List of open electives offered by Department of Civil Engineering to other Departments of the University

Sr. No.	Category	Subject Code	Course Title	Contact Hours			Credits
1.	Open Elective	BTCE901C	Rock Mechanics and Engineering Geology	L	T	P	3
				3	0	0	
Internal Marks: 40, External Marks: 60, Total Marks: 100							

Course Objectives: The course should enable the students:

1. To describe weathering process and mass movements
2. To gain knowledge about various properties of minerals and their engineering significance.
3. To acquire knowledge of various classification of rocks.
4. To interpret the importance of different geological features and their effects.

UNIT-I

General Geology: Importance of Engg. Geology applied to Civil Engg. Practices, Weathering, Definition- types and effect, Geological works of rivers, wind, glaciers as agents of erosion, transportation and deposition.

Rocks & Minerals: Minerals, their identification, igneous, sedimentary & metamorphic rocks. Classification of rocks for engineering purposes, Rock quality designation (RQD).

UNIT-II

Structural Geology: Brief idea about stratification, apparent dip, true dip, strike and in Conformities, Folds, faults & joints: definition, classification relation to engineering operations.

Engineering Geology: Geological considerations in the Engg. Projects like tunnels, highways, foundation, dams, reservoirs. Earthquake: Definition, terminology, earthquake waves, intensity, recording of earthquake.

UNIT-III

Engineering properties of rocks and laboratory measurement: Uniaxial compression test, tensile tests, permeability test, shear tests, size and shape of specimen rate of testing. Confining pressure, stress strain curves of typical rocks. Strength of intact and fissured rocks, effect of anisotropy, effect of saturation and temperature.**In-situ determination of Engineering Properties of Rock masses:** Necessity of in-situ tests, uniaxial load tests in tunnels and open excavations, cable tests, flat jack test, shear test, pressure tunnel test, Simple methods of determining in situ stresses, bore hole test.

UNIT-IV

Improvement in Properties of Rock Masses: Pressure grouting for dams and tunnels, rock reinforcement, rock bolting.

Course Outcomes: Upon completion of this course the student shall be able to have:

1. Classify the various geological agents and processes involved.
2. Identify the available minerals by their properties and behavior.
3. Classify and identify the available rock in the construction site.
4. Interpret the different geological features and their engineering importance.
5. Apply the geological concepts in civil engineering projects.

Books Recommended :

1. Richard E. Goodman, 'Introduction to Rock Mechanics'.
2. I.W. Farmar, 'Engineering Behaviour of Rocks'.
3. C. Jaager, 'Rock Mechanics and Engineering'.
4. Jaager and Cook, 'Fundamentals of Rock Mechanics'.
5. D.S. Arora, 'Engineering Geology'.
6. Parbin Singh, 'Engineering Geology'.
7. B.P. Verma, 'Rock Mechanics for Engineering'.

Sr. No.	Category	Subject Code	Course Title	Contact Hours			Credits
1.	Open Elective	BTCE902C	Disaster Management	L	T	P	3
				3	0	0	
Internal Marks: 40, External Marks: 60, Total Marks: 100							

Course Objectives: The course should enable the students to understand:

1. Basic concepts in disaster management.
2. Definitions and terminologies used in Disaster Management
3. Types and categories of disasters
4. Challenges posed by disasters

UNIT-I

Introduction: Concepts and definitions -disaster, hazard, vulnerability, risks-severity, frequency and details, capacity, impact, prevention, mitigation, Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills, transportation accidents, terrorist strikes, etc.); hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility.

UNIT-II

Disaster Impacts: Disaster impacts (environmental, physical, social, ecological, economic, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate change and urban disasters.

UNIT-III

Disaster Risk Reduction (DRR): Disaster management cycle –its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post-disaster environmental response (water, sanitation, food safety, waste management, disease control, security, communications); Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

UNIT-IV

Disasters, Environment and Development: Factors affecting vulnerability such as impact of developmental projects and environmental modifications (including of dams, land-use changes, urbanization etc.),sustainable and environmental friendly recovery; reconstruction and development.

