special considerations in hilly areas.

Module-2

Geometric design standards: classification of rural roads, terrain classification, design speed, basic principles of geometric design cross sectional elements, camber, sight distances. Horizontal alignment: general guidelines, super elevation, transition curve, widening and set back distances, vertical alignment: gradient, grade compensation at curves, valley curves, alignment compatibility, lateral and vertical clearances.

Module-3

Soil and material surveys, soil investigations for low embankment, high embankment, cut sections, subgrade, Survey for marginal materials and aggregates/ low grade materials Artificial aggregates, waste materials, new materials and stabilizers Design parameters, pavement components Design of flexible pavement: pavement thickness, pavement surfacing Design of semi rigid pavement: dry lean concrete / lime flyash concrete bases Design of rigid pavement: cement concrete pavement Design of special pavements: concrete block pavement , interlocking concrete block pavement Choice of pavement type and materials, maximize use of Locally available materials, Use of Geo-synthetics in LVR

Module-4

Types of road drainage, requirements of surface drain; road side drains, shoulder drains, catch water drains. Requirements subsurface drain Cross drains; types, requirements, choice of different types of cross drains Standard designs of culverts Standard design of small bridges.

Module-5

Selection of materials and methodology, construction techniques, machinery and tools.
Construction of Embankment/subgrade; materials, requirements and construction operations. Choice and requirements of coarse sand sub base, gravel roads.
Pavement Maintenance and Rehabilitation Management System (RMS) for LVR

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Highway Engineering	S.K. Khanna, C.E.G Justo and A. Veeraragavan	Nem Chand andBros., Roorkee. Revised 10th Edition	
2	Low-Volume Road Engineering, Design, Construction, and Maintenance	Robert A. Douglas	I edition, CRC Press	
3	Guidelines for the design of Flexible Pavements for Low Volume Roads		IRC: SP:72-2015, First Revision	
4	Guidelines for Design & Construction of CC pavements for low volume roads		IRC:SP:62-2014	
5	IRC SP 20 Rural Roads Manual			
6	Relevant IRC Publications			

(GROUP-4): 20CTM31	**ROAD ASSET MANAGEMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Highway Asset Management: Principles, types of asset management definition, structure, historical background, elements of highway asset management, asset Inventory, activity and cost model development, public assets versus private assets, motivation for asset management, benefits of road asset, management system, financial management systems, roads billing, roads payment and cost accounting and tools for asset management.

Module-2

Highway Asset Valuation and Frame Work:
Asset Valuation approaches, guidelines, overview of highway asset valuation procedure, valuation principles, basis and rules, depreciation, highway lighting and high mast lighting, land associated with the highways

Module-3

Construction ManagementSystems: Preconstruction scheduling, utility management, ROW management, user occupancy permits, project control, agreement monitoring and contractor management.

Module-4

Roadway Operations Management Systems
Joint operations center, district operations center, traveler information systems.

Module-5

Road Asset Management Modules: Bridge inventory and rating, bridge management, Workforce Management Systems, Payroll detail, personal information and employee accident. Safety Management Systems Accident records, hazardous location and highway safety information Equipment Management Systems Equipment management information, fleet management

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	AASHTO Transportation Asset Management Guide: A Focus on Implementation		AASHTO	2011
2	Transportation: Asset Management	Hamilton, W.E.	House Fiscal Agency	2001
3	Performance Measures and Targets for Transportation Asset Management	NCHRP Report 551	TRB	2006
4	An Asset-Management Framework for the Inter State Highways	NCHRP Report 632	TRB	2009
5	Use of Transportation Asset Management Principles in State Highway Agencies	NCHRP Synthesis 439	TRB	2013
6	Transportation Asset Management, Federal Highway Administration, National Highway Institute	NHS	USA	2003
7	Asset Management for the Roads Sector, Organization for Economic Co- operation and Development	OECD	France	2001
8	AASHTO Transportation Asset Management Guide: A Focus on Implementation	Thompson, P.D.	USA	2011
9	Pavement Asset Design and Management Guide		Transportation Association of Canada	December, 2013
10	https://www.youtube.com/watch?v=ep3j7f_LuM			

(GROUP-4): 20CSE251	**DESIGN OF INDUSTRIAL STRUCTURES**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Analysis of industrial building for Gravity and Wind load. Analysis and design of framing components namely, girders, trusses, gable frames

Module-2

Analysis and design of gantry column (stepped column / column with bracket), purlins, girts, bracings including all connections.

Module-3

Analysis of transmission line towers for wind load and design of towers including all connections.

Module-4

Forms of light gauge sections, Effective width computation of unstiffened, stiffened, multiple stiffened compression elements of cold formed light gauge sections. Concept of local buckling of thin elements. Limiting width to thickness ratio. Post buckling strength.

Module-5

Concept of Pre- engineered buildings, Design of compression and tension members of cold formed light gauge sections, Design of flexural members (Laterally restrained / laterally unrestrained).

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Bureau of Indian Standards, IS800-2007, IS875-1987, IS-801-1975. Steel Tables		SP 6 (1)	1984
2	Design of Steel Structure	N Subramanian	oxford University Press	
3	Design of Steel Structures	B.C. Punmia, A.K. Jain	Laxmi Publications, New Delhi	
4	Design of Steel Structures Vol. 1 and Vol.2	Ramchandra and Virendra Gehlot	Scientific Publishers, Jodhpur	
5	Limit State Design of Steel Structures	Duggal	TMH	

(GROUP-4): 20CCS321	**STRUCTURAL OPTIMIZATION - THEORY & COMPUTATIONS**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction: Introduction to optimization, engineering applications of optimization, Formulation of structural optimization problems as programming problems. Optimization Techniques: Classical optimization techniques, single variable optimization, multivariable optimization with no constraints, unconstrained minimization techniques and algorithms constrained optimization solutions by penalty function techniques, Lagrange multipliers techniques and feasibility techniques.

Module-2

Linear Programming: Linear programming, standard form of linear programming, geometry of linear programming problems, solution of a system of linear simultaneous equations, pivotal production of general systems of equations, simplex algorithms, revised simpler methods, duality in linear programming.

Module-3

Non-linear programming: Non-linear programming, one dimensional minimization methods, elimination methods, Fibonacci method, golden section method, interpolation methods, quadratic and cubic methods, Unconstrained optimization methods, direct search methods, random search methods, descent methods.

Module-4

Constrained optimization techniques such as direct methods, the complex methods, cutting plane method, exterior penalty function methods for structural engineering problems. Formulation and solution of structural optimization problems by different technique.

Module-5

Geometric programming: Geometric programming, conversion of NLP as a sequence of LP / geometric programming. Dynamic programming: Dynamic programming conversion of NLP as a sequence of LP/ Dynamic programming.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Optimum Structural Design	Spunt, L	Prentice Hall	1971
2	Optimization – Theory and Practice	Rao S. S.	Wiley Eastern Ltd.	1978
3	Optimum Structural Design	Uri Kirsch	McGraw Hill, New York	1981
4	Operation Research	Bronson R. and Govindsami N.	Schaum's Outline Series	2017
5	Structural optimization using sequential linear programming	Bhavikatti S. S.	Vikas publishing	2003
6	Optimization Methods for Engineering Design	Fox. R. L	Addison Wesley	1971
7	System simulation with digital computer	Narsingk Deo	Prentice Hall of India, New Delhi	1989
8	Mathematical Foundations for Design	Stark. R.M. Nicholls. R .L	McGraw Hill New York	1972

(GROUP-4): 20CCT251	**BUILDING COST AND QUALITY MANAGEMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Estimation of quantities for R.C.C. multi storeyed complex viz. earthwork, concrete in foundation, D.P.C., R.C.C. work, flooring and roofing, plastering and pointing etc., wood work, white washing.

Module-2

Analysis of rates for multi storeyed building works – Brick work in foundations and Superstructure, cement concrete, R.C. C., Plastering, Flooring, Timber work etc. Checking of construction quality– various tests for bricks, cement, concrete, aggregates, and steel as per IS codes.

Module-3

Preparation of bills for payment, measurement book, mode of payment, running account bill. Ledger and Cash book details, Arbitration.

Module-4

Estimation of building services viz. water supply works, electrification, sanitary fitting etc, and their cost analysis.

Module-5

Elements of Valuation: methods, techniques and examples Completion report of the project; Checking of Plan, Details of various works, and issue of completion report of the project.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Estimating and Costing	B.N. Dutta	UBS Publishers' Distributors Pvt. Ltd, 28th Revised Edition	2016
2	Estimating and Costing	G.S. Birdie	Dhanpat Rai Publishing Company	
3	Professional Practice	Roshan N Namavati	Lakahni Book Depot, Mumbai	

(GROUP-4): 20WLM251 IRRIGATION TECHNOLOGY AND IRRIGATION WATER MANAGEMENT	
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction: Types & Techniques of Irrigation including advanced techniques, Present situation of irrigation in India Soil-Moisture Irrigation Relationship, Estimating depth and frequency of irrigation.

Module-2

Soil and Land Management in Agriculture: classification and surveys-land capability farm development, grading-equipment, land management techniques.

Module-3

Crop requirements and irrigation scheduling : Major Indian crops times of sowing and harvesting –critical periods of growth moisture stress, Duty & delta of crops, Irrigation scheduling, Consumptive use of Crop- Blanney-Criddle, Thornth wait penman, Christiansen methods, Water-use efficiency, scope of computerization in irrigation.

