Master of Technology

In

Civil Engineering (Transportation)

Course Structure & Syllabus

Civil Engineering Department

National Institute of Technology Hamirpur

Hamirpur (HP) – 177005, India

Course Structure of M. Tech. Civil Engineering (Transportation)

SEMESTER-I

Sr. No.	Course No.	Course Name	Teaching Schedule			Hours/ week	Credit
			L	T	P		
1	CE-671	Application of Probability and Statistics in Transportation Engineering	4	0	0	4	4
2	CE-672	Traffic Engineering	4	0	0	4	4
3	CE-673	Pavement Materials and Design	4	0	0	4	4
4	CE-7MN	Programme Elective-I	4	0	0	4	4
5	CE-7MN	Programme Elective-II	4	0	0	4	4
6	CE-674	Computational Tools for Transportation Engineering	0	0	4	4	2
	Total		**20**	**0**	**4**	**24**	**22**

Programme Elective-I & II: List of Programme Electives is given in the Annexure.

SEMESTER-II

Sr. No.	Course No.	Course Name	Teaching Schedule			Hours/ week	Credit
			L	T	P		
1	CE-681	Highway Construction and Maintenance	4	0	0	4	4
2	CE-682	Urban Transportation System Planning	4	0	0	4	4
3	CE-683	Geometric Design of Transport Facilities	4	0	0	4	4
4	CE-7MN	Programme Elective-III	4	0	0	4	4
5	CE-7MN	Programme Elective-IV	4	0	0	4	4
6	CE-684	Pavement and Traffic Engineering Lab	0	0	4	4	2
	Total		**20**	**0**	**4**	**24**	**22**

Programme Elective –III & IV: List of Programme Electives is given in the Annexure.

SEMESTER-III

Sr. No.	Course No.	Course Name	Hours/week	Credit
1	CE-800	M.Tech. Dissertation	--	20
	Total			**20**

SEMESTER-IV

Sr. No.	Course No.	Course Name	Hours/week	Credit
1	CE-800	M.Tech. Dissertation	--	20
	Total		**--**	**20**

Total Credit of the Programme = 84

Annexure
List of Programme Electives

Programme Elective-I

CE-771	Planning and construction of rural roads
CE-772	Design of Highway and Railway Bridges
CE-713	Computation Techniques in Civil Engineering
CE-714	Earth Dams
CE-715	Environmental Impact Assessment

Programme Elective-II

CE-776	Design of Airports and Waterways
CE-777	Geotechnical Investigations
CE-718	GIS and Its Application In Civil Engineering
CE-719	Disputes and Arbitration in Engineering Projects

Programme Elective-III

CE-781	Planning and scheduling of linear projects
CE-782	Road Safety Evaluation
CE-723	Disaster Management
CE-724	Finite Element Method

Programme Elective-IV

CE-785	Public Transportation
CE-786	Transportation Environment Interaction
CE-727	Optimization Methods
CE-728	Project Planning and Scheduling

Course Name: **Application of Probability and Statistics in Transportation Engineering**
Course Code: **CE-671**
Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To develop the skills of applying probability and statistics in solving the Transportation Engg. related problem

Course Content

Elements of Probability Theory, Linear and Non-linear Regression, Experimental Data and Model Parameters, Transportation and Assignment problems. Dynamic programming, Queuing theory, Decision theory, Hypothesis Testing and Model Evaluation, Computer Simulation.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Perform linear and non-linear regression

CO2: Perform hypothesis testing

CO3: Apply queuing theory in Traffic Engineering problem

Books and References

1. Urban transportation networks: Equilibrium analysis with mathematical programming methods by Sheffi, Y. New Jersey.
2. Probability, statistics, & decision for Civil Engineers by Benjamin J.R. & Comell G.A., Dover Publications.
3. Probability Concepts in Engineering, Planning and Design by Ang, H.S. and Tang, W.H., Wiley.
4. Introductory Mathematical Statistics by Kreyszig, E., Wiley.

Course Name: **Traffic Engineering**
Course Code: **CE-672**
Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To introduce fundamental knowledge of traffic engineering
- To make the students learn to deal with traffic issues including traffic safety, operation and control.

Course Content

Traffic flow characteristics, Design Hourly volumes and speed Composite distributions, Highway capacity and performance characteristics Travel forecasting principles and techniques; Traffic flow modeling and Simulation; Parking studies, O-D studies and other traffic data collection methods, Gap Acceptance methods. Traffic signs and marking; Miscellaneous Traffic control devices. Road Lighting, Un-signalized and Signalized traffic interaction design, Signal co-ordination.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Identify traffic stream characteristics

CO2: Design a pre-timed signalized intersection, and determine the signal splits

CO3: Assess level of services of roadway facilities

Books and References

1. Transportation Engineering: An Introduction by Khisty, Lall, Pearson.
2. Principles of Traffic Engineering by G.J. Pingnataro, Mc Graw-Hill.
3. Traffic System Analysis for Engineering and Planners by Wohl and Martin., Mc Graw Hill.

Course Name: **Pavement Materials and Design**
Course Code: **CE-673**
Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about pavement materials and design
- To introduce the fundamental concepts of pavement designing
- To enable the students to understand the importance of design features of pavements

Course Content

Pavement materials, Characteristics of aggregates, cement and bitumen, components of a flexible and a rigid pavement, Design approaches, Factors affecting design, Stresses in Flexible Pavements, Various design methods, Westergaard's theory, stresses on rigid pavements due to load and temperature, Various design methods, Dowel Bars and Tie bars. IRC method of flexible and rigid pavement design

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: carry out the design of flexible pavement
CO2: carry out the design of rigid pavements
CO3: understand the factors that affect pavement designing
CO4: understand the important features of pavement designing

Books and References

1. Pavement design and materials. Papagiannakis by A. Thomas, and Eyad A. Masad, John Wiley & Sons.
2. Principles of pavement design by Yoder, Eldon Joseph, and Matthew W. Witczak. ,John Wiley & Sons.
3. Pavement Analysis and Design by Huang, Y. H., TRB Publications, ISBN: 0136552757

Course Name: **Computational Tools for Transportation Engineering**
Course Code: **CE-674**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To make the students learn various software related to Transportation Engineering

List of Experiments

1. To design a road segment using MxRoad
2. To simulate traffic stream using PTV VISSIM
3. To analyze traffic data using SPSS
4. To develop a transport network using ArcGIS

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Use few software to design road segment, to simulate traffic stream, to analyze traffic data and to develop transport network

Course Name: **Highway Construction and Maintenance**
Course Code: **CE-681**
Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about pavement construction and maintenance
- To introduce the fundamental concepts of highway construction
- To enable the students to understand the importance of right construction methodology

Course Content

Bitumen grading system, Stone aggregates, Hot mix asphalt mix design, Bituminous paving mixes and surface treatments, Hot mix asphalt production and construction, Asphalt pavement distresses, Causes and treatments, Maintenance and rehabilitation of asphalt pavements, Recycling of asphalt pavements, Construction and maintenance of rigid pavements, Equipment in highway construction.

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: understand the construction of flexible pavement
CO2: understand the construction of rigid pavement
CO3: understand the factors that affect flexible pavement construction methodology
CO4: understand the factors that affect rigid pavement construction methodology

Books and References

1. Bituminous road construction in India by Prithvi Singh Kandhal, PHI Learning Pvt. Ltd.
2. Highway Engineering by S. K. Khanna, C.E.G Justo, em Chand and Bros, Roorkee.
3. Highway Construction and Maintenance by Avinash Gupta, Random Publications.

Course Name: **Urban Transportation System Planning**
Course Code: **CE-682**
Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about urban transportation planning
- To introduce the fundamental concepts of urban transportation planning
- To enable the students to understand the importance of urban transportation planning

Course Content

Fundamentals of transportation planning. Components of transportation system and their interaction. Land use-transportation interaction, transportation economics, Historical development and current status of techniques used in travel demand forecasting; Economic theory of travel demand forecasting; Trip generation, trip distribution , mode choice, traffic assignment, Transport system models, Transportation impact study, Data Collection, Passenger and freight movement in urban and regional contexts, public transportation, transportation system management (TSM), evaluation of transportation improvement

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: understand the urban transportation system
CO2: understand the urban transportation planning
CO3: understand the factors that affect urban transportation system
CO4: understand the factors that affect urban transportation planning

Books and References

1. Metropolitan transportation planning by Dickey, J.W., McGraw Hill, Inc.
2. Transportation Engineering by C. J. Khisty and B. K. Lall, Pearson Education India.
3. An Introduction to Transportation Engineering and Planning by Morlok,E.R., McGraw Hill, Inc.,
4. Principles of Urban transportation Planning by Kagakusha. Hutchinson, B., McGraw Hill, Inc.
5. Urban public transportation; Systems and technology by Vuchic, V. R., Prentice-Hall, Englewood Cliffs, New Jersey

Course Name: **Geometric Design of Transport Facilities**
Course Code: **CE-683**
Course Type: **Core**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart the knowledge of specifications for different road geometrical elements
- To make the students understand the design principles for intersections and roundabouts
- To make the students understand the design principles for bicycle, pedestrian and parking facilities

Course Content

Classification of roads, Design and control criteria. Design of Road Segment: Specifications for Road width, Shoulder width and Median width, Median opening, Determination of required number of lanes, Design of turning path, super elevation, vertical alignment. Design of Intersection: Types of intersection, Design principles, Design considerations, Priority movement, Capacity Analysis, Design of roundabout, entrance and exit ramps, acceleration and deceleration lanes. Design of Pedestrian and Bicycle Facilities: Pedestrian and cyclist characteristics, Pedestrian crossing, PV2 criteria, design of sidewalk, Design of bicycle facilities, Design of Parking Facilities: Parking dimensions, Design of on-street parking space, Design of off-street parking space

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Design cross-sectional, horizontal and vertical elements of roads

CO2: Design intersection, roundabout, exit & entry ramps

CO3: Design pedestrian, bicycle and parking facilities

Books and References

1. A Policy on Geometric Design of Highways and Streets. AASHTO.
2. Highway Capacity Manual 2010. Transportation Research Board, Washington D.C.
3. Highway Engineering by Rogers, M., Blackwell Publishing.
4. Highway Engineering by Wright, P.H., John Wiley & Sons.
5. Transport Planning and Traffic Engineering by O'Flaherty, C. A., Taylor & Francis Group.
6. IRC 73- 1980: Geometric Design Standards for Rural (Non-urban) Highways. Indian Roads Congress, India.
7. IRC 86-1983: Geometric Design Standards for Urban Roads in Plain. Indian Roads Congress, India.

Course Name: **Pavement and Traffic Engineering Lab**
Course Code: **CE-684**

Contact Hours/Week: **2P** Course Credits: **01**

Course Objectives

- To provide skills for testing pavement materials
- To provide skills for traffic studies on different roadway facilities

List of Experiments

1. California Bearing Ratio test for undisturbed soil sample
2. Marshall stability test
3. Rutting test for asphalt mixture
4. Test of Skid Resistance on pavement surface
5. Test of Pavement Unevenness using bump integrator
6. Traffic volume study on mid-block road segment
7. Traffic speed study on mid-block road segment
8. Parking study
9. Pedestrian volume study on sidewalk
10. Traffic volume study at intersection

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Conduct different tests on road construction materials

CO2: Test skid resistance and unevenness of pavement surface

CO3: Measure traffic flow parameters in the field

Course Name: **Planning and construction of rural roads**
Course Code: CE-771
Course Type: **Programme Elective I**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart the knowledge of different types of rural road and their features
- To make the students learn how to plan a rural network
- To impart the primary knowledge of the materials used in rural road constructions
- To make the students understand the problems faced in maintaining the rural road after construction

Course Content

Classification of Rural Roads, Rural Road Development in India, Reason for low connectivity in Rural Area, Pradhan Mantri Gram Sadak Yojna (PMGSY), Geometrical standards of PMGSY. Planning of Rural Roads: System approach, CRRI model, NATPAC model, Gravity model, Deprivity model, FBRNP model. Materials used in construction: Specifiactions for soil and aggregates, use of waste materials, Mixing of materials, CRRI method, Rothfutch method, Triangular chart method, Fuller's method, Mechanical stabilization, Mehra's method, Chemical stabilization, Design of soil cement-mix, Treatment in water-logged area, Use of geo-textiles. Maintenance of rural roads: Problems and remedies for maintaining rural roads, Special maintenance for hilly roads, Typical failures of rural roads, Causes of pavement failure, Drainage condition.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Plan rural road network using different approaches

CO2: Identify the cause of a pavement failure

CO3: Design drainage facility for rural roads

Books and References

1. Traffic Engineering and Transport Planning by Kadiyali, L. R. Khanna Publishers.
2. Highway Engineering. Khanna by S. K. & Justo, C. E. G., Nem Chand & Bros, Roorkee, India.
3. Institutional considerations in rural roads projects. Cook, Cynthia C., Henri L. Beenhakker, and Richard E. Hartwig, The World Bank.

Course Name: **Design of Highway and Railway Bridges**
Course Code: **CE-772**
Course Type: **Programme Elective I**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about designing of bridges
- To introduce the fundamental concepts pf bridge designing
- To enable the students to understand the importance of design features of bridges

Course Content

Investigation and site selection, hydraulic factors, alignment, traffic aspects, types of bridges; loading standard, IRC specification, impact factor, general design consideration, structural design of highway and railway bridges in masonry, reinforced, pre-stressed concrete and steel; superstructures: slab bridge, beam and slab bridge, plate girder and composite bridges, bearings and expansion joints, bridge foundation: types of foundation, design of well and pile foundation, bridge vibration: traffic loading, seismic and wind effect, construction techniques and maintenance.

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: carry out the design of highway bridges
CO2: carry out the design of railway bridges
CO3: understand the factors that affect bridge designing
CO4: understand the important features of bridge designing

Books and References

1. Essentials of Bridge Engineering by Victor, D.J., Oxford and IBH.
2. Design of Bridges by N. Kridhna Raju, Oxford and IBH.
3. Innovative bridge design handbook: Construction, rehabilitation and maintenance. Pipinato, Alessio, Butterworth-Heinemann.

Course Name: **Computation Techniques in Civil Engineering**
Course Code: **CE-713**
Course Type: **Programme Elective I**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To provide an introduction to the basic principles, techniques, and applications of soft computing.
- To provide the mathematical background for carrying out the optimization associated with neural network learning.
- To impart the skills of using soft computing in research problems.

Course Content

Introduction: Introduction of soft computing, soft computing vs. hard computing, various types of soft computing techniques, Fuzzy Computing, Neural Computing, Genetic Algorithms. GA: Gene, Chromisome, Allele, Schemata Theory, genotype, phenotype, competition and selection – different types, Crossover – different techniques, elitism, mutation – different types, stopping criteria, Flow chart of GA.

Evolutionary Algorithm: Simulated annealing, Evolutionary programming, hill climbing, Fuzzy: Membership function, fuzzyfication, fuzzy operator, interference rules, defuzzyfication, exploration and exploitation, PSO, Ant colony optimization

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Apply soft computing techniques in research problems

Books and References

1. Neuro-Fuzzy and Soft Computing by J.S.R.Jang, C.T.Sun and E.Mizutani, Pearson Education.
2. Artificial Neural Network by Simon O. Haykin, PHI.
3. Project Cost Control in Construction by Pilcher, R.. Brien J.J. CPM in "Construction Management", Mc. Graw Hill.

Course Name: **Earth Dams**
Course Code: **CE-714**
Course Type: **Programme Elective I**

Contact Hours/Week: **4L** Course Credits**: 04**

Course Objectives

- To impart knowledge about different types of dams and their basic design requirements.
- To introduce the analysis and concepts of seepage, stability and failure mechanism of dams.
- To enable the students to design different dam components.

Course Content

Classification of dams, Selection of site, Basic design requirements, Preliminary section, Seepage through dam section and its control, fundamentals of seepage flow, flow nets, Seepage through foundation, seepage control, filters, impervious core, drainage, foundation trench cutoff, upstream impervious blanket, horizontal drainage blanket, relief wells, drainage trenches, cut-off walls, downstream loading berm, Foundation treatment such as treatment of pervious, impervious and rock foundations, core contact treatment, grouting, foundation excavation. Stability analysis: critical slip surfaces, test conditions, strength parameters, pore pressures, stability analysis-method of slices, Bishops method, Morgenstern- price method, Janbu method. Construction of earth dams: construction equipment, procedures for pervious, semi-pervious, impervious and rock fill sections, construction supervision. Failures and damages of earth dams: nature of failures – piping, settlement cracks, slides, earthquake & miscellaneous damages.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1 To know different types of dams, their basic design requirements and loads imposed.
CO2 To learn the analysis of dams.
CO3 To assess the seepage through earth dams and seepage control measures.
CO4 To proportion and design different types of dams.
CO5 To perform stability analysis and foundation treatment in dams.
CO5 To assess the construction aspects and design procedures of different dam components.
CO6 To evaluate the causes and mechanism of failure of earth dams.

Books and References

1. Design of Earth Dams by A.L. Goldin, CRC Press.
2. Earth and Rockfill Dams: Principles for Design and Construction by Christian Kutzner, CRC Press.
3. Geotechnical Engineering of Dams by Robin Fell, Patrick MacGregor, David Stapledon, Graeme Bell, Mark Foster, CRC press.

Course Name: **Environmental Impact Assessment**
Course Code: **CE-715**
Course Type: **Programme Elective I**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To understand the concepts of ecology, sustainable development and EIA.
- To explore current EIA process in India.
- To acquire knowledge about various methods for conducting EIA, Environmental Legislation & Environmental Audit

Course Content

Environmental management- problems and strategies - Review of political, ecological and remedial actions - future strategies - multidisciplinary environmental strategies decision making and concepts of sustainable development. Concept of environmental audit - Life Cycle Analysis (LCA) - Environmental Management System - Introduction to ISO 14000, OSHA and Clean Development Mechanism (CDM) & Carbon credits. Introduction to various major natural disasters - flood, tropical cyclone, droughts, landslides, heat waves, earthquakes, fire hazards, tsunami etc., Factors for disaster - climate change, global rise in sea level, coastal erosion, environmental degradation, large dams, Legislative responsibilities of disaster management. Environmental legislation of Air, Water & Hazardous Waste - Environment Protection Act-1986 - Regulatory standards of CPCB / GPCB / BIS - EIA need and Notification - Environmental clearance. Introduction and Planning: Evolution of Environmental Impact Assessment - concepts of EIA - EIA methodologies screening and scoping - rapid and comprehensive EIA - General framework of EIA - characterization and site assessment - Environmental inventory - Prediction and assessment of impact - Impact assessment methodologies like adhoc method, checklist, overlap, network, model and index method. Decision methods of evaluation of alternatives - development of decision matrix - Public participation in environmental decision making - Objective of public participation -Technique for conflict management and dispute resolution- Verbal communication and Public Hearing in EIA studies - Status of EIA in India - Some typical case studies of EIA industrial and infrastructure projects.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO 1: Understand the importance & concepts of carrying out EIA.

CO 2: Acquire knowledge about current EIA process in India.

CO 3: Acquire knowledge about various methods & data requirements for conducting EIA.

CO 4: Analyze Impact's associated with various components of environment.

CO 5: Plan for mitigation of the impacts & monitor the mitigation measures.

CO 6: Acquire knowledge about Environmental Legislation & Environmental Audit.

Books and References

1. Environmental Impact Assessment by Larry W. Canter, Tata McGraw Hill Co, Singapore.
2. Environmental Impact Analysis by R. K. Jain, L. V. Urban & G. S. Stacey, Van Nostrand Reinhold Company, New York.
3. Environmental Impact Assessment by R. E. Munn, John Wiley & Sons, Toronto.
4. Environmental Engineering and Management by Suresh K. Dhameja, S. K. Kataria & Sons, Delhi.
5. Relevant MoEF Notifications and CPCB / GPCB Acts & Rules.

Course Name: **Design of Airports and Waterways**
Course Code: **CE-776**
Course Type: **Programme Elective II**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about designing of airports and waterways
- To introduce the fundamental concepts pf airport and waterway designing
- To enable the students to understand the importance of design features of airports and waterways

Course Content

Air Transport-structure and organization, the challenges and the issues, Forecasting air travel demand trend forecasts and analytical methods; Air freight demand, Characteristics of the aircraft as they affect airport; Airport planning-requirements: site selection, layout plan and financial plan; Air traffic control lighting and signing; Airport capacity and configuration; Geometric design of runway, taxiway and aprons; passenger terminal functions, passenger and baggage flow, design concepts, analysis of flow through terminals, parking configurations and apron facilities; Air cargo facilities-flow through cargo terminals, unitized systems; Airport drainage and pavement design; Airport access problem; Environmental impact of airports.

Syncrolift equipment in ports (General definition consideration and aspects in planning and design of ports and terminals) physical planning, location and orientation of major port components, access channels, basins, breakwaters, wharfs, quays piers, jetties, fendors, simulation modeling, analytical solutions, cargo handling systems, economic feasