

Course Name	:	GEOMETRIC DESIGN OF TRANSPORTATION INFRASTRUCTURE
Course Code	:	CEN 521
Credits	:	3
LTP	:	3 0 0
Course Objectives:		
To understand the principles of geometric design for various transportation facilities, To know the design of at-grade and grade separated intersections along with design of drainage facilities.		

Total No. of Lectures : 42

Lecture Wise Break Up		No. of Lectures
1	Introduction : Geometric design provision for various transportation facilities as per IRC guidelines, geometric design of horizontal and vertical alignment, design of expressways/ high speed corridors	11
2	Design of at grade intersections : Principles of design, channelization, roundabouts, staggered intersections	6
3	Design of interchanges: Major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes	8
4	Geometric design of facilities for non motorized traffic: Bicycles and pedestrian facility design, slow carriageways	5
5	Introduction to Geometric design of air fields: Airport design standards, runways, taxiways	6
6	Design of drainage facilities: Importance, Principles, drainage of various geometric elements, surface and subsurface drainage	6

Course Outcomes:	
1	The students can apply the Interpretation of geometric design fundamentals in the field.
2	Also design of intersections and drainage facilities are very important applications of this course.

Suggested Books:		
Sr. No.	Name of Book/ Authors/Publishers	Year of Publication/ Reprint
1	Kadyali L.R. and Lal N.B., "Principles and Practices of Highway Engineering", Khanna Publishers	2006
2	O'Flaherty, A. Coleman, "Highways: the Location, Design, Construction and Maintenance of Road Pavements", 4 th Ed. , Elsevier	2006

3	C. Jotin Khistya and B. Kent Lall, "Transportation Engineering", by Prentice Hall of India Private Limited	2006
4	Relevant IRC Codes	
5	Pocket book of Highway Engineers	2002
6	Khanna S.K., Arora M.G. and S.S. Jain; Airport Planning and Design, Nem Chand & Brothers	1999

Course Name	:	ADVANCED TRAFFIC ENGINEERING
Course Code	:	CEN522
Credits	:	3
LTP	:	3 0 0
Course Objectives:		
To know the traffic flow characteristics, To study various traffic surveys, To understand the Traffic Signal timing design and Traffic Flow theories.		

Total No. of Lectures : 42

Lecture Wise Break Up		No. of Lectures
1	Introduction to Traffic Engineering Properties of Traffic Engineering Elements, Road Vehicle performance	4
2	Traffic Studies Volume studies, Speed studies, Origin and destination studies and parking studies	6
3	Traffic Control devices Various Traffic Control devices, Principles of Intersection Design, Design of signalized and unsignalized intersections, Signal Coordination	8
4	Traffic Regulations and Statistical methods	5
5	Traffic Safety and Level-of-service Accidents, Lighting, Capacity and Level-of-service analysis	4
6	Uninterrupted traffic Flow Theory Fundamentals of Traffic flow theory, Uninterrupted Traffic flow including Macroscopic and Microscopic Traffic flow models	5
7	Interrupted traffic Flow Theory Fundamentals of Interrupted Traffic Flow, Shockwave Analysis, Car following theory, Queuing Theory, Vehicle arrival: Gap and Gap acceptance	8
8	Simulation of Traffic Systems	2

Course Outcomes:
Use the Traffic survey analysis for management of traffic and for designing new road infrastructure, Ability to design various types of intersections, Implementation of Traffic Control devices and traffic regulations, Applications of Traffic flow theories in solving congestion problems and use of simulation techniques

Suggested Books:		
Sr. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Kadiyali, L. R., Traffic Engineering and Transport Planning., Khanna Publishers	2011
2	O'Flaherty C A, "Transport Planning and Traffic Engineering", Butterworth Heinemann, Elsevier, Burlington, MA	2006

3	Manning Fred L., Kilarski Walter P. and Washburn Scott S., Principles of Traffic Engineering and Traffic Analysis, Third Edition, Wiley	2007
4	Roess, R. P., Prassas, E. S., and McShane, W. R., Traffic Engineering, 4th Edition, Prentice Hall	2010
5	Chakroborty Partha and Animesh Das, Principles of Transportation Engineering, Prentice hall	2005

Course Name	:	TRAFFIC ENGINEERING LABORATORY
Course Code	:	CEN523P
Credits	:	2
LTP	:	0 0 3
Course Objectives:		
To carry out various traffic studies in the field and to analyse the field data		

Total no. of Hours: 42

List of Experiments:		No. of Hours
1	Traffic volume studies	6
2	Speed studies	6
3	O & D studies	6
4	Signalised and non-signalised intersection studies	9
5	Parking surveys	6
6	Design service volume and capacity studies	3
7	Introduction to various Softwares	6

Course Outcomes:
The applications of the field studies will be helpful in designing the existing and new infrastructure by using the available software

Course Name	:	CONSTRUCTION PROJECT MANAGEMENT & BOT SYSTEM
Course Code	:	CEN524
Credits	:	3
LTP	:	3 0 0
Course Objectives:		

Total No. of LectRures : 42

Lecture Wise Break Up		No. of Lectures
1	Construction Project Management: an Overview- Construction industry; construction project; product development process; project management ; main causes of project failure; BOT, BOOT, BORT and other variants of BOT. causes of introducing this system, Liberalization policies of GOI for these system; GOI, state governments, other local bodies, board, corporation etc are adopting these system for construction project management.	4
2	Project Management Information System : PMIS concept; PMIS framework; information system computerization; user's system specifications development; acquiring a system; problems in information system management; benefits of computerized information system	3
3	Risk management in infrastructure projects: Introduction; identification of risks: an important principle, task involvement, aspects to analyze; Stages of project implementation: gestation stage, development stage, construction stage, operational stage, termination stage; Specific categories of risk: revenue risk, design risk, construction risk, operating risk, financial risk, political risk, legal risk, environmental risk, force majeure risk.; allocation & management of risks: concept of risk management, management of risk, risk matrix.; Developers perspective of risk; Government's perspective of risk.	6
4	Management in Construction: Overview; Risk Management process: when to use, procedure of providing Advice; Risk Management Responsibility: risk manager, risk owner, team approach; Stages of risk Management: stages , assessment, management, typical sequence, identification classification, direct/ indirect costs, risk matrix, quantification; Response: hold, avoid, reduce, transfer, share, review.; conclusion.	5
5	Management Process: Introduction; risk identification; brainstorming: interviews, The Delphi Technique, expert systems.; Qualitative Assessment: classification and reference, description of risk, risk trigger, relationship to other risk, potential impact, likelihood of occurrence, response.; Mitigation: meaning, avoidance, risk avoidance risk transfer, residual or retained risk. Risk analyse: meaning, a brief introduction to stastics, method of risk assessment	5
6	Tools and techniques of risk management: Introduction; qualitative methods: risk register, risk estimate, simple arithmetic analysis, MERA, decision trees, sensitivity analysis, influence diagrams, probability analysis, computer software; conclusion.	5
7	Technical procedure for management: Introduction; phases of construction: the design phase, construction phase; post construction; risk matrix; exhibits	3
8	Construction Project Insurance: Introduction; insurance policy structure; types of insurance mentioned in the model; guidance on insurance for construction projects; current conditions of contract; general services provided by the project insurance companies.	3

9	Construction Project Insurance policies: Introduction; storage cum erection and marine cum erection insurance, subject matter, insured party, cover ,sum insured, period of cover, deductible franchise, basis of claim settlement, extension of basic cover, risk distributor, marine cum erection.; contractor's all risk policy: introduction, scope of cover, main exclusions, sum assured , period of contract, basis of settlement of claims, various extensions of the policy, escalation, maintenance, claims procedure and documents, documents required	8
----------	---	---

Course Outcomes:

Suggested Books:		
Sr. No.	Name of Book/ Authors/Publishers	Year of Publication/R eprint
1	Construction project management by KK Chitkara, Tata McGraw Hill	2010
2	Indian highways – a framework for commercialization by Gajendra Haldia	2010
3	Risk management in construction projects NCP-centre of distance education for construction industry manager	
4	NHAI & CIDC websites with some national and international journals of construction field with the proceedings of conferences/ seminars organized by CIDC & NICMAR	

Course Name	:	TRANSPORTATION SYSTEM PLANNING AND MANAGEMENT
Course Code	:	CEN525
Credits	:	3
LTP	:	3 0 0
Course Objectives:		
To study the various techniques of transportation management To study the performance of various transportation systems		

Total No. of Lectures : 42

Lecture Wise Break Up		No. of Lectures
1	General Importance of transportation, transportation planning methodology, hierarchical levels of planning and its relation to rural, urban areas. Long range planning, Passenger and goods transportation, General concept and process of transport planning, Land-use transport interactions, Socio-economic characteristics of Land use	8
2	Transportation Systems Multi modal transportation system; Characteristics of Mass Transit systems including technical, demand operational and economic problems, fixed Track Facility, Mass Rapid Transit System-Elevated, Surface and Underground construction , Express Bus System, integrated Operating Characteristics of Terminal and Transfer facilities	8
3	Urban Transportation Planning Studies Urban Travel Characteristics, Private and Public Behavior analysis, Transportation demand Surveys, Delineation of the urban area, zoning, Origin-Destination Studies, Home Interviews, trip Classification and Socio- Economic variables in trip making projections	10
4	Planning Methodology and Systems analysis Study of existing network-trip generation techniques, Category analysis, multiple regression techniques, Modal split analysis, Trip distribution techniques, Growth Factor model, Gravity models, Opportunity models and multiple regression models, Traffic assignment methods, Minimum Path tree-All or nothing assignment and capacity restraint techniques, analysis and evaluation techniques	16

Course Outcomes:
Gain Knowledge of various systems of transportation. Have an in depth knowledge of Demand projection techniques of various transportation systems.

Suggested Books:		
Sr. No.	Name of Book/ Authors/Publishers	Year of Publication/ Reprint
1	Kadiyali, L. R., Traffic Engineering and Transport Planning, Khanna Publishers	2011
2	Highway Engg.-Khanna S.K. and Justo C. E. G. New Chand Publication	2008
3	C A O'Flaherty, "Transport Planning and Traffic Engineering", Butterworth Heinemann, Elsevier, Burlington, MA	2006

4	Transportation Engineering and Planning, by C. S. Papacostas and P. D. Prevedouros, Prentice Hall of India Private Limited	2001
---	--	------

Course Name	:	PAVEMENT MATERIALS AND EVALUATION LABORATORY
Course Code	:	CEN526P
Credits	:	2
LTP	:	3 0 0
Course Objectives:		
To have knowledge about the various tests which need to be carried out on soils, aggregate and bitumen for the design of bituminous mixes and pavements. Evaluation tests for pavement strengthening and use of software in highway development		

Total No. of Hours : 42

List of Experiments:		No. of Hours
1	Tests on Soils (Gradation, atterberg limits, OMC and CBR)	6
2	Test on Aggregates (Aggregate grading and Proportioning, Impact, Abrasion crushing, water absorption, specific gravity)	6
3	Tests on Bitumen and Bitumen Mixes (Marshall method of mix design and Bitumen content test)	12
4	Pavement Evaluation tests (Benkelman beam test)	6
5	Exposure to latest software	12

Course Outcomes:
The students can have thorough knowledge of tests and bituminous mix design which will give the students added confidence when they go actually in the field

Suggested Books:		
Sr. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Khanna, S. K., Justo, C. E. G., and Veeraragavan, A., Highway Materials laboratory Testing, Nem Chand & Brothers	2008
2	Relevant IRC and AASHTO Codes	

Course Name	:	Numerical Methods and Optimization Techniques
Course Code	:	CEN599
Credits	:	3
L T P	:	3 0 0
Course Objectives:		
To understand the concept of optimization and its application in civil engineering project, and to learn the concept of relevant mathematical tools.		

Total No. of Lectures: 42

Lecture Wise Break Up		No. of Lectures
1	RDBMS Civil Engg. Software Packages	6
2	Fundamentals of optimization, Statistical optimization	6
3	Linear Programming, Dynamic Programming.	7
4	Finite difference methods, Taylor's series, Fourier series	7
5	Different Implicit and Explicit schemes- MacCormack Scheme, Lambada Scheme, Preissmann Scheme	8
6	Stability analysis, Boundary Conditions, Algebra of tensors.	8

Course Outcomes:
Students will be able to make use of Software Packages and its application in solving the civil engineering project problems.

Suggested Books:		
S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Software Engineering – Roger Pressman.	1982
2	Software Development in 'C' – Yashwant Kanetkar	2013
3	Operations Research – D.S.Heera & P.K.Gupta	2005
4	Optimisation Theory & Applications – S.S.Rao, S. Chand & Company Ltd	2014

Course Name	:	Design of Experiments & Research Methodology
Course Code	:	ENN505
Credits	:	3
L T P	:	3 0 0
Course Objectives:		
To introduce the fundamentals of Statistical techniques, Sampling techniques, and Data collection and their interpretation.		

Total No. of Lectures: 42

Lecture Wise Break Up		No. of Lectures
1	Basic principles of design of experiment, Error analysis in experiments.	5
2	Concept of modeling, Different types of models, Random variables, Random numbers, and Analysis of variance	6
3	Estimation of parameters, Residual analysis and model checking, Sample size problem	6
4	Different types of distributions, Distribution tests, Concept of simulation, Monte Carlo simulations	6
5	Geostatistics	5
6	Que model, Time series analysis, Fitting statistics	5
7	Research Methodology – Nature and objective of research, Research topic, Literature review, Formulation of problem, Research design, Sampling techniques, Data collection	5
8	Statistical and sensitive analysis of data, Interpretation of result and report writing	4

Course Outcomes:
Students will be able to make use of various Research methodologies and its applications in the relevant field of engineering.

Suggested Books:		
S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Probability and Statistics for Engineers and scientists, Walpole, Myers, Myers and Ye, Pearson Education.	7th edition, 2002
2	Statistics in Research, Bernard Ostle and Richard N.Mensing, Oxford & IBH Pub Co.	3rd edition, 1975
3	Probability and Statistics in Engineering, Hines, Montgomery, Goldsman and Borror, John Wiley & Sons.	4th edition, 2003
5	Introduction to probability & statistics for Engineers and scientists, Sheldon M. Ross Elsevier Academic press, California, USA	2014

Course Name	:	PAVEMENT MANAGEMENT SYSTEM
Course Code	:	CEN527
Credits	:	3
LTP	:	3 0 0
Course Objectives:		
To know Pavement management process, pavement evaluation and performance, design alternatives, analysis, evaluation and selection, implementation		