Module-4

Water conveyance Computing the capacity of canals, Losses in water canals, Distribution of water into the fields through water courses, Lined canals

Module-5

Reclaimation of Water Logged and Saline Soils: Glances of water logging- design of surface and subsurface drains, Saline and alkaline lands reclamation and management of Salt affected lands.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Irrigation, Water Resources & Water Power Engineering	Modi. P. N.	Standard Publishers, New Delhi	
2	Irrigation and water power engineering	B. C. Punmia, Pande, Ashok kumar and Arunkumar Jain	Laxmi Publications (P) LTD.	
3	Water Resources Systems Planning and Management	Chaturvedi. M.C	Tata McGraw Hill. NY	
4	Water Resources Engineering	Linsley, R. K. and Frazinini, J. B.	2nd Ed. McGraw Hill, NY	
5	Economics of Water Resources Systems Planning	James L.D and Lee R.R.	McGraw Hill. NY	

(GROUP-5): 20CSE243 ADVANCED CONCRETE TECHNOLOGY

Exam Hours: 3 hours	Exam Marks (Maximum): 100

Module-1

Fibre reinforced concrete:
History, mechanism, different types of fibres, Aspect ratio, Volume of fibres, orientation of fibres, balling effect, properties of fibre reinforced concrete, applications of fibre reinforced concrete. Types of Fibre reinforced concrete.

Ferro cement:
Definition, different materials used, casting techniques, properties of Ferro cement, applications.

Module-2

Light Weight Concrete:
Introduction, classification, properties, strength and durability, mix proportioning and problems

High Density Concrete:
Radiation shielding ability of concrete, materials for high density concrete, mix proportioning, properties in fresh and hardened state, placement methods.

Module-3

Ready mix concrete:
Concept, ready mix concrete plants, difficulties faced and their solution , use of admixtures in ready mix concrete, economics and quality control aspects of ready mix concrete.

High Performance Concrete:
Constituents, mix proportioning, properties in fresh and hardened states, applications & limitations

Module-4

Polymer concrete:
Polymers, resins, polymerization, different types of polymer concrete like polymer impregnated concrete, polymer concrete (Resin concrete) and polymer modified concrete, their properties and applications.

Self-compacting concrete:
Development of SCC, basic principles and requirements , workability tests for SCC, mix design of SCC, acceptance criteria for SCC, adoption of SCC in the precast industry, present status of SCC

Module-5

Concrete from Industrial wastes:
a. Blast furnace slag cement concrete
b. Fly-ash concrete
c. Silica fume concrete
d. Recycled aggregate Concrete

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	High performance concrete	Aitcin P.C.	E and FN, Spon London	1998
2	CONCRETE, Microstructure, Properties and Materials	Kumar Mehta.P, Paul J.N.Monterio	Tata McGraw Hill	
3	Chemical admixtures in concrete	Rixom R and Mailvaganam N.	E and FN, Spon London	1999
4	Light Weight concrete	Rudnai.G.	Akademiaikiado, Budapest	1963
5	Short A and Kinniburgh.W	Light Weight Concrete	Asia Publishing House	1963
6	High Performance Concrete	Aitcin P C	E and FN, London	

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
7	light weight Concrete	Andrew short and William Kinnibargh	applied science publishers ltd London	
8	Light weight concretes	GyulaRudani	house of the Hungarian academy of sciences, Budapest (Hungary)	
9	Hand book of structural concrete	Kong, Evans, Cohen and Roll	Pitman pub. Inc., 1020, Plain street, Marsh field, Massachusetts	
10	Concrete	Sidney Mindness and Francis young	Printice Hall inc. Englewood cliffs. New Jersey	
11	Design of concrete mixes	Krishnaraju.N	CBS Publication and distributors, Delhi	
12	Concrete	Mehta P K & P J M Monteiro	Prentice Hall, New Jersey (Special Student Edition by Indian Concrete Institute Chennai)	
13	Properties of Concrete	Neville. A. M	ELBS Edition, Longman Ltd., London	
14	Special Structural Concretes	Rafat Siddique	Galgotia publications, New Delhi	
15	Concrete Technology	Santhakumar A R	Oxford University Press	
16	Concrete Technology	Shetty M S	S. Chand publishing House Ltd., New Delhi	

(GROUP-5): 20CGT23	**DESIGN OF DEEP FOUNDATIONS**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Single pile - Static capacity and lateral loads: Introduction, Timber, Concrete, Steel piles, Corrosion of steel piles, Soil properties for static pile capacity, Ultimate static pile point capacity, Skin resistance, Static load capacity using load transfer, load test data, Tension piles, Piles for resisting uplift, Laterally loaded piles, Numerical problems.

Module-2

Single pile – Dynamic analysis and load tests: Dynamic analysis, Pile driving, Rational pile formulae, other dynamic pile driving formulae and general considerations, Reliability of dynamic pile driving formulae. The wave equation, pile load tests, pile driving stresses, general comments on pile driving, Numerical problems.

Module-3

Pile foundations – Group, Single pile v/s Pile group, Pile group considerations, efficiency of pile groups, stresses on underlying strata from piles, settlements of pile groups, pile caps, Batter piles, Negative skin friction, Numerical problems.

Module-4

Well Foundation: Design and construction. Bearing capacity, settlement and lateral resistance. Tilts and shifts, Numerical problems.

Drilled Shaft: Construction procedures, Design Considerations, Load Carrying Capacity and settlement analysis, Numerical problems.

Module-5

Special Topics of Foundation Engineering Foundations on Collapsible Soils: Origin and occurrence, Identification, Sampling and Testing, Preventive and Remedial measures.

Foundations on Expansive Soils: The nature, origin and occurrence, Identifying, testing and evaluating expansive soils, typical structural distress patterns and Preventive design & construction measures, Numerical Problems.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Analysis and design of Substructures	Swami Saran	Oxford & IBH Publications Pvt. Ltd.	2009
2	Foundation design in practices	Kaurna Moy Ghosh	PHI	2010
3	Foundation engineering	J E Bowles	McGraw Hill	2012
4	Pile Foundation Analysis and Design	H.G. Poulos, and E.H.Davis	John Wiley and Sons, New York	
5	Design of Foundation Systems, Principles & Practices	N.P. Kurien	Narosa, New Delhi	1992
6	Foundation Engineering Hand Book	H. F. Winterkorn and H Y Fang	Galgotia Book source	1990

(GROUP-5): 20CWM241 OCCUPATIONAL SAFETY AND HEALTH MANAGEMENT	
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Sector Specific Occupational Health and Safety Issues – Health and safety risks in mining, Health hazards in electronics industry, food processing industry, textile industry, construction industry, wastewater treatment plants, solid waste landfills.

Module-2

Health hazards and risk assessment - Hazard and risk, biological, chemical, physical and psychological health hazards, health risk assessment and management.

Soico-Economic Aspects of Occupational Health and Safety – women and Occupational Health and Safety, child labour. Occupational Health, health problems in unorganized sectors.

Module-3

Occupational Diseases, Health problems and Preventions: - Asbestosis, Silicosis, Farmer's lung, Pneumoconiosis, Anthracosis, Bagassosis, Byssinosis, Tobacossis.

Health Screening Measures – Stages of medical examination, occupational history,Pulmonary Function Test (PFT), Noise Induced Hearing Losses (NIHL). Audiometry.

Module-4

Basics of Preventive Techniques – Accident analysis, monitoring of hazards, reporting and investigation of accidents, prevention and control of accidents, ensuring safety measures, PPE.

Module-5

Occupational health and safety legislations in India – overview of existing OHS legislations in India, Factories act, Mining act, Workmen's compensation act, Employee's state insurance act, Present state of OHS legislation in India. Inadequacy of OHS Legislation in India.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Occupational Safety and Health for Technologists	Goetsch D.L.	Engineers and Managers, Prentice Hall	1999
2	Industrial Accident Prevention	Heinrich H.W.	McGraw Hill Publication , New york	
3	Industrial Safety Management and Technology	Colling D.A.	Prentice Hall, New Delhi	
4	Industrial Safety and Pollution Control Handbook	H.G. Poulos, and E.H.Davis	National Safety Council and Associate (Data) Publishers Pvt. Ltd.	1991

(GROUP-5): 20CEE242	**RISK ASSESMENT AND HAZARDOUS WASTES MANAGEMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Risk factor calculation, impact identification – Risk Area, impact, Likelihood, consequences, Controls, Severity, risk score calculation; Toxicology and Risk Assessment: Toxic effects, Dose response assessment, Risk exposure assessment, Carcinogenesis, eco toxicology, risk characterization.

Module-2

Hazard identification and Risk Assessment – HAZOP, HAZID, Risk Ranking Matrix, Process and Instrumentation Diagram, and importance of Standard operating procedures, Material safety and Data Sheets, Guidelines, case study
Emergency Preparedness, Incident Investigation, Non Conformity, action and Preventive and Corrective Actions, Auditing.

Module-3

Hazard identification and Risk Assessment – HAZOP, HAZID, Risk Ranking Matrix, Process and Instrumentation Diagram, and importance of Standard operating procedures, Material safety and Data Sheets, Guidelines, case study
Emergency Preparedness, Incident Investigation, Non Conformity, action and Preventive and Corrective Actions, Auditing.

Module-4

Hazardous Waste Management
Sources, Classification, Impacts of Mismanagement, Problems in Developing Counties and Regulations for Hazardous Waste Management **Hazardous Waste Characterization**, Designated Hazardous Wastes, Waste Minimization and Resource Recovery – Approaches, Development of a Waste Tracking System, Selection of waste Minimization Process, Case Studies.

Module-5

Biomedical Waste management: Biomedical (Handling and Management) Rules 2008 ,sources, treatment and disposal **Transportation of Hazardous Waste** – requirements, regulations, containers and Labelling, bulk and non-bulk transport, Emergency Response, personal protective equipment.