Course Outcomes: Upon completion of this course the student shall be able to have:

1. Familiarity with disaster management theory (cycle, phases).
2. Knowledge about existing global frameworks and existing agreements.
3. Humanitarian Assistance before and after disaster.
4. Technological innovations in Disaster Risk Reduction: Advantages and problems.
5. Experience on conducting independent DM study including data search, analysis and presentation of disaster case study.

Books Recommended :

1. Natural Hazards in the Urban Habitat by Iyengar, C.B.R.I., Tata McGraw Hill Publisher.
2. Natural Disaster management, Jon Ingleton (Ed), Published by Tudor Rose, Leicester 92.
3. Singh B.K., Handbook of disaster management: Techniques & Guidelines, Rajat Publications.
4. Disaster Management, R.B. Singh (Ed), Rawat Publications.
5. ESCAP: Asian and the Pacific Report on Natural Hazards and Natural Disaster Reduction.

Sr. No.	Category	Subject Code	Course Title	Contact Hours			Credits
1.	Open Elective	BTCE903C	Remote Sensing & GIS	L	T	P	3
				3	0	0	
Internal Marks: 40, External Marks: 60, Total Marks: 100							

Course Objectives: The course should enable the students to:

1. Introduce the concepts of remote sensing, satellite image characteristics and its components.
2. Understand various remote sensing platforms and sensors and to introduce the concepts of GIS, GPS and GNSS.

UNIT-I

Remote Sensing: Physics of remote sensing, Remote sensing satellites, and their data products, Sensors and orbital characteristics, Spectral reflectance curves, resolution and multi-concept, FCC

UNIT-II

Satellite Image: Characteristics and formats, Image histogram, Introduction to Image rectification, Image Enhancement, Elements of interpretation, Land use and land cover classification system, Unsupervised and Supervised Classification, Applications of remote sensing

UNIT-III

Disaster Risk Reduction (DRR): Basic concepts of geographic data, GIS and its components, Data models, Topology, Process in GIS: Data capture, data sources, data encoding, geospatial analysis, GIS Applications

UNIT-IV

Navigation Systems: Global Navigation Satellite System (GNSS), GPS, GLONASS, GALILEO, GPS: Space segment, Control segment, User segment, GPS satellite signals, Static, Kinematic and Differential GPS, GPS Applications

Course Outcomes: Upon completion of this course the student shall be able to:

1. Get familiarized about various image enhancement and image processing techniques.
2. Acquire knowledge about cartographic principles, spatial data models and spatial analysis.
3. Familiarise various areas of GNSS applications and new developments.

Books Recommended :

1. Anji Reddy, M. (2004), “Geoinformatics for Environmental Management” .B.S. Publications B. Bhatta, “Remote Sensing & GIS” by Oxford University Press.
2. Gupta, R.P., (1990), “ Remote Sensing Geology” Springer Verlag.
3. Jensen, J.R. (2000), “ Remote Sensing of the Environment: An Earth Resource Perspective” Prentice Hall.
4. Lillesand, T.M., and Kieffer, R.M., (1987), “ Remote Sensing and Image Interpretation”, John Wiley.
5. Manoj K. Arora & Prof. R.C. Badjatia, “Geomatics Engineering - Modern Surveying, GPS, Astronomy, Photogrammetry, Remote Sensing & GIS” by McGraw Hill.

Sr. No.	Category	Subject Code	Course Title	Contact Hours			Credits
1.	Open Elective	BTCE904C	Construction Engineering & Management	L	T	P	3
				3	0	0	
Internal Marks: 40, External Marks: 60, Total Marks: 100							

Course Objectives: The course should enable the students to give an exposure of management skills and familiarization with various aspects of management related to various construction projects.

UNIT-I

Basics of Construction: Unique features of construction, construction projects types and features, phases of a project, agencies involved and their methods of execution.

Brief Introduction of Construction Project Planning: Stages of project planning: pre-tender planning, pre-construction planning, detailed construction planning, role of client and contractor, level of detail. Process of development of plans and schedules.

UNIT-II

Introduction: Need for project planning & management, time, activity & event, bar chart, Milestone chart, uses & draw backs.

PERT Technology: Construction of PERT network, time estimates, network analysis, forward pass & backward pass, slack, critical path, data reduction, suitability of PERT for research project.

UNIT-III

CPM Technology: Definitions, network construction, critical path, fundamental rules, determination of project schedule, activity time estimates, float types, their significance in project control.

Construction Methods Basics: Types of foundations and construction methods; Basics of Formwork and Staging; Common building construction methods (conventional walls and slabs; conventional framed structure with block work walls; Modular construction methods for repetitive works.)

UNIT-IV

Construction Equipment: Conventional construction methods Vs Mechanized methods and advantages of latter; Equipment for Earthmoving, Dewatering; Concrete mixing, transporting & placing; Cranes, Hoists and other equipment for lifting; Equipment for transportation of materials. Equipment for Productivities.

Contracts Management Basics: Importance of contracts; Types of Contracts, parties to a contract; Common contract clauses (Notice to precede, rights and duties of various parties, notices to be given, Contract Duration and Price; Delays, penalties and liquidated damages; Force Majeure, Suspension and Termination. Changes & variations, Dispute Resolution methods.

Course Outcomes: Upon completion of this course the student shall be able to:

1.Develop basic ability to plan, control and monitor construction projects with respect to time and cost.
2. Develop an idea of how to optimize construction projects based on costs.
3. Develop an idea how construction projects are administered with respect to various contract systems and issues.
1. Develop an ability to put forward ideas and understandings to others with effective communication processes.

Books Recommended :

1.Varghese, P.C., "Building Construction", Prentice Hall India, 2007.
2. National Building Code, Bureau of Indian Standards, New Delhi, 2017.
3. Chudley, R., Construction Technology, ELBS Publishers, 2007.
4. Peurifoy, R.L. Construction Planning, Methods and Equipment, McGraw Hill, 2011
5. Nunnally, S.W. Construction Methods and Management, Prentice Hall, 2006
6. Jha, Kumar Neeraj., Construction Project management, Theory & Practice, Pearson Education
7. Punmia, B.C., Khandelwal, K.K., Project Planning with PERT and CPM, Laxmi Publications.

Sr. No.	Category	Subject Code	Course Title	Contact Hours			Credits
1.	Open Elective	BTCE905C	Concrete Technology	L	T	P	3
				3	0	0	
Internal Marks: 40, External Marks: 60, Total Marks: 100							

Course Objectives: The course should enable the students to:

1. Inculcate the basic concepts of concrete composition, properties and behaviour for designing the structures with Indian Standard Code.
2. Learn the concrete production process and methods of quality control under different environmental conditions.
3. Gain knowledge about various testing methods of Concrete, defect & deterioration identification, and evaluation of strength and durability.
4. Acquire an in-depth understanding of the classifications, characteristics and practical applications of an array of advanced concrete materials.

UNIT-I

Concrete and its ingredients: Properties of cement, aggregate, admixture, water and other additives; Related Indian Standard codes & guidelines.

Concrete behaviour in fresh and hardened states: Workability, Elasticity, Shrinkage, Creep, Fatigue, Strength in compression, tension, shear and bond; Influence of various factors on test results; Concrete cracking and type of cracks; Permeability and durability characteristics of concrete including resistance to sulphate & acid attack, alkali-aggregate reaction, freezing and thawing; Fire resistance.

UNIT-II

Production of concrete: Mixing, handling, placing, compaction of concrete and related issues; Quality control; Behaviour in extreme environmental conditions like hot weather, cold weather and under water conditions.

UNIT-III

Inspection and testing of concrete: Defects in concrete; Deterioration of concrete; Strength tests including compressive, split tensile, flexural, pull-out etc.; Durability tests including permeability, carbonation, rapid chlorine ion penetration etc

UNIT-IV

Special concretes: Types and specifications; Fibre reinforced and steel reinforced concrete; Polymer concrete; Light weight concrete, High strength concrete, Pre-stressed concrete, Self-Compacting Concrete, Pervious Concrete, Self-Healing Concrete.

Course Outcomes: Upon completion of this course the student shall be able to:

1. Identify different properties of constituent materials on properties of concrete.
2. Apply various testing methods for concrete and their applicability.
3. Knowledge of special type of non-conventional concretes.

Books/Manual Recommended:

1. Neville. A.M. & Hall Prentice. “Properties of Concrete”
2. Shetty.M. S.“Concrete Technology”,S. Chand & Co.
3. Gambhir. M.L. “Concrete Technology”,Tata McGraw Hill Publishers, New Delhi.
4. Kumar. A.R. Santha.“Concrete Technology”, Oxford University Press, New Delhi.

Sr. No.	Category	Subject Code	Course Title	Contact Hours			Credits
1.	Open Elective	BTCE906C	Metro system and Engineering	L	T	P	3
				3	0	0	
Internal Marks: 40, External Marks: 60, Total Marks: 100							

Course Objectives: The course should enable the students to:

1. Understand the concept of Efficient Route Planning.
2. Ensuring seamless connectivity with other modes of transport, such as buses, trains, and other public transit options.
3. Implementing rigorous quality control measures throughout the project lifecycle to ensure the safety and reliability of the metro system.

UNIT-I

Introduction to Metro systems: Overview of Metro Systems, Need for Metros, Routing studies, Basic Planning and Financials.

Planning and Development: Overview and construction methods for Elevated and underground Stations, Viaduct, spans and bridges, Under ground tunnels, Depots, Commercial Land Service buildings, Initial Surveys & Investigations.

UNIT-II

Traffic Management Systems: Basics of Construction Planning &Management, Construction Quality& Safety Systems, Traffic integration, multimodal transfers and pedestrian facilities, Environmental and social safeguards, Track systems-permanent way, Facilities Management Module.

UNIT-III

Signalling Systems: Introduction to Signalling systems, Automatic fare collection, Operation Control Centre(OCCand BCC), SCADA and other control systems, Platform Screen Doors.

UNIT-IV

Electrical Systems: OHE, Traction Power, Substations-TSS and ASS, Power SCADA, Standby and Back-up systems, Green buildings, Carbon credits and clear air mechanics.

Course Outcomes: Upon completion of this course the student shall be able to:

1. Apply construction methods for both elevated and underground sections.
2. Learn about routing studies, basic planning, and the process of selecting suitable routes for metro lines.

Books Recommended :

1. "Electric Traction for Railway Trains: A Book for Students, Electrical and Mechanical Engineers, Superintendents of Motive Power and Others" Edward Parris Burch Palala Press2018.
2. "Metropolitan Railways: Rapid Transit in America (Railroad's Past and Present)",Middleton, IndianaUniversityPress2013.
3. "World Metro Systems",Garbutt, Capital TransportPublishing;2ndRevisededition1997.

Sr. No.	Category	Subject Code	Course Title	Contact Hours			Credits
1.	Open Elective	BTCE907C	Traffic Management	L	T	P	3
				3	0	0	
Internal Marks: 40, External Marks: 60, Total Marks: 100							

Course Objectives: The course should enable the students to:

1. Learn the basics of traffic management, regulation & control devices.

UNIT-I

Fundamentals of Traffic Management:

Principles of Traffic management; Highway capacity and Level of service; Mixed Traffic flow: PCU concept and its limitations; Traffic stream parameters: Interrupted and Uninterrupted flow.

UNIT-II

Traffic Regulation and Control devices:

Road Signs and markings; Channelization; At-grade and Grade separated intersections; Traffic Rotary; Designprinciples of traffic signals.

UNIT-III

Traffic Management Techniques:

Regulatory measures for Traffic management; Travel Demand Management; Role of ITS in traffic management.

UNIT-IV

Logistics for Traffic Management:

Definition, domain, role and responsibility of traffic management agencies, Principles and systems of coordination in Traffic management; Intelligent transport system- concept, Traffic Management logistics - equipment's, vehicles and traffic control centre; Centralized Data Processing and Monitoring, Traffic personnel-skills & deployment systems.

Course Outcomes: Upon completion of this course the student shall be able to:

1. Have an overall knowledge of the traffic components and assess the traffic characteristics and related problems.
2. Develop a strong knowledge base of traffic planning and its management in any transportation area.
3. Provide knowledge of traffic control devices and its techniques in transportation interaction.
4. Traffic data, traffic volume count, intersection studies and spot and journey speed studies and further to analyse them.

Books Recommended :

1. Fred, L. Mannering, Scott S. Washburn. Principles of Highway Engineering and Traffic Analysis.7th Edition, Wiley, 2019.
2. Kadiyali, L.R. "Traffic Engineering & Transport Planning". KhannaPublications,2013.
3. Khisty, C.J. and Lall B.K. "Transportation Engineering–An Introduction".3rd Edition, Pearson, 2017.
4. Khanna, S.K., Justo C.E.G and Veeraragavan A. "Highway Engineering". Revised 10 th Edition, Nem Chand Bros, 2017.

Sr. No.	Category	Subject Code	Course Title	Contact Hours			Credits
1.	Open Elective	BTCE908C	Road Safety	L	T	P	3
				3	0	0	
Internal Marks: 40, External Marks: 60, Total Marks: 100							

Course Objectives: The course should enable the students to:

1. learn the basics of road safety measures & audits.

UNIT-I

Road Accidents:

Causes of road accidents: Vehicle design factors & Driver characteristics influencing road safety, Road condition, Parking and its influence on traffic safety

UNIT-II

Road safety measures:

Accident data collection methods; Representation of accident data: Collision and condition diagram; Methods to identify and prioritize black spots.

UNIT-III

Road safety audits:

Key elements in Road safety audit; Road safety audit procedure and investigations; Role of ITS in Road safety

UNIT-IV

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, Guardrails & Barriers and Road Lighting.

Course Outcomes: Upon completion of this course the student shall be able to:

1. Investigate & determine the collective factors and remedies of accident involved.
2. Able to collect and represent accident data to identify black spots.
3. Understand the role of intelligent transport system in Road safety.

Books Recommended :

1. K.W. Ogden, “Safer Roads – A Guide to Road Safety Engg”Averbury Technical, Ashgate Publishing Ltd., Alder shot, England, 1996.
2. Kadiyali, L.R., “Traffic Engineering and Transport Planning”, Khanna Publications, New Delhi, 2009.
3. C. JotinKishty& B. Kent Lall, “Transportation Engineering-An Introduction”, Third Edition, Prentice Hallof India Private Limited, New Delhi, 2006.

Sr. No.	Category	Subject Code	Course Title	Contact Hours			Credits
1.	Open Elective	BTCE909C	Environmental Impact Assessment	L	T	P	3
				3	0	0	
Internal Marks: 40, External Marks: 60, Total Marks: 100							

Course Objectives: The course should enable the students to:

1. Familiarize with the environmental legislation and acts, role of MOEFCC, pollution control boards/committees and their procedures.
2. Understanding of various aspects related to EIA processes and inculcate capabilities to interpret environmental management plans and EIA documents.

UNIT-I

Introduction to EIA: EIA origin, development, purpose and aims, core values and principles of EIA.

UNIT-II

Legal Aspects of EIA: Environmental legislation in India, Environmental Appraisal procedures in India, EIA Gazette notifications of the year 1994, 2006 & 2020, Environmental clearance process

UNIT-III

Project and the Environment Description: Environmental components of EIA, Identification of key issues, Terms of Reference, Baseline studies, Prediction and assessment of impacts on Air, Noise, Water, Soil & Geological, Biotic, Socioeconomic, Cultural and Aesthetic environment.

UNIT-IV

Environmental Management Plan and EIA Documentation: Principles, Anticipated environmental impacts, Mitigation measures, Identification, comparison and evaluation of different alternatives, Mitigation measures, Preparation of EIA documents.

Course Outcomes: Upon completion of this course the student shall be able to:

1. Know about the environmental requirements applicable to the environmental impact assessment, and the environmental clearance process of developmental projects.
2. Evaluate the environmental impacts of developmental projects.
3. Apply suitable methods and tools of prediction of environmental impacts.
4. Recommend mitigation measures in environment management plan.

Books Recommended :

1. Barthwal R.R. (2002), Environmental impact assessment, New Age International (P) Ltd. Publishers, New Delhi.
2. Abbasi S.A. and Arya D.S. (2002), Environmental Impact Assessment: Available Techniques and Emerging Trends, Discovery Publishing Pvt. Ltd.
3. EIA notifications:
   Gazette Notification (1994) SO 60 (E) dated 27-01-1994, MOEF, GOI, New Delhi.
   Gazette Notification (2006) SO 1533 dated 14-09-2006, MOEF, GOI, New Delhi.
   Gazette Notification (2020) SO 1199 (E) dated 23-03-2020, MOEFCC, GOI, New Delhi

Sr. No.	Category	Subject Code	Course Title	Contact Hours			Credits
1.	Open Elective	BTCE910C	Air & Noise Pollution	L	T	P	3
				3	0	0	
Internal Marks: 40, External Marks: 60, Total Marks: 100							

Course Objectives: The course should enable the students to:

1. Understanding of basic concepts of air pollution & noise pollution.
2. Study of air & noise pollution, identification of the parameters, conditions, mechanisms.
3. Study of sampling types and methods for ambient air and stack.
4. Study of macro and micro meteorology for understanding the dispersion of pollutants.
5. Study of pollution control methods, mechanism and devices.

UNIT-I

Air Pollution: Composition and structure of atmosphere, global implications of air Pollution, Classification of air pollutants: Particulates, hydrocarbon, Carbon monoxide, Oxides of sulphur, Oxides of nitrogen and photo chemical oxidants. Indoor air pollution, Effects of air pollutants on humans, animals, property and plants.

Air Pollution Chemistry: Meteorological aspects of air pollution dispersion; temperature lapse rate and stability, wind velocity and turbulence, plume behaviour, dispersion of air pollutants, the Gaussian Plume Model, stack height and dispersion.

UNIT-II

Air Sampling & Measurement: Ambient air quality and standards, air sampling and measurements; ambient air sampling, Collection of gaseous air pollutants, collection of particulate air pollutants, stack sampling, Control devices for particulate contaminants: gravitational settling chambers, cyclone separators, wet collectors, fabric filters (Bag-house filter), electrostatic precipitators (ESP).

UNIT-III

Control of Gaseous Contaminants: Absorption, Adsorption, Condensation and Combustion, Control of sulphur oxides, nitrogen oxides, carbon monoxide, and hydro carbons, automotive emission control, catalytic convertor, Euro-I, Euro-II and Euro-III specifications, Indian specifications.

UNIT-IV

Noise Pollution: Basics of acoustics and specification of sound; sound power, sound intensity and sound pressure levels; plane, point and line sources, multiple sources; outdoor and indoor noise propagation; psycho-acoustics and noise criteria, effects of noise on health, annoyance rating schemes; special noise environments: Infra-sound, ultrasound, impulsive sound and sonic boom; noise standards and limit values; noise instrumentation and monitoring procedure, Noise indices

Course Outcomes: The course will enable the student to:

1. Explain basic principles on various aspects of atmospheric chemistry.
2. Identify the major sources, effects and monitoring of air and noise pollutants.
3. Explain the key transformations and meteorological influence on air and noise.
4. Relate and analyse the pollution regulation on its scientific basis.

Books Recommended:

1. Peavy, Rowe and Tchobanoglous: Environmental Engineering.
2. S.K. Garg, “Environmental Engineering (Vol. II)” , Khanna Publishers, Delhi
3. K. Kant and R. Kant, “Air Pollution and Control Engineering”, Khanna Publishers House.
4. C.S. Rao, “Environmental Pollution Control Engineering”, Wiley Eastern Ltd., New Delhi
5. P.E. Cunniff, “Environmental Noise Pollution”, McGraw Hill.