Total No. of Lectures : 42

Lecture Wise Break Up		No. of Lectures
1	Introduction Pavement Management Systems; Components of pavement management systems	5
2	Pavement conditions survey and ratings	5
3	Pavement performance prediction Concepts, modeling techniques, Comparison of different deterioration models	6
4	Highway Development and Management tools Rehabilitation budget planning; Ranking and optimization methodologies	6
5	Alternate pavement design Strategies and economic evaluation	5
6	Reliability concepts in pavement engineering; life cycle costing	5
7	Road asset management , pavement preservation programs	5
8	Expert systems and pavement management	5

Course Outcomes:
Skill Development for macro and micro techno-economic management of wide area pavement network

Suggested Books:		
Sr. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Haas, R., W.R. Hudson, and J.P. Zaniewski, "Modern Pavement Management", Krieger Press	1994
2	Yoder E.J. and Witezak, "Principles of Pavement Design," John Wiley & Sons	1975
3	Shahin M.Y. "Pavement Management for Air Port, Roads and Parking Lots", Chapman and Hall/Springer	2005

4	K.B Woods, Highway Engineering Handbook McGraw Hill	1960
---	---	------

Course Name	:	LAND USE & REGIONAL TRANSPORTATION PLANNING
Course Code	:	CEN528
Credits	:	3
LTP	:	3 0 0
Course Objectives:		
To know about various landuse Transportation models. To estimate regional, intercity travel demand and freight travel demand which are useful for policy formulation		

Total No. of Lectures :42

Lecture Wise Break Up		No. of Lectures
1	Urbanisation; urban forms and structures, Delineation of regions	5
2	Landuse transportation models;	8
3	Transit oriented landuse planning	5
4	Regional and intercity travel demand estimation	6
5	Freight travel demand modeling	5
6	Regional network planning	7
7	Policy formulation and evaluation	6

Course Outcomes:
The students will learn about various land use models and their applications for policy formulation and evaluation

Suggested Books:		
Sr. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Blundon, W. R. and J Black, The Land Use Transport System, 2nd Edition, Australian Natl Univ Press	1984
2	Eric Koomen and Judith Borsboom-van Beurden, Land-Use Modelling in Planning Practice (GeoJournal Library), 1st Edition, Springer	2011

Course Name	:	TRANSPORTATION ECONOMICS AND FINANCE
Course Code	:	CEN529
Credits	:	3
LTP	:	3 0 0
Course Objectives:		
To know Economic evaluation of transportation projects, ownership financing of transport, economic function of transportation, road user and transportation cost, finance and taxation		

Total No. of Lectures : 42

Lecture Wise Break Up		No. of Lectures
1	Economic evaluation of transport plans Need for economic evaluation, cost and benefits of transport projects, time horizon in economic assessment, basic principles of economic evaluation, interest rate, method of economic evaluation, benefit cost ratio method, first year rate of return, net present value method, internal rate of return method, comparison of various methods of economic evaluation.	10
2	Vehicle operating costs Introduction, road user cost study in India , components of VOC, factors affecting VOC, fuel consumption relationship, spare parts consumption, maintenance and repairs, labour cost, tyre life, lubricants, utilization, and fixed costs.	8
3	Value of travel time savings Introduction, classes of transport users enjoying travel time savings, methodology for monetary evaluation of passengers' travel time, review of work in India on passengers' travel time.	6
4	Accident costs Introduction, relevance of accident costing for a developing country, review of alternative methodologies for accident costing, Indian studies.	6
5	Traffic congestion, traffic restraints and road pricing Congestion as a factor in road traffic, traffic restraint, road pricing.	6
6	Highway finance Basic principles, distribution of highway cost, sources of revenue, highway financing in India.	6

Course Outcomes:
Ability to analyze and evaluate transportation project case studies

Suggested Books:		
Sr. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Principles of Transportation engineering by Chakroborty & Das, Prentice Hall, India.	2009
2	Highway Engg by S.K Khanna & CEG Justo, Nem Chand Bros., Roorkee	2001

3	Principles and practices of Highway engg by L.R Kadyali, Khanna Publishers, Delhi.Edition 6	2013
4	Principles of Transportation and Highway engg by G.V Rao, Tata Mc graw- Hill Publishing Co.Ltd. N.Delhi	1996
5	Harral Clell G., A Manual for the Economic Appraisal of Transport Projects, World Bank Report, Washington D.C	1980

Course Name	:	TRANSPORTATION AND ENVIRONMENT
Course Code	:	CEN530
Credits	:	3
LTP	:	3 0 0
Course Objectives:		
To know how the transportation systems are polluting the environment and how the EIA studies are necessary for highways taking various case studies		

Total No. of Lectures : 42

Lecture Wise Break Up		No. of Lectures
1	Introduction Classification, effects of air pollutants on humans, plants and materials	6
2	Vehicular emissions Sources, meteorology and photochemical reactivity of pollutants; Monitoring and control measures of automobile emissions	8
3	EIA studies of highways and ambient air quality standards	12
4	Noise measurements, noise levels and noise control Effects of transportation noise, road traffic noise, train and rail noise, aircraft noise; Active noise control, vibration control principles; Noise survey; Environmental Impact Statements and case studies on noise control	12
5	Introduction to sustainable Transportation infrastructure	4

Course Outcomes:
This course will be very useful for controlling pollution from various transportation systems. Now EIA study is very important for any highway construction

Suggested Books:		
Sr. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Transport, Environment and Society by Michael Cahill	2010

2	India and the Path to Environmental Sustainability By Ethan Goffman	2008
3	Transport, Environment and Health, World Health Organisation	2000

Course Name	:	MASS TRANSPORTATION SYSTEMS
Course Code	:	CEN531
Credits	:	3
LTP	:	3 0 0
Course Objectives:		
To study the various Mass Transit techniques and to have in depth knowledge of Bus Routing Techniques		

Total No. of Lectures : 42

Lecture Wise Break Up		No. of Lectures
1	Introduction to various types of mass transportation systems Need of mass transportation, recent trends in transit, mass transportation characteristics	8
2	Urban mass transportation planning demand projection, selection of mass transportation system, Economic evaluation methods	8
3	Terminals and their functions conceptual design, typical requirement, scheduling, vehicle dispatch policy, spacing of stops, route spacing and performance	18
4	Operational and management issues in transit planning. Priority measures and their implementation	8

Course Outcomes:
Gain knowledge of various terminals and have extension knowledge of Route spacing Techniques

Suggested Books:		
Sr. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Principles & Practices of Traffic Engg.-L.R.Kadiyali	2013
2	Principles, Practice and design of Highway Engg.-S.K.Sharma	2010
3	Highway Engg.-Khanna S K & Justo C.E. G	2001
4	Metropolitan Transportation Planning- John W.Dickey Taylor & Francis Group	1983

Course Name	:	INTELLIGENT TRANSPORTATION SYSTEMS
Course Code	:	CEN532
Credits	:	3
LTP	:	3 0 0
Course Objectives:		
To familiarize the students with latest techniques of transportation systems, To learn the techniques of existing toll system using ITS		

Total No. of Lectures :- 42

Lecture Wise Break Up		No. of Lectures
1	Advanced traffic management systems	5
2	Advanced traveller information systems	6
3	Commercial vehicle operations	4
4	Advanced public transportation systems	7
5	Advanced rural transportation systems	7
6	Advanced vehicle control systems	6
7	ITS standards; ITS technologies and future of ITS	7

Course Outcomes:
Design and implement the application of Electronic Systems in Transportation, Develop the system of tackling the congestion in the various transportation modes.

Suggested Books:		
Sr. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Chowdhury, M. A., and Sadek, A., Fundamentals of Intelligent Transportation Systems Planning, Artech House	2003
2	Sussman, J. M., Perspectives on Intelligent Transportation Systems (ITS), Springer	2005
3	Turban, E., and Aronson, J. E., Decision Support Systems and Intelligent Systems, 5th Edition, Prentice Hall	2004

Course Name	:	Airport Infrastructure, Planning and Design
Course Code	:	CEN533
Credits	:	3
LTP	:	3 0 0
Course Objectives:		
To make the students conversant with the types of pavements and their design. To make them learn the importance of orientation of runways, Air traffic control devices and airport drainage		

Total No. Of Lectures :- 42

Lecture Wise Break Up		No. of Lectures
1	Introduction Air transport- structure and organization, the challenges and the issues..	4
2	Airport Planning and Geometric Design Airport master plan, Aircraft characteristics, Geometric design of airfields	10
3	Planning and design of the terminal area The planning terminal system; design considerations and visual aids	5
4	Structural design of airport pavements Design factors, Design of flexible and rigid pavements	10
5	Airside Capacity and delay Mathematical models for capacity and delay, space time concept	6
6	Air traffic control Elements; major components and functions of the National airspace system	4
7	Airport drainage Design runoff, inlet size and location design, surface and subsurface design	3

Course Outcomes:
The students feel comfortable in design of airfield pavements and they can apply this knowledge in the field

Suggested Books:		
Sr. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Horonjeff , R. Mickelvey, F.X, Planning & design of airports, Mc Graw Hill, New York, 4 th edition.	2010
2	Khanna, S.K., Arora, M.G., and S.S. Jain; Airport Planning and Design, Nem Chand & Brothers	2012
3	Air transportation planning and design by Virender Kumar & Satish Chandra, Galgotia Publications, N.Delhi	2012

Course Name	:	ADVANCED SOIL ENGINEERING
Course Code	:	CEN534
Credits	:	3
LTP	:	3 0 0
Course Objectives:		
To understand the engineering properties and behavior of Soil under different field condition and loading.		

Total No. of Lectures :- 42

Lecture Wise Break Up		No. of Lectures
1	Origin, nature and distribution of soils. Engineering Behaviour of Soils of India: Black cotton soils, alluvial silts and sands, laterites, collapsible and sensitive soils, aeolin deposits	4
2	Description of individual particle Clay mineralogy, clay-water-electrolytes. Soil fabric and structure. Effective stress principle. Steady state flow in soils. Effect of flow on effective stress.	5
3	Consolidation One, two and three dimensional and radial consolidation. Sand drain and prefabricated drain. Variation of effective stress during consolidation, Stress-path. Shear behaviour of granular soils. Factors affecting shear behaviour. Determination of parameters. Shear behaviour of fine grained soils. Pore-pressure parameters. UU, CU, CD tests. Total and effective stress paths.	6
4	Factors affecting strength: Stress history, rate of testing, structure and temperature. Anisotropy of strength, thixotropy, creep. Stress-strain characteristics of soils. Determination of modulus values. Critical state model.	5
5	Geosynthetics: Types and functions; Materials and manufacturing processes; Principles of soil reinforcement; Design and construction of geosynthetic reinforced soil retaining structures – walls and slopes; embankments on soft soils; Geosynthetics in Pavements: Geosynthetics in roads and railways; separations, drainage and filtering in road pavements and railway tracks.	8
6	Methods of site investigations: Direct methods, semi-direct methods and indirect methods, Drilling methods. Boring in soils and rocks, methods of stabilizing the bore holes, measurement of water table, field record. Field tests: In-situ shear test, in-situ permeability test, SPT, DCPT, SCPT, in-situ vane shear test, pressure meter test, Dilatometer test Codal provisions.	8
7	Slope Stability analysis- Bishop (Rigorous and Simplified) Method, Mongestern's Method, Spencer's Method.	6

Course Outcomes:	
1	To be able to ascertain the behavior of Soil as a construction material or supporting medium for Civil Engineering structures.
2	To be able to analyze distress/failure condition relating to Soil and hence to suggest remedial measures.

Suggested Books:		
S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Soil Mechanics in Engineering Practice, Terzaghi and Peck, John Wiley and Sons.	1967
2	Physical and geotechnical properties of soils, Bowles	1984
3	Design aids in soil mechanics and foundation engineering, Kaniraj S.K.	1988
4	Soil Mechanics, Lambe and Whitman, Wiley India	2000
5	Reinforced soil and its engineering application, Swami Saran, I k International	2010(2 nd Ed.)

Course Name	:	ADVANCED ENGINEERING GEOLOGY
Course Code	:	CEN535
Credits	:	3
LTP	:	3 0 0
Course Objectives:		
Enhance megascopic and microscopic knowledge of mineral and rocks in turn. Importance of Geomorphic principles operated in the past. Aerial photo-interpretation and its use in identification of different Landforms. To understand significance of Landslides and Structural features in engineering construction. Critically examine role of Geological considerations in Civil Engineering Structures		

Total No. of Lectures : 42

Lecture Wise Break Up		No. of Lectures
1	MINEROLOGY AND GEOMECHANICS Important rock forming minerals, their megascopic and Microscopic properties. Outline classification, mode of formation & occurrence of important Rock groups (Sedimentary, Igneous and Metamorphic).	10
2	GEOMORPHOLOGY Principles of geomorphology, occurrence of ground water in different rock types. Geophoto interpretation of Aerial photograph. Application in highway planning, Analysis of land forms, soil types, vegetative cover, Land forms (glacial, arid and fluvial), Snow cover features from aerial photographs.	14
3	ENGINEERING PROBLEMS Landslides: cause, classification, zonation and protection, subsidence and related phenomenon, structure of rocks (folds, faults, joints, unconformity) and their significance in Engineering construction, foundation problems in different types rocks. Geological considerations in the selection of site for buildings, dams, reservoirs, tunnels, abutments, air fields. Road stones and suitability of various rocks for road use.	18

Practical:

1	Identification of Crystal forms	14 Hours
2	Microscopic studies of important rocks and minerals through thin section slides	
3	Studies of representative aerial photographs under Mirror Stereoscope	
4	Understand Geological maps & their utility in the Civil Engineering Projects	
5	Draw structural & cross sectional profiles from the Geological map.	

Course Outcomes:	
Students should be able:	
1	To distinguish minerals in hand specimen and under the microscope.
2	To ascertain rocks and know their occurrence.
3	To use aerial photographs for interpretation of different landforms.
4	To apply knowledge of geological structures in engineering construction. Geological considerations as site for selection to various civil engineering structures.

Suggested Books:		
S. No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Blyth, F.G.H. and de Freitas, M.H. Geology for Engineers, ELBS	1994
2	Goodman, R.E. Engineering Geology, John Wiley and Sons, NY	1993
3	Skinner, B.J. and Porter, S.C. The Dynamic Earth-An Introduction to Physical Geology, John Wiley and Sons, N.Y	1989

Course Name	:	PAVEMENT ANALYSIS AND DESIGN
Course Code	:	CEN536
Credits	:	3
LTP	:	3 0 0
Course Objectives:		
To make the students conversant with the different components of pavement structures. To study the latest design methods of flexible and rigid pavements. To study the art of maintenance and Rehabilitation of Pavements		

Total No. of Lectures :- 42

Lecture Wise Break Up		No. of Lectures
1	Fundamentals of pavement design: Requirements of an ideal pavement, elements of pavement structure and their function. Type of pavements, comparison of flexible and rigid pavements, comparison of highway and airport pavements, factors affecting pavement design	8
2	Analysis and Design of Flexible pavements: Stress distribution phenomenon, CBR, IRC design guidelines	10
3	Analysis and Design of rigid pavements: IRC design methods, Westergaad's analysis, wheel load stresses, temperature stresses and their evaluation, design of joints	10
4	Rehabilitation and Maintenance of pavements: Causes of failures of flexible pavements and remedial measures, causes of failures of rigid pavements and remedial measures, maintenance of pavements	7
5	Pavement evaluation and overlay design: Introduction, method of pavement evaluation, design principles of overlay, IRC design guidelines	7

Course Outcomes:	
1	The students will have in-depth knowledge of the design and failures of the flexible and rigid pavements

Suggested Books:		
Sr. No.	Name of Book/ Authors/Publishers	Year of Publication/Re print
1	L.R. Kadyali & N.B Lal ,Principles and practices of Highway Engineering	2006
2	Sharma S.K, Principles and Practices of Highway Engineering	2012

3	Highway Engineering S.K .Khanna & Justo Highway Engineering Nem Chand Jain and Bros, 8th Ed	2005
4	Relevant IRC and AASHTO codes	
5	O'Flaherty, A. Coleman, "Highways : the Location, Design, Construction and Maintenance of Road Pavements", 4th Ed., Elsevier	2006

Course Name	:	Railway Infrastructure, Planning and Design
Course Code	:	CEN537
Credits	:	3
LTP	:	3 0 0
Course Objectives:		
To make them learn about Basics of railways Stations, Yards, Signal, points & crossings & tunnel design. To know about the geometric design of track, railways in metro cities and modernization of railways		

Total No. of Lectures : 42

Lecture Wise Break Up		No. of Lectures
1	Rail transportation Importance, rail transportation as compared to other means of transport, current position, demand analysis and forecasting, project analysis and design, case studies.	6
2	Railway track gauges and Geometric design of track	11
3	Track maintenance including modern method Necessity and advantages of track maintenance; equipment and tools for tracks; mechanized methods of track maintenance; off-track tampers	8
4	Railway accidents and Disaster Management Train accidents; classification of accidents; Derailment and its causes; safety measures	5
5	Suburban railways in Metro cities Urban transport; MRTS in Delhi	8

Course Outcomes:	
Good idea about Geometric design of rail track, railways, permanent way stations and yards and tunnel ventilation is attained by the students. Also they may be able to know the applications of MRTS in metro cities	

Suggested Books:		
Sr. No.	Name of Book/ Authors/Publishers	Year of Publication/Re print
1	Railway Engineering by Rangwala	2008
2	Chandra S. and Aggarwal M.M., Railway Engg	2007
3	Saxena S.C. and Arora S.P., Railway Engineering Dhanpat rai	1981
4	Hay, W.W Railway Engineering John Wiley and Sons, New York	1982
5	Victor D.J Essential of Bridge Engineering Oxford & I.B.H. Publishing Co., New Delhi	1973

Course Name	:	HIGHWAY MATERIALS, DESIGN AND CONSTRUCTION
Course Code	:	CEN538
Credits	:	3
LTP	:	3 0 0
Course Objectives:		
To introduce advance knowledge in highway materials, granular, bituminous and cementitious mix proportion design and construction for highway development, quality assurance, and economic selection of pavement materials for durable roads		

Total No. of Lectures :42

Lecture Wise Break Up		No. of Lectures
1	Soil sub-grade, soil stabilization and low cost road	6
2	Desirable characteristics of Road aggregates, proportioning of aggregates	6
3	Types of bitumen, bitumen Constituents, characterization of bitumen, emulsions, modified bitumen	6
4	Desirable properties of bitumen mixes and design of bitumen mixes, tests on Bitumen, theory of filler and specification	6
5	Factors influencing and design of pavement grade concrete mixes	6
6	Bituminous and concrete road construction Procedure and specification	6
7	Quality assurance	6

Course Outcomes:
The selection design and construction using various pavement materials would be optimized for various global road development programs

Suggested Books:		
Sr. No.	Name of Book/ Authors/Publishers	Year of Publication/Reprint
1	Krebs and walker-Highway materials, McGraw Hill Book Co.	1971
2	Sharma S.K. Principles, practice and design of Highway Engg	2010
3	Kadiyali, L.R., 'Principles and Practices of Highway Engineering	2006
4	Relevant IRC and MORT&H codes and guidelines	

Course Name	:	BRIDGE ENGINEERING
Course Code	:	CEN510
Credits	:	3
L T P	:	3 0 0
Course Objectives:		
To familiarize with the types, suitability, selection, design criteria of various types of bridges, Introduction to Analysis and Design of various types of bridges and construction methods.		

Total No. of Lectures: 42

Lecture Wise Break Up		No. of Lectures
1	General Bridge systems: Considerations in alignment, Planning, Economic considerations, Aesthetics and selection of type of bridge, Bridge Hydrology, Scour Depth, Depth of foundation, Estimation of Design Discharge	7
2	Loading Standards: Specifications for loading, geometrical proportioning etc. Road, Rail-cum-Road bridges, Indian Road Congress and Indian Railway loading standards and their comparison with loading standards followed in U.K., U.S.A. and Europe.	7
3	Design of Bridges: Reinforced Concrete Bridges, Slab culverts, T-Beam Bridges, Box Girder Bridges	8
4	Bridge Bearings	3
5	Design of sub structure - Piers and Abutments.	4
6	Dynamic Response of Bridges: Design considerations for pre-stressed bridges, trussed steel, Cable stayed and suspension bridges.	9
7	Limit State concept for Design of RCC bridges.	4

Course Outcomes:
Students can be able to design the various types of bridge and the construction technique.

Suggested Books:		
S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Bridge Superstructure, N. Rajagopalan, Narosa Publishing House	2006
2	Bridge Engineering Handbook, W. F. Chen and L. Duan, CRC press	2003
3	Bridge Analysis Simplified, B. Bakht and L.G. Jaeger, McGraw Hill	1987
4	Bridge Deck Analysis, E. J. O'Brien, and D. L. Keogh, Taylor and Francis	1999
5	Structural Bearings, H. Eggert and W. Kauschke, Ernst & Sohn	2002
6	Design of Prestressed Concrete Structures, T. Y. Lin and N. H. Burns, John Wiley and Sons	1981
7	L. Fryba, Dynamics of Railway Bridges, Thomas Telford	1996
8	Bridge Deck Analysis, E. J. O'Brien, and D. L. Keogh, Taylor and Francis	1999
9	Structural Bearings, H. Eggert and W. Kauschke, Ernst & Sohn	2002
10	Design of Prestressed Concrete Structures, T. Y. Lin and N. H. Burns, John Wiley and Sons	1981
11	Dynamics of Railway Bridges, L. Fryba, Thomas Telford	1996
12	Design of Bridges, N.Krishna Raju, Oxford and IBH Publications	1988
13	Victor D.J, Essential of Bridge Engineering Oxford & I.B.H. Publishing Co., New Delhi.	2001

Course Name	:	ADVANCED FOUNDATION ENGINEERING
Course Code	:	CEN514
Credits	:	3
L T P	:	3 0 0
Course Objectives:		
To learn the different types of foundation and their suitability for particular site and structure. To understand soil-structure interaction and calculation of allowable load and settlement of the foundation.		

Total No. of Lectures: 42

Lecture Wise Break Up		No. of Lectures
1	Shallow Foundations: Design considerations - factors of safety (including limit state), allowable settlements, location and depth of foundations, Codal provisions. Presumptive bearing, capacity. Bearing capacity theories. Layered soils. Choice of shear strength parameters. Bearing capacity from N-values, static cone tests, plate load tests .Settlement: Total and differential settlement. Stress distribution. Consolidation settlement in clays (with correction factors). Immediate settlement. Settlement in sands from N-values, elastic solutions. Static cone tests, Plate load test.	14
2	Deep foundations: Type of Piles. Construction methods. Axial capacity of single piles-static formulae, Skin friction and end bearing in sands and clays. Axial capacity of groups. Settlement of single piles and groups. Uplift capacity (including under-reamed piles). Negative skin friction. Pile load tests. Pile integrity tests. Codal provisions. Laterally Loaded Piles: Short and long piles; Free head and fixed head piles; Lateral load capacity of single piles; Lateral deflection; Elastic analysis; Group effect; Lateral load test; Codal provisions. Caissons and Wells.	12
3	Soil structure interaction: Introduction to soil-foundation interaction problems, soil behaviour , Foundation behaviour, Interface behaviour, Soil Foundation interaction analysis, Soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic plastic behaviour, Time dependent behaviour.	6
4	Soil Liquefaction and remedial measures, stone column, vibrfloatation, deep compaction.	4
5	Foundations in difficult soils: Expansive soils, chemically aggressive environment, soft soils, fills, regions of subsidence.	6

Course Outcomes:
Ability to make geotechnical design the foundation for civil engineering structure under varied field conditions.

Suggested Books:		
S.No.	Name of Book/Authors/Publishers	Year of Publication/ Reprint
1	Design aids in soil mechanics and foundation engineering, Kaniraj S.K.	1988
2	Pile Foundation Analysis and Design, Poulos, H.G., and Davis, E.H., John Wiley	1980
3	Foundation Analysis and Design, Joseph E. Bowles	1996