Treatment & Disposal: Physico-chemical, Chemical and Biological Treatment of hazardous waste, Thermal treatment-Incineration and pyrolysis.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Hazardous waste Management	Lagrega M.D., Buckingham P.L. and Evans J.C.	McGraw Hill International Edition	
2	Hazardous Waste Management	Wentz C.A.	McGraw Hill International Edition	1995
3	Hazardous waste (management and handling) Rules			2001
4	Biomedical (Handling and Management) Rules			2008
5	Hazardous Waste Management	Charles A. Wentz	McGraw Hill Publication	1995

(GROUP-5): 20WRM31	**SEDIMENT TRANSPORT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Properties of sediment. Initiation of motion of sediment. Analysis of non-cohesive sediment movement. Shield's diagram. Critical shear stress, critical velocity, lift on particles, Hydraulic relations for alluvial streams.

Module-2

Sediment Sources & sediment yield: Gross erosion, sediment yield, delivery ratio, estimation of sheet erosion, Universal soil loss equation (USLE), different factors affecting erosion process.

Module-3

Sediment delivery ratio from watershed, flow duration curve and sediment rating curve, reservoir sedimentation: empirical equations, trap efficiency, sediment control method.

Module-4

Fundamentals of sediment transport: general relationships. Bed forms. Wash load, suspended load and Bed load, Rouse equation for suspended sediment load. Sediment discharge formulas by DuBoys, Mayer-Peter & Muller, Schoklitsch, Einstein-Brown and Engelund- Hansen. Sediment sampling.

Module-5

Introduction to Meandering of rivers and river engineering. Scour: local scour at a bridge & abutment, Indian Codal provision for design scour depth.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Sedimentation Engineering	Vito A. Vanoni	Manuals and Reports on Engineering Practice No. 54	
2	Sediment Transport (Theory and Practice)	C.T. Yang		
3	Sediment and Ecohydaulics	T. Kusuda, H. Yamanishi, J. Spearman, and J.Z. Gailani	INTERCOH	2005
4	Mechanics of Sediment Transportation and Alluvial Stream Problems	R.J. Garde, K. G. RangaRaju		
5	Sediment Transport (in 3 parts)	L. van Rijn	ASCE	
6	Hydraulics of Sediment Transport	W.H. Graf		
7	Fundamentals of Fluvial Geomorphology	Ro Charlton		

(GROUP-5): 20CCT22 PRE-ENGINEERED CONSTRUCTION TECHNOLOGY

Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

General Principles of Pre Fabrication

Comparison with monolithic construction, Types of prefabrication, site and plant prefabrication, Economy of prefabrication, Modular coordination, Standardization, Planning for Components of prefabricated structures, Disuniting of structures, Handling and erection stresses, Elimination of erection stresses (Beams, columns) Symmetrical frames.

Module-2

Prefabricated Elements

Roof and floor panels, ribbed floor panels, wall panels, footings, Joints for different structural Connections, Effective sealing of joints for water proofing, Provisions for non-structural fastenings, Expansion joints in pre-cast construction.
Construction of precast structural components (Purlins, Principal rafters, roof trusses, lattice girders, gable frames, Single span single storeyed frames, Single storeyed buildings – slabs, beams and columns.)

Module-3

Production and Hoisting Technology

Choice of production setup, Manufacturing methods, Stationary and mobile production, Planning of production setup, Storage of precast elements, Dimensional tolerances, Acceleration of concrete hardening. Equipments for hoisting and erection, Techniques for erection of different types of members like Beams, Slabs, Wall panels and Columns, Vacuum lifting pads.

Module-4

Precast sandwich Panels ,Pre-stressed concrete solid flat slabs, Hollow core slab/panels, Pre-stressed concrete Double "T", Bridge, Precast segmental Box Girders, Specifications and design considerations.

Module-5

Pre-Engineered Buildings

Introduction, Advantages, Pre Engineered Buildings Vs. Conventional Steel Buildings, Design Consideration of Pre Engineered Buildings (PEB) – Applications

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Prefabricated Concrete for Industrial and Public Structures	L. Mokk	Publishing House of the Hungarian Academy of Sciences, Budapest	2007
2	Manual of Precast Concrete Construction Vol. I, II, III & IV	T. Koncz	Berlin	1971
3	Building with Large Prefabricates	B. Lewicki	Elsevier Publishing Company, Amsterdam, London, New York	1998
4	Structural Design Manual, Precast Concrete Connection Details		Society for the Studies in the use of Precast Concrete, Netherland Betor Verlag	2009
5	Precast concrete design and Applications	Hass, A.M.	Applied Science Publishers	1983

(GROUP-5): 20CEM31 CONSTRUCTION QUALITY AND SAFETY MANAGEMENT

Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Quality and concept of QM-Necessity for improving quality, concept of quality control, quality assurance, quality management and total quality management, Total quality management concepts; ISO9000 documentation; QA/QC systems and organizations, Quality Audits; Problem solving techniques; Statistical Quality Control; Quality Function Deployment; Material Quality Assurance; Specifications and Tolerances.
Quality Planning-Quality policy, objectives and methods in construction industry-consumers satisfaction, time of completion-statistical tolerance.

Module-2

Codes and standards quality manuals-documents-contract and construction programming- inspection procedures - processes and products-total QA/QC programme and cost implication.
Managing Quality in various projects stages from concept to completion by building quality into design of structures, Inspection of incoming material and machinery In process quality inspections and tests.
Reliability & Probability testing, reliability coefficient and reliability prediction-selection of new materials-influence of drawings, detailing, specification, standardization-bid preparation-construction activity, environmental safety and social factors-natural causes and speed of construction-life cycle costing-value engineering and value analysis.

Module-3

Quality Assurance Department -and quality control responsibilities of the line organization, developing quality culture in the organization, training of people,
Construction accidents-importance, causes of accident, safety measures, construction industry related laws. Human factors in safety–legal and financial aspects of accidents in construction–occupational and safety hazard assessment.

Module-4

Safety Programmes-elements of safety programmes, job-site assessment, safety meetings, safety incentives, contractual obligations, safety in construction contracts
Safety in Design-safety culture-Safe Workers-Safety and First Line Supervisors-Safety and Middle Managers-Top Management Practices, Company Activities and Safety-Safety Personnel-Sub-contractual Obligation-Project Coordination and Safety Procedures-Workers Compensation, Safety issues; Injury accidents and their causes; Safety program components; Role of workers, Supervisors, Managers and Owners; Safety Procedures for various construction operations; Safety audits; Safety laws.

Module-5

Safety Management-safety and first line supervisors, safety and middle managers, top management practices, safety audit, safety equipment planning and site preparation, safety system of storing construction materials Excavation-blasting- timbering-scaffolding- safe use of ladders-safety in welding. First- aid- Fire hazards and preventing methods

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Construction Inspection Handbook-Quality Assurance and Quality Control	James, J.O Brian	Van Nostrand, New York	1989
2	Fundamentals of Construction Management and Organization	Kwaku, A., Tenah, Jose, M. Guevara	Reston Publishing Co., Inc., Virginia	1985
3	Quality Planning and Analysis	Juran Frank, J.M. and Gryna, F.M	Tata McGraw Hill	1982
4	ISO 9000	Hutchins.G	Viva Books, New Delhi	1993

Visvesvaraya Technological University, Belagavi.

Ph.D. Coursework Courses – 2020 in Civil Engineering.

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
5	Productivity Improvement in Construction	Clarkson H. Ogiesby	McGraw-Hill	1989
6	IS, IRC, Other codes			
7	Construction Safety	Jimmy W. Hinze	Prentice Hall Inc.	1997
8	Construction Safety and Health Management	Richard J. Coble, Jimmie Hinze and Theo C. Haupt	Prentice Hall Inc.	2001
9	Hand Book on Construction Safety Practices		SP 70, BIS	2001

(GROUP-5): 20CIM332	**BUILDING SERVICES & MAINTENANCE**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Standard fire, fire resistance, classification of buildings, means of escape, alarms, etc., provisions of NBC. Engineering services in a building as a system, Lifts, escalators, cold and hot water systems, waste water systems and electrical systems

Module-2

Building Maintenance: Preventive and protective maintenance, Scheduled and contingency maintenance planning, M.I.S. for building maintenance. Maintenance standards. Economic maintenance decisions

Module-3

Quality policy in construction industry: Consumer satisfaction, Ergonomics-Time of Completion-Statistical Tolerance-Taguchi's concept of quality.

Module-4

Contract and construction programming-Inspectional procedures. Total QA/QC Program and cost implication.

Module-5

Different aspects of quality - Appraisals - failure mode analysis, Stability methods and tools, Influence of drawings, detailing, specification, Standardization - Bid preparation. Construction activity, Environmental safety, Social and environmental factors

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Productivity Improvement in Construction	Clarkson H. Oglesby	McGraw Hill	
2	Construction Inspection Handbook - Quality Assurance and Quality Control	James, J.O Brian	Van No strand, New York	1989
3	F.M. Quality Planning and Analysis	Juran Frank, J.M. and Gryna	Tata McGraw Hill	1982
4	Relevant Parts	NBC	BIS New Delhi	
5	Services in Building Complex and High Rise Buildings	Jain V K	Khanna Pub.	
6	Fire Resistance of Buildings	Pchelinstev V. A.	McGraw-Hill	1989

(GROUP-5): 20CTE322	**INTELLIGENT TRANSPORTATION SYSTEMS**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Basic elements of intelligent transportation systems (ITS), focusing on technological, systems and institutional aspects.
Benefits of ITS -ITS Data collection techniques – Detectors, Automatic Vehicle
Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection.

Module-2

Advanced traveler information systems; transportation network operations; commercial vehicle operations and intermodal freight;

Module-3

Public transportation applications, ITS and regional strategic transportation planning, including regional architectures

Module-4

ITS and changing transportation institutions, ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS and sustainable mobility.

Module-5

Travel demand management, electronic toll collection, and ITS and road-pricing.
Automated Highway Systems- Vehicles in Platoons –ITS in World – Overview of ITS implementations in developed countries, ITS in developing countries.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Fundamentals of Intelligent Transportation Systems Planning	Choudury M A and Sadek A	Artech House	
2	Recommendations for World Road Association (PIARC)	Kan Paul Chen, John Miles	ITS Hand Book	2000
3	Perspective on ITS	Sussman, J. M.	Artech House Publishers	2005
4	National ITS Architecture Documentation	CDROM	US Department of Transportation	2007
5	Decision Support Systems and Intelligent Systems	Turban. E and Aronson. J. E	Prentice Hall	

(GROUP-5): 20CHT31	**CONSTRUCTION PLANNING AND ECONOMICS**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Various types of highway development projects in progress in India and their scope. Factors to be considered in planning of new highway /expressway / bypass and up-gradation of existing roads.

Planning of Road Projects –project management framework, scope, project objectives, project environment, causes of project failure, project development process.

Resource planning – human resources, project man power grouping, structuring site organization, construction materials-classification of construction materials, materials usage, materials inventory, cost and budget.

Module-2

Time planning – project work breakdown, determining activities involved, assessment of duration, CPM / PERT network analysis, work scheduling, methods of work scheduling, factors affecting work scheduling, Problems.

Planning Control System – resource production, project cost, project time, codification and project management, information system, use of software

Use of softwares: Primavera V8i, MSP (Microsoft project), PPM (Project Portfolio Management)

Module-3

Highway Engineering Economics, principle, supply and demand models, equilibrium, sensitivity of travel demand, Elasticities – types, models (Kraft demand model) consumer surplus cost – cost elasticity pricing and subsidy policies, rates of interest, Vehicle operation cost, direct and indirect benefits due to road improvement, Total transportation cost, fixed and variable costs. Road user cost studies in India.

Module-4

Economic analysis, different methods, determination of annual cost, benefit cost ratio, IRR, FIRR, NPV. Sensitivity of economic analysis, Examples of economic analysis for different types of road improvement measures, pavement options, construction of bypasses and upgrading of intersections. Project priorities, methods of dealing with uncertainties.

Module-5

Highway financing, various options for road and bridge projects, special cess, tolling, BOT, BOOT and other options. Economic and financial analysis of highway projects and use of computer software packages. Road investment decision packages.

Use of software: HDM-4 software, Primavera V8i, MSP (Microsoft project), PPM (Project Portfolio Management)

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Traffic Engineering and Transport Planning	L.R. Kadiyali	Khanna Publishers, New Delhi	
2	Construction Project Management Planning, Scheduling and Controlling	K.K. Chitkara	Tata McGraw Hill publications	
3	Economic analysis for Highways	Winfrey	International Textbook Company, Pennslyvania	1969
4	Theory and Applications of Economics in Highway& Transport Planning	Dr. Vinay Maitri and Dr. P.K. Sarkar	Standard Publishers Distributors, Delhi	
5	Financial Management	Prasanna Chandra	Tata McGraw, New Delhi	
6	Highway Engineering	Hewes C.I. and Oglesby, C.H.	Asia Publishing House	
7	Transportation Engineering Economics	Ian G. Heggie	McGraw Hill Book Co.	

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
8	Road User Cost Study in India		Final Report, Central Road Research Institute, New Delhi,	1982
9	Value of Travel Time Savings	L.R. Kadiyali, et al	Traffic Engineering, HRB	
10	Road Development Plan for India- 2001-2021	Ministry of Road Transport and Highways	Indian Roads Congress, New Delhi	2002
11	Manual for the Application of Critical Path Method to Highway Projects in India		IRC	
Nhai.org, pmgsy.nic.in websites				
Standard Data Book on Highway Technology issued by the University may be referred in the PG Examination of VTU.				

(GROUP-5): 20CTM321	**ROAD SAFETY AND MANAGEMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Road accidents, Causes, Scientific Investigations and Data Collection: Analysis of Individual accidents to arrive at Real Causes, Statistical Methods of Analysis of Accident Data, Application of Computer Analysis of Accident Data.

Module-2

Ensuring Traffic Safety in Designing New Roads: Meteorological Conditions, Structure of Traffic Streams, Orientation of a Driver on the Direction of a Road beyond the Limits of Actual Visibility and Roadway Cross Section & Objects on the Right-of-Way.

Module-3

Ensuring Traffic Safety in Road Reconstruction: Road Reconstruction and Traffic Safety, Reconstruction Principles, Plotting of Speed Diagram for Working out Reconstruction Projects, Use of Accident Data in Planning Reconstruction of Roads, Examples of Reconstruction of Selected Road Sections for Improving Traffic Safety, Improving Traffic Conditions on Grades, Sharp Curves, Redesign of Intersections, Channelized At-Grade Intersections, Bus Stops, Parking & Rest Areas and Effectiveness of Minor Road Improvements.

Module-4

Ensuring Traffic Safety in Road Operation: Ensuring Traffic Safety during Repair and Maintenance, Prevention of Slipperiness and Influence of Pavement Smoothness, Restriction speeds on Roads, Safety of Pedestrians, Cycle Paths, Informing Drivers on Road Conditions with Aid of Signs, Traffic Control Lines & Guide Posts, Guard rails & Barrier sand Road Lighting.

Module-5

Road Safety Audit and Traffic Management Techniques: Principles-Procedures and Practice, Code of Good Practice and Checklists. Road safety issues and engineering, education, enforcement measures for improving road safety. Local area management, Various types of long term traffic management measures and their uses. Evaluation of the effectiveness and benefits of different traffic management measures, management and safety practices during road works.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Traffic Engineering and Transport Planning	Kadiyali, L.R.	Khanna Publications, New Delhi	2009
2	Transportation Engineering-An Introduction	C. Jotin Kishty & B. Kent Lall	Third Edition, Prentice Hall of India Private Limited, New Delhi	2006
3	Design of Roads and Road Safety		Latest Editions of Relevant Indian Roads Congress (IRC)	
4	Text book of Highway Engineering	Khanna and Justo	Nemchand Brothers, Roorkee	2001

(GROUP-5): 20CSE252	**ADVANCES IN ARTIFICIAL INTELLIGENCE**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction: What is AI? Foundations of AI, History of AI, Agents and environments, The nature of the Environment, Problem solving Agents, Problem Formulation, Search Strategies

Module-2

Knowledge and Reasoning: Knowledge-based Agents, Representation, Reasoning and Logic, Prepositional logic, First-order logic, Using First-order logic, Inference in First- order logic, forward and Backward Chaining

Module-3

Learning: Learning from observations, Forms of Learning, Inductive Learning, Learning decision trees, why learning works, Learning in Neural and Belief networks

Module-4

Practical Natural Language Processing: Practical applications, Efficient parsing, Scaling up the lexicon, Scaling up the Grammar, Ambiguity, Perception, Image formation, Image processing operations for Early vision, Speech recognition and Speech Synthesis

Module-5

Robotics: Introduction, Tasks, parts, effectors, Sensors, Architectures, Configuration spaces, Navigation and motion planning, Introduction to AI based programming Tools

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Artificial Intelligence: A Modern Approach	Stuart Russell, Peter Norvig	2nd Edition, Pearson Education	2007
2	Artificial Neural Networks	B. Yagna Narayana	PHI	
3	Artificial Intelligence	E. Rich and K. Knight	2nd Edition TMH	
4	Artificial Intelligence and Expert Systems	Patterson	PHI	
5	Expert Systems: Principles and Programming	Giarrantana/ Riley	Fourth Edn, Thomson	
6	PROLOG Programming for Artificial Intelligence	Ivan Bratka	Third Edition – Pearson Education	
7	Neural Networks	Simon Haykin	PHI	

(GROUP-5): 20CCS331 DESIGN OF STACK, TOWER AND WATER STORAGE STRUCTURAL SYSTEMS	
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Steel Chimneys: Lining for chimneys–breach opening–Forces acting on steel chimneys including seismic forces. Analysis Design and Detailing of RC chimneys for different load combinations. Design of thickness of steel plate–Design of base plate–Design of anchor bolts–Design of foundation.

Module-2

Transmission line towers of various shapes and member types: Loads on towers Analysis and Design of Steel transmission line towers. Design of Foundations.

Module-3

Trestles: Analysis and design of Steel Trestles for vertical and horizontal loads.

Module-4

Water Storage structures: Properties of un-cracked section – Calculation of thickness and reinforcement for Liquid retaining structure, Design and Detailing of underground, Ground Level reservoirs.

Module-5

Overhead water tanks: Circular, Rectangular on framed and Shaft type of Staging systems as per IS 3370 Parts 1 to 4.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Design of Steel structures Vol. 1 and Vol. 2	Ramachandra	Standard Publications	2016 and 2018
2	Design of Steel structures	S.K. Duggal	Tata McGraw Hill	2000
3	Design and Analysis of Steel structures	Vazirani V. N. & Ratwani M. M	Khanna Publishers	2015
4	Code of Practice for Design and Construction of steel chimneys		IS: 6533	
5	Use Of Structural Steel In Overhead Transmission Line		IS 802	
6	Code of practice for design and construction of foundations for transmission line Towers and poles		IS :4091	
7	IS 3370 Part 1 to 4			

(GROUP-5): 20CCT331	**ENERGY AND BUILDINGS**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Conservation & energy efficiency concepts-overview of significance of energy use- Renewable and Non- Renewable, energy and their significance, Global energy and environmental resources, Impact of temperature change, Energy crises Energy processes in buildings

Module-2

Solar energy fundamentals & practices in building design- solar astronomical relations and radiation physics and measurements, design decision for optimal orientation of building, shadow analysis.

Module-3

Heating and ventilation design- Human thermal comfort, climatological factors, material specifications and heat transfer principles, thermal performance evaluation, Heat loss from buildings, design of artificial ventilation system, design of insulators

Module-4

Design audits & economic optimization-Concept of cost/benefit of energy conservation & carbon footprint estimation. Energy efficient lighting system design: Basic terminologies and standards, day lighting and artificial lighting design, auditing.

Module-5

Computerenergysimulationprograms-Needforenergysimulationprogramsand its working, Energy simulation tools, Implementation of computer simulation programs.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Energy Efficient Buildings In India	Mili Majumdar	The Energy Research Institute	
2	Energy-Efficient Building Systems	Lal Jayamaha	McGraw Hill Publication	
3	Solar Energy and thermal processes	J A Duffie & W A Beckman	John Wiley	
4	Energy Conservation Building		Code, 2007	
5	Handbook of functional requirement of buildings		SP: 41:1987	

(GROUP-5): 20WLM333	**GLOBAL WARMING AND CLIMATE CHANGE**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction: Introduction and history of meteorology and climatology: The atmosphere, Solar energy, Global circulation, Climatology, Mid-latitude disturbances , The polar regions, Tropical weather, Paleoclimates, The global climate system
Atmospheric composition, mass and structure Composition of the atmosphere: Primary gases, Greenhouse gases, Reactive gas species, Aerosols, Variations with height, Variations with latitude and season, Variations with time
Mass of the atmosphere: Total pressure, Vapor pressure

Module-2

Atmospheric composition, mass and structure The layering of the atmosphere: Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere and magnetosphere
Solar radiation and the global energy budget: Solar radiation: Solar output, Terrestrial infrared radiation and the greenhouse effect, Heat budget of the earth
Atmospheric moisture budget: The global hydrological cycle, Humidity, Evaporation, Condensation, Precipitation characteristics and measurement

Module-3

Numerical models of the general circulation, climate and weather prediction
Fundamentals of the GCM, Model simulations: GCMs, Simpler models, Regional models, Data sources for forecasting, Numerical weather prediction: Short- and medium- range forecasting, Now casting, Long-range outlooks.

Module-4

Boundary layer climates
Surface energy budgets, Non-vegetated natural surfaces : Rock and sand, Water, Snow and ice Vegetated surfaces: Short green crops, Forests
Urban surfaces: Modification of atmospheric composition, Modification of the heat budget, Modification of surface characteristics, Tropical urban climates.

Module-5

Climate change: General considerations, Climate forcing, feedback and response: Climate forcing, Climate feedbacks, Climate response, The importance of framework
The climatic record : The geological record, The last glacial cycle and post- glacial conditions, The past 1000 years
Understanding recent climatic change : Circulation changes, Solar variability, Volcanic activity, Anthropogenic factors
Projections of temperature change through the twenty-first century : Applications of General Circulation Models, The IPCC simulations **Projected change in other system components :** Hydrologic cycle and atmospheric circulation, Global sea level, Snow and ice, Vegetation, Post scrip

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Atmosphere, Weather and Climate	Barry R.G., and Chorley R.L.	4th Edition, ELBS Publication	
2	Carbon Cycle Modelling	Bolin B., (Ed.)	John Wiley and Sons Publications	
3	Global Warming	Srivatsava A.K.	APH Publications	
4	Global Climate Change and Life on Earth	Wyman R.L., (Ed.),	Chapman and Hall Publications	
5	Global Warming: India's Response and Strategy	Yadav, Chander and Bhan	RPH Publications	

(GROUP-6): 20CSE332	**DESIGN OF MASONRY STRUCTURES**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction, Masonry units, materials and types:

History of masonry, Masonry units–Brick-Types of bricks, Tests conducted on bricks. Other masonry units - stone, clay block, concrete block, laterite block, stabilized mud block masonry units Masonry materials–Classification and properties of mortars, selection of mortars. Cracks - Cracks in masonry structures, Type of crack, causes and prevention of crack.

Module-2

Strength of Masonry in Compression:

Behaviour of Masonry under compression, strength and elastic properties, influence of masonry unit and mortar Characteristics, effect of masonry unit height on compressive strength, influence of masonry bonding patterns on strength, prediction of strength of masonry in Indian context, Failure theories of masonry under Compression. Effects of slenderness and eccentricity, effect of rate of absorption, effect of curing, effect of ageing, workmanship on compressive strength

Masonry Bond Strength and Masonry in Shear and Flexure

Bond between masonry unit and mortar, tests for determining flexural and shear bond strengths, factors affecting bond strength, effect of bond strength on compressive strength, orthotropic strength properties of masonry in flexure, shear strength of masonry, test procedures for evaluating flexural and shear strength

Module-3

Design of load bearing masonry wall

Permissible stresses: Types of walls, permissible compressive stress, stress reduction and shape modification factors, increase in permissible stresses for eccentric vertical and lateral load, permissible tensile stress and shear stresses. Design Considerations: Effective height of walls and columns, openings in walls, effective length, effective thickness, slenderness ratio, eccentricity, load dispersion, arching action in lintels. Problems on design considerations for solid walls, cavity walls, wall with pillars.

Load considerations and design of Masonry subjected to axial loads: Design criteria, design examples of walls under UDL, solid walls, cavity walls, solid wall supported at the ends by cross wall, walls with piers.

Module-4

Design of walls subjected to concentrated axial loads: Solid walls, cavity walls, solid wall supported at the ends by cross wall, walls with piers, design of wall with openings. Design of walls subjected to eccentric loads: Design criteria – stress distribution under eccentric loads – problems on eccentrically loaded solid walls, cavity walls, walls with piers.

Design of Laterally and transversely loaded walls: Design criteria, design of solid wall under wind loading, design of shear wall – design of compound walls.

Module-5

Earthquake resistant masonry buildings:

Behaviour of masonry during earthquakes, concepts and design procedure for earthquake resistant masonry, BIS codal provisions. In-filled frames: Types–modes of failures

Reinforced brick masonry

Methods of reinforcing Masonry, Analysis of reinforced Masonry under axial, flexural and shear loading

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Structural Masonry	Henry, A.W.	Macmillan Education Ltd.	1990
2	Structural masonry	K.S. Jagadish	I. K. International Publishing House Pvt. Ltd	
3	Brick and Reinforced Brick Structures	Dayaratnam P	Oxford & IBH	1987
4	Building and Construction Materials	M. L. Gambhir	Mc Graw Hill education Pvt. Ltd.	

(GROUP-6): 20CGT254	**SOIL STRUCTURE INTERACTION**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Soil-Foundation Interaction: Introduction to soil-foundation interaction problems, Soil behavior, Foundation behavior, Interface behavior, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behavior, Time dependent behavior.

Module-2

Beam on Elastic Foundation- Soil Models: Infinite beam, Two parameters, Isotropic elastic half space, Analysis of beams of finite length, Classification of finite beams in relation to their stiffness. Plate on Elastic Medium: Thin and thick plates, Analysis of finite plates, Numerical analysis of finite plates, simple solutions.

Module-3

Plates on Elastic Continuum: Thin and thick rafts, Analysis of finite plates, Numerical analysis of finite plates.

Module-4

Elastic Analysis of Pile: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap.

Module-5

Laterally Loaded Pile: Load deflection prediction for laterally loaded piles, Subgrade reaction and elastic analysis, Interaction analysis, Pile-raft system, Solutions through influence charts. An introduction to soil-foundation interaction under dynamic loads.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Foundation analysis and design	J E Bowles	McGraw Hill, NY	
2	Soil Mechanics in Engineering Practice	Karl Terzaghi and R B Peck	John Wiley and Sons, NY	1967
3	Analysis and Design of Foundations and Retaining Structures	S Prakash	Sarita Prakashana, Meerut	1979
4	Soil Mechanics and Foundation Engineering	S K Garg	Khanna Publications	
5	Geotechnical Engineering	C Venkataramaiah	New Age International Publishers	

(GROUP-6): 20CWM243	**AQUATIC CHEMISTRY AND MICROBIOLOGY**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Microbiology - Importance of Microorganisms in air, water and soil environment. Difference between Prokaryotic and Eukaryotic cells. Principles and applications of microscopy – Bright field, Dark field, Fluoresce, TEM, SEM. Metabolism and metabolic pathways (Meaning and Importance).

Module-2

Bacteria – Morphology, typical growth curve and generation time, classification and their importance.
Algae - Morphology, classification and their importance.
Fungi - Morphology, classification and their importance.
Protozoa - Morphology, classification and their importance.
Enzymes- classification, factors influencing enzyme reaction, Derivation of Michaelis – Menten equation.

Module-3

Control & Measurement of Microorganisms–Physical agents, chemicals agents (Types and Importance in brief). Measurement Techniques - APC, MPN, MFT.
Microbiology of Domestic water and wastewater. Eutrophication of lakes. Bio concentration, Bio magnification and Bioaccumulation.

Module-4

Introduction to Fundamental Chemistry-Importance of environmental Chemistry. Toxic chemicals, Heavy metals and effects, Electrochemistry and its applications.
pH–Principle, Measurement, Numerical Examples, Buffers and Buffer index. **Colourimetry–Principles and applications.**
Dissolved Oxygen–Environmental Significance, methods of determining DO, DO membrane probes, problems.

Module-5

Water Softening–Methods, Causes and Sources of hardness, types of hardness, methods of determination, public health significance, problems.
Instrumental methods of analysis of pollutants–Working principles using Infrared Spectroscopy, Atomic Emission Spectroscopy, Atomic Absorption Spectroscopy, Fluorimetry, Gas Chromatography, HPLC.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	**Chemistry for Environmental Engineering and Science**	Sawyer C.N. and McCarty, P. L.	5th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi	2003
2	**Textbook of Microbiology**	Pelczar M. J , Chan ECS, Krieg, NR	5th edition Tata McGraw Hill Publishing Co.	1998
3	**Microbiology for Sanitary Engineers**	McKinney R.E.	New York McGraw Hill	1962
4	**Standard Methods for Examination of Water and Wastewater**	APHA	21st Edition	2002
5	**Microbiology for Environmental Scientists and Engineers**	Gaudy and Gaudy	McGraw Hill	1980
6	**Microbiology**	L.M. Prescott, Harley, Klein	5th edition, McGraw-Hill Higher Education	2002

(GROUP-6): 20CEE251	**WATER RESOURCES ENGINEERING AND APPLIED HYDRAULICS**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Hydrology: Water resources of the world, India and Karnataka, National Water Policy, Hydrologic cycle, estimation of missing precipitation and rain gauge density.

Module-2

Hydrograph theory: Unit hydrograph-derivation, flow routing, low flow analysis. Urban Hydrology - Run-off estimation – Design of Storm water Drains.

Module-3

Unsteady Flow through Conduits: Water hammer analysis, Water hammer protection methods-surge tanks.
Flow Measurements: Area–Velocity method, Weir method, flumes, end-depth method & chemical and radioactive tracers method

Module-4

Groundwater: Basic equations of flow, confined and unconfined aquifers, sea water intrusion, artificial recharge, groundwater pollution, borewells - types & design principles, open wells – types, yield tests

Module-5

Basics and applications of Remote Sensing and GIS: Characteristics of Recently launched Indian Remote sensing satellites with Advantages and Disadvantages various applications related to agriculture, water resource and urban planning etc. Different types of sensors used in remote sensing, Spectral properties of soil, water and vegetation. Contrast enhancement techniques/Image enhancement techniques, Different types data input techniques used in GIS,
Theoretical framework for GIS

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Engineering Hydrology	K. Subramanya	Tata McGraw Hill Publishers, New Delhi.	
2	Ground Water Hydrology	K. Todd	Wiley and Sons, New Delhi	
3	Advanced Hydrology	Raghunath H.M.	Wiley Eastern Ltd New Delhi.	
4	Hand Book of Applied Hydrology	Ven T. Chow	1st Edition McGraw Hill Publications	
5	Remote Sensing and Image Interpretation	Lillesand, Kiefer, Chipman	Wiley	2011

(GROUP-6): 20WRM322	**WATER POWER AND DAM ENGINEERING**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction, sources of energy, role of hydropower in a power system, development of water power potential in India and the world, Features and characteristics of water power generation. Data requirement for assessment of water power potential-flow duration and mass curves, energy flow diagram, demand and prediction, Types of Hydropower generation plants-site selection and Planning – Environmental Considerations and its layouts,

Module-2

Components of a hydropower structure-regulatory structures-intake structures –types, location, losses, air entrainment, anti-vortex device, air vent, fore bay, trash racks, power canals, tunnels, surge tanks, settling basins, anchor blanks, penstocks-classification, resonance in penstocks, design criteria, losses, anchor blocks, valves, bends and manifolds,

Module-3

Tunnels- geometric and hydraulic design, water hammer and surges, surge tank- functions, type, design of surge tank, methods of surge analysis, channel surges Types of water power house- structural and geotechnical aspects of power house design, location, site and general arrangements, draft tubes, tail trace and their hydraulic design, draught and cooling towers, turbines - characteristics, hydraulics of turbines,

Module-4

cavitations, transients caused by turbine and foundations, pumps-efficiency and characteristics, generators, exciters, switchboard, transformers and other accessories Water retaining structures-Dams-Classifications, types, planning and investigation of reservoir and dam sites, reservoir capacity and regulation, reservoir silting, dam optimization, analysis and design of earthen and rockfill dams, internal seepage, stability and stress, settlement and deformation, foundation treatment, analysis for failure and safety criteria.

Module-5

Gravity dam - forces acting and criteria, elementary and practical profile, stability analysis, modes of failures, joints, seals, keys and galleries in gravity dams, spillways-types, location and design, energy dissipaters, dam break analysis, dam safety and hazard mitigation

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Water Power Engineering	Barrows, H. K	Tata McGraw Hill Publishing Company Ltd, New Delhi	2000
2	Engineering for dams	Creager, W.P, Justin, J. D and Hinds J	Nem Chand and Brothers, Roorkee	1995
3	Water Power Engineering	Dandekar, M.M., and Sharma, K.N	Vikas Publishing House, New Delhi	1994
4	Irrigation Engineering and Hydraulic Structures	Garg S. K	Khanna Publishers, New Delhi	1998
5	Hydraulics of spillways and energy dissipaters	Khatsuria, R. M	CRC Press, New Delhi	2005
6	Water Power Engineering	Sharma, R.K and Sharma,T.K	S. Chand and company Ltd, New Delhi	2003
7	Fluid Transients	Streeter, V.L and Wylie B	McGraw-Hill Book Company. New Delhi	1967

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Ph.D. Coursework Courses – 2020 in Civil Engineering.

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
8	Hydro Power Structures	Varshney, R .S	Nem Chand & Bros, Roorkee	2001
9	Hydraulic Structures	Novak, P, Moffat, A.I.B, Nalluri, C and Narayanan, R	CRC press, Fourth Edition	2006

(GROUP-6): 20CCT31 CONSTRUCTION CONTRACTS, SPECIFICATIONS AND ESTIMATION

Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Estimation: Estimate, Data required to prepare estimate, Types of estimate, Report for estimate, Factors affecting estimation of major construction project.

Analysis of Rates: Purpose of rate analysis, Procedure for rate analysis, Factors affecting rate analysis. Rate analysis for Lime concreting in foundation or floor, Cement concreting in foundation or floor, RCC work in beams, slabs & column, Reinforced brick work in slabs, First class brick work in foundation & superstructure, Coursed Rubble stone masonry in superstructure, Ashlar stone masonry in superstructure, Cement plastering & Pointing, Cement Concrete Floor, Mosaic or terrazzo Tile floor, white washing & distempering, Damp proof course, Painting, Varnishing , Earth work in excavation, Centering, Shuttering, formwork for RCCbeam, slab, Galvanizedcorrugatedironsheet roofing.

Module-2

General/brief specifications of a first class building, Second class building, Third class building, fourth class building.

Detailed specifications for Earth work in excavation in foundation, Lime concrete in foundation, Cement concrete, Reinforced cement concrete, Damp proof course, Brick work first class, Reinforced brick work, Plastering, pointing, Cement concrete floor, Mosaic or terrazzo floor, White washing, Colour washing, Distempering, Painting, Varnishing, Wood work (carpenter's work), Doors and windows, Glazing, Centering and shuttering, Ashlar stone masonry, Coursed Rubble masonry, Galvanized corrugated iron sheet roofing.

Module-3

Introduction to Contracts:

Agreement, Contract, Essentials conditions of a Valid Contract, Terminologies of Contract, Distinction between Agreement and Contract, Types of Contracts, Indian Contract Act 1872.

Tendering, Bidding & Contracting:

Tender and Tender Documents, Tendering procedure, Tender Notice, Methods of Bidding/Tendering, Conditions of Contract, Securities/Guarantees in contract.

Module-4

Construction Claims: Reasons for Claims in Construction Contracts, Types of Claims, Causes of claims, effects of claims Preparation And Presentation of Claims, Deviations/ Variations: Extraitem, Excess quantity, Deficit quantity, Price Escalation.

Dispute Resolution: Dispute Resolution Mechanism, Types of Dispute Resolution: Arbitration, Mediation, Conciliation, Litigation, Dispute Resolution Board [DRB].

Module-5

BOT Contract: Types of contract, PPP framework, types of risk, concession agreement.

Relational Contracts: Partnering, Alliancing.

Laws affecting Engineers: Labour Law, Sales Tax, VAT, Service Tax, Excise Duty.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Estimation and Costing in Civil Engineering	B.N.Dutta	28th revised edition, UBS Publishers Distributors Pvt. Ltd.	2016
2	*Managing Construction Contracts*	Collier, K.	Reston Publishing Company	
3	Contract Management and Dispute Resolutions	S. Ranaga Rao	Engineering staff College of India	January 2008

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
4	General Conditions of Contract		Central Public Works Department, New Delhi	2010
5	Professionalconstruction management including C.M. Design construct and general contracting	D.S. Berrie and B.c. Paulson	McGraw Hill InternationaL, Third Edition	1992
6	Construction & Contract Management Practices	V. K. Raina	SPD, New Delhi	

(GROUP-6): 20CEM241	**INFRASTRUCTURE FOR SMART CITY PLANNING**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

INTRODUCTION

Understanding – Dimensions – Global experience, Global standards and performance bench marks, Practice codes. India 100 smart cities policy and mission, Smart city planning and development, Financing smart cities development, Governance of smart cities.

Module-2

GREEN BUILDING CONCEPTS AND SUSTAINABLE DEVELOPMENT

Green projects in smart cities, sustainability–green building–Rating system–Energy efficient building–energy saving systems

Module-3

WATER SUPPLY AND DRAINAGE

Water–sources of water, treatment and storage, transportation and distribution, quality, networks, distribution losses, water harvesting, recycling and reuse, norms and standards of provision, institutional arrangements, planning provisions and management issues. Sanitation–points of generation, collection, treatment, disposal, norms and standards, grey water disposal, DEWATS, institutional arrangements, planning provisions and management issues. Municipal and other wastes–generation, typology, quantity, collection, storage, transportation, treatment, disposal, recycling and reuse, wealth from waste, norms and standards, institutional arrangements, planning provisions and management issues. Power–Sources of power procurement, distribution networks, demand assessment, norms and standards, planning provisions and management

Module-4

SMART URBAN TRANSPORT SYSTEMS

Elements of Infrastructure (Physical, Social, Utilities and services), Basic definitions, concepts, significance and importance; Data required for provision and planning of urban networks and services; Resource analysis, Provision of infrastructure. Role of transport, types of transport systems, evolution of transport modes, transport problems and mobility issues. Urban form and Transport patterns, land use–transport cycle, concept of accessibility. Hierarchy, capacity and geometric design elements of roads and intersections. Basic principles of Transport infrastructure design. Urban transport planning process–Transport, environment and safety issues. Principles and approaches of Traffic Management, Transport System Management

Module-5

E- GOVERNANCE AND IOT

The concept of management, concept of e-management & e-business, e-Government Principles, Form e-Government to e-governance, e-governance and developing countries, Designing and Implementing e-Government Strategy, E governance: Issues in implementation. IOT fundamentals, protocols, design and development, data analytics and supporting services, case studies.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Regional Development and Planning for the 21st Century: New Priorities and New Philosophies	Allen G.Noble, (Eds)	Aldershot, USA	1988
2	Handbook of Local and Regional Development	Andy Pike, Andres Rodriguez-Pose, John Tomaney	Taylor & Francis	2010

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Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
3	Fifty years of Dutch National Physical Planning	Andreas Faludi and Sheryl Goldberg	Alexandrine Press, Oxford	1991
4	Form Based Codes: A Guide for Planners, Urban Designers, Municipalities, and Developers	Daniel G. Parolek, AIA, Karen Parolek, Paul C. Crawford, FAICP	John Wiley & Sons	2008

(GROUP-6): 20CIM334	**CONSTRUCTION DEMOLITION AND WASTE MANAGEMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Environmental Impact of Building Materials Embodied energy of materials; impact on the local environment; toxicity of the material; life cycle assessment. Nature and Source Direct and indirect waste; site types and origins; composition; quantity; current recycling/reuse potential of building materials.

Module-2

Construction and Demolition Waste Management Plans International good practice; planning requirements; DoEHLG guidance document; company policy; demolition plans; site implementation; supplier agreements; sub−contractor management; role of waste management contractor; training; auditing; skip management; current markets; current disposal options; health and

Module-3

Designing for Waste Prevention and Minimisation Waste prevention and minimization; client, contractor and designer attitudes; proper maintenance of existing buildings; reuse of existing building structure; design flexibility; design for reuse and recycling; dimensional co−ordination and standardization; modular design; material selection and control.

Module-4

Waste Forecasting Tools Application of WRAP's designing out waste tool for buildings and civil engineering; WRAP net waste tool; BRE SMART Waste; WRAP Site Waste Management Plan Tracker

Module-5

Future developments Potential future markets; ‘smart' materials; use of eco−materials.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher’s Name	Publication year
1	Recycling and Resource Recovery Engineering	Springer – Verlag, Berlin Heidelberg	Springer	1996
2	Recycling Construction and Demolition waste: A LEED - Based Toolkit (Green Source)	Greg Winkler ISBN: 978-0071713382	1e, McGraw Hill Professional	2010
3	Reuse of Construction and Demolition Waste in Housing Development	V M Tam, Chi Ming Tam	Nova Science Publishers ISBN: 9781604563627	2008
4	Sustainable Materials in Building Construction	JMPQ Delgado	Volume 11, Building Pathology and Rehabilitation, Springer, ISBN 978-3-030-46799-9 ISBN 978-3-030-46800-2 (eBook)	2020
5	Current Literature			

(GROUP-6): 20CTE333	**PAVEMENT EVALUATION AND MANEGMENT**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction to pavement evaluation:
Structural and functional requirements of flexible and rigid pavements. Distress and different types of failures in pavements. Functional and structural deterioration of flexible and rigid pavements, Deterioration models.

Module-2

Structural and functional evaluation of pavements-Structural deterioration of pavements, causes, effects, methods of treatment. Structural evaluation of flexible pavements by Rebound deflection method, Analysis of data, interpretation and applications, design of overlay. "Use of FWD and other methods for evaluation of flexible and rigid pavements and their application. Problems. Rating methods. Use of modern equipment for pavement surface condition measurements.

Module-3

Functional deterioration of pavements, causes, effects, methods of treatment. **Pavement surface condition**-Causes, effects, methods of measurement. Functional evaluation and treatment of: a) Pavement slipperiness b) Riding quality and unevenness c) Rutting d) Cracking e) Potholes f) Edge breaking etc. Rating methods. Use of modern equipment for pavement surface condition measurements. Analysis of data, interpretation and application.

Module-4

Evaluation of Pavement Structural Condition & Overlay Design: Evaluation by non- destructive tests such as FWD, Benkelman Beam rebound deflection, Plate load test, wave propagation and other methods; evaluation by destructive test methods, and specimen testing.
Overlay Design: Design of Flexible overlay over flexible pavement, choice of overlays on existing flexible& rigid pavement.

Module-5

Model Pavements & Instrumentation in Pavement Testing: Testing of new pavement materials and model pavements under controlled conditions, test set up and instrumentation.
Instrumentation in Pavement Testing: Details, applications and limitations of various equipment/ instrument/accessories, for, in-situ measurement of strain, pressure, moisture and pavement temperature.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Modern Pavement Management	Hass R., Hudson W. R., Zaniewisti. J.	Krieger Publishing Company, Florida	1994
2	Design and performance of road pavements	David and Paul Croney	Third edition, McGraw hill	1998
3	Pavement Analysis	Per Ulitz	Elsevier Amsterdam	
4	Highway Hand Book	FAW	Publication from NUS, Singapore	
5	Traffic and Highway Engineering	Nicholas J. Garber, Lester A. Hoel	Third Edition Thompson Learning	
6	GUIDELINES FOR STRENGTHENING OF FLEXIBLE ROAD PAVEMENTS USING BENKELMAN BEAM DEFLECTION TECHNIQUE		IRC 81, 1997	
7	Guidelines for Surface Evenness of Highway Pavements		IRC SP 16, 2004	
8	Recommendation about Overlays on Cement concrete Pavements		IRC SP 17	

(GROUP-6): 20CHT323 SPECIAL PROBLEMS IN ROAD CONSTRUCTION

Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Problems of construction of roads in marshy areas and weak / expansive soils and water- logged - areas. Various effective measures for solving the problems, machinery required and method of construction.
Control of water table, capillary rise and seepage flow in road construction. Design and construction of filter drains and capillary cut-off. Construction of subgrade in marshy areas and weak / expansive soils and water- logged - areas.

Module-2

Methods of strengthening weak foundation soil, acceleration of consolidation and settlement of compressible embankment foundation, vertical sand drains -Application, design and construction method.

Module-3

Problems in construction of high embankments, stability of foundation and embankment slopes. Stability of hill slopes, control of erosion.

Module-4

Use of special materials such as geo-synthetics for drainage and in pavement layers. Use of reinforced earth retaining walls, Nailing Technique, Techniques of pavement construction using recycled materials – cold and hot mix recycling of bituminous materials.

Module-5

Special construction techniques - construction techniques of cell filled concrete Pavements – design, economics and construction method, and its application. Road construction on desert region and coastal areas, alternative methods, **Special problems** in construction & maintenance of hill roads, land slide, causes, investigation, and preventive and remedial measures, protection of embankment and cut slopes.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Designing with Geosynthetics	R.M. Koerner	4th Edition Prentice Hall, New Jerssey	1997
2	Geotechnical Aspects of Pavements	Reference Manual / Participant Workbook U.S. Department of Transportation	Publication No. FHWA NHI-05-037 Federal Highway Administration	May 2006
https://www.fhwa.dot.gov/engineering/geotech/pubs/05037/05037.pdf				
3	Pavement Drainage- Theory and Practice	G.L. Shivakumar Babu, Prithvi S Kandhal, Nivedya Mandankara Kottayi, Rajib Mallick	A. Veeraragavan, CRC Press	
4	Guidelines for the design of High embankments	IRC-75	IRC	2015
5	Foundation engineering	Leonards G.A	McGraw Hill Book Company, New York	1962
6	Drainage of highway and airfield pavement	Cedgreen H.R.	John Willey and Sons. Inc., New York	1974
7	Pavements on Expansive clays	G. Kassiff M. Livnet. G. Wisemen	Jerusalem Academy Press, Jerusalem. Israel	1969
8	Highway Materials	R.D. Krebs & R.D.Walker	McGraw Hill Book House, New York	1971

(GROUP-6): 20CTM333	**REMOTE SENSING AND GIS IN TRANSPORT PLANNING**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Introduction to remote sensing: Definition–Components of Remote Sensing Energy, Sensor, Interacting Body –Active and Passive Remote Sensing–Platforms– Aerial and Space Platforms – Balloons, Helicopters, Aircraft and Satellites Electromagnetic Radiation– EMR Spectrum.

Module-2

Introduction to GIS : Basic Concept and Components – Hardware, Software –Data Spatial and non- spatial – Geo-referencing – Map Projection – Types of Projection – Simple Analysis – Data retrieval and querying.

Module-3

Data structures and analysis: Database–Raster and Vector data structures–Data storage–Run length, Chain and Block coding– Vector data storage–Topology–GIS Modeling-Raster and Vector data analysis–Buffering and overlaying techniques–Network Analysis–Spatial Analysis

Module-4

Basic applications in transportation: Highway and Railway Alignment, location of transport terminals and roadside facilities, bus stops–Route optimization–Bus route rationalization–Accident analysis–Applications of Aerial Photography and Satellite Imageries

Module-5

Advanced applications: GIS as an integration technology–Integration of GIS, GPS and Remote Sensing Techniques–Advanced Traveller Information System (ATIS) – Automatic Vehicle Location System (AVLS)

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Remote Sensing and Image Interpretation	Anji Reddy	John Wiley and Sons Inc. New York	1987
2	Remote Sensing Applications	M.G.Srinivas	Narosa Publishing House	2001
3	Principles of GIS for Land Resources Assessment	Burrough P. A	Oxford Publication	1994
4	Geographical Information System–An Introduction	Jeffrey Star and John Ester	Prentice Hall Inc., Englewood Cliffe	1990
5	Basic Readings in GIS	Marble, D.F, Calkins, H.W and Penquest	Speed System Ltd., New York	1984

(GROUP-6): 20CSE254	**DESIGN OF TALL STRUCTURE**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Design Criteria: Design philosophy, loading, sequential loading, and materials – high performance concrete, fiber reinforced concrete, lightweight concrete, design mixes. Loading and Movement: Gravity loading: Dead and live load, methods of live load reduction, Impact, Gravity loading, Construction loads

Module-2

Wind loading: static and dynamic approach, Analytical andwind tunnel experimentation method. Earthquake loading: Equivalent lateral force, modal analysis, combinations of loading, working stress design, Limit state design, Plastic design.

Module-3

Behavior of Various Structural Systems: Factors affecting growth, Height and structural form; High rise behavior, Rigid frames, braced frames, in-filled frames, shear walls, coupled shear walls, wall-frames, tubular, cores, Futigger – braced and hybrid mega system.

Module-4

Analysis and Design: Modeling for approximate analysis, accurate analysis and reduction techniques, analysis of building as total structural system considering overall integrity and major subsystem interaction, analysis for member forces; drift and twist, computerized general three dimensional analyses.

Module-5

Stability of Tall Buildings: Overall buckling analysis of frames, wall frames, approximate methods, second order effects of gravity of loading, P-Delta analysis, simultaneous first order and P-Delta analysis, Transnational, Torsional instability, out of plum effects, stiffness of member in stability, effect of foundation rotation. Structural elements: sectional shapes, properties and resisting capacities, design, deflection, cracking, pre-stressing, shear flow. Design for differential movement, creep and shrinkage effects, temperature effects and fire

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Structural Analysis and Design of Tall Buildings	Taranath B.S	McGraw Hill	
2	High rise building structures	Wilf gang Schuller	John Wiley	
3	Tall building structures Analysis and Design	Bryan Stafford Smith & Alexcoull	John Wiley	
4	Structural concepts and system for Architects and Engineers	T.Y Lin & D.Stotes Burry	John Wiley	
5	Advances in Tall Buildings	Lynn S.Beedle	CBS Publishers and Distributors	
6	Proceedings National Seminar on High Rise Structures- Design and Construction practices for middle level cities	Dr. Y.P. Gupta– Editor	New Age International Limited	

(GROUP-6): 20CCS12 COMPUTATIONAL STRUCTURAL MECHANICS - CLASSICAL AND FE APPROACH

Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Direct Stiffness Method – Trusses Degrees of Static and Kinematic indeterminacies, Concepts of Stiffness and Flexibility, Local and Global Coordinate System, Analysis of indeterminate Trusses, with and without initial strains for different types of boundary conditions such as Fixed, Hinged, Roller, Slider, Elastic (Spring) supports, support settlement. Numerical examples.

Module-2

Direct Stiffness Method-Continuous Beam, and Frames. Analysis of Continuous beams, for different types of boundary conditions such as Fixed, Hinged, Roller, Slider, Elastic (Spring) supports, support settlement. Numerical examples. Element stiffness matrix formulation for 2D, Grids and 3D frames (Local and Global).

Module-3

FE Analysis using Bar Elements:
Element Stiffness matrix of two and three noded elements. Examples with constant and varying cross sectional area subjected to concentrated loads, distributed body force and surface traction and Initial strains due to temperature.

Module-4

Isoparametric formulation of Bar Elements. Element stiffness matrix of two noded element with constant area, linear variation in area, Consistent Load due to body force, Surface traction. Element stiffness matrix of three noded bar Element, Consistent load due to UDL, Linearly Varying Load, Quadratic Varying Load.

Module-5

FE Analysis using Beam Element. Element Stiffness matrix, Consistent Nodal loads, Concept of Reduced or Lumped Loads, Examples. Cantilever and Simply Supported beams.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Computational Structural Mechanics	Rajasekaran, S. and Shankarsubramanian, G.	PHI New Delhi	2001
2	Matrix analysis of framed structures	Weaver, W. and Gere, J. M.	CBS Publishers and Distributors Pvt. Ltd.	2004
3	Basic Structural Analysis	Reddy. C. S.	TMH, New Delhi	2001
4	Concepts and Applications of Finite Element Analysis	Robert D Cook, Malkas, D. S. and Plesha., M. E.	3rd Edition, John Wiley and Sons, New York	2007
5	Finite element procedures in Engineering Analysis	Bathe. K. J.	PHI. New Delhi	2007
6	Matrix Computer Analysis of structures	Rubinstein M.F	Prentice-Hall, Eaglewood Cliffs, New Jersey	1966
7	Fundamental finite element analysis and applications	M. Asghar Bhatti	John Wiley & Sons	2005

(GROUP-6): 20CTM22	**ADVANCED TRAFFIC ENGINEERING**
Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Traffic Forecast: General travel forecasting principles, different methods of traffic forecast - Mechanical and analytical methods, Demand relationships, methods for future projection

Module-2

Design Hourly Volume For Varying Demand Conditions: Concept of Design vehicle units and determination of PCU under mixed traffic conditions, Price-volume relationships, demand functions. Determination of design hourly volume; critical hour concept

Module-3

HighwayCapacity: Factorsaffectingcapacity,levelofservice;Capacitystudies- Capacity of different highway facilities including un signalized and signalized intersections. Problems in Mixed Traffic flow; Case studies

Module-4

Accident Analysis: Analysis of individual accidents and statistical data; Methods of representing accident rate; Factors in traffic accidents; influence of roadway and traffic conditions on traffic safety; accident coefficients; Driver strains due to road way and traffic conditions.

Module-5

Traffic Flow Theory: Fundamental flow relationship and their applications, Traffic flow theories and applications; Shock waves; Queuing theory and applications. Probabilistic Aspects Of Traffic Flow: Vehicle arrivals, distribution models, gaps and Head way distribution models; gap acceptance merging parameters, applications.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Traffic Engineering and Transport Planning	Kadiyali, L.R	Khanna Publications	
2	Traffic Flow Theory and Control	Drew, D.R.	McGraw Hill Book Co.	
3	Road conditions and Traffic Safety	BABKOV, V. F.	MIR publications	1975
4	Traffic Engineering –Theory and Practice'	Pignataro, Louis	John Wiley	
5	Research on Road Safety	RRL, DSIR	HMSO, London	
6	IRC Third Highway Safety Workshop	Lecture Notes 1978 and other IRC publications		
7	Traffic Flow Theory	Barenbag	Monograph	
8	Traffic Flow Theory	Gerlan, D. L. and Hember, M. J.	A Monograph, Special report 165 TRRB	
9	Manual of Transportation Engineering Studies	Institute of Transportation Engineers	Prentice Hall	

(GROUP-6): 20WLM331 GROUND WATER ASSESSMENT, DEVELOPMENT AND MANAGEMENT

Exam Hours: 3 hours	**Exam Marks (Maximum): 100**

Module-1

Zones of Aeration and Saturation: Zone of aeration, Zone of saturation, Storage efficient of aquifers, Fluctuations of the water table, Fluctuations of the piezometric surface, Recharge and discharge areas.
Ground Water Flow: Properties of water in relation to flow, Head distribution, Laminar and turbulent flow, Darcy's law. Formation constants, Flow through aquifers.

Module-2

Evaluation of Aquifer Properties: Aquifer tests, Confined aquifers, Semi confined aquifers, Unconfined and semi unconfined aquifers, Transition for artesian to water table conditions, Bounded aquifers, Partially penetrated aquifers, Sloping piezometric and phreatic surfaces, Areal methods. Sea Water Intrusion: Sea Water Intrusion in Coastal Aquifers, Modelling of Pollutant Transport in the Unsaturated Zone. Prevention and Control of Seawater Intrusion.

Module-3

Ground Water Recharge, Discharge and Balance: Parameters of Ground- Water Balance, Estimation of Recharge Components, Nuclear Methods, Estimation of Ground Water Discharge, Ground Water Resources Evaluation In India, Case History.

Module-4

Ground Water Development and Management: Ground-Water Development, Water logging, Conjunctive use, Desalination, Modelling Techniques in Ground-Water Management, Ground Water Legislation.
Management of Groundwater: Pollution in Relation to water use, Municipal sources and causes, Industrial sources and causes, Agricultural sources and causes, Miscellaneous sources And causes, Attenuation of Pollution, Monitoring Groundwater Quality

Module-5

Groundwater Basin Management and Conjunctive Use: Groundwater Basin Management, Conjunctive Use, Mathematical modelling of a dual aquifer system.

Question paper pattern:

- The question paper will have ten questions.
- Each full question is for 20 marks.
- There will be 2 full questions (with a maximum of four sub questions in one full question) from each module.
- Each full question with sub questions will cover the contents under a module.
- Students will have to answer 5 full questions, selecting one full question from each module.

Textbook/Reference Books

Sl. No.	Title of the book	Author Name	Publisher's Name	Publication year
1	Ground Water Assessment Development and Management	K. R. Karanth	Tata McGraw- Hill Publishing Company Limited, New Delhi.1	
2	Groundwater Hydrology	David Keith Todd	Gopsons Paper Ltd., Noida, Second Edition	
3	Ground Water	H. M. Raghunath	New Age International (P) Ltd., New Delhi, Third Edition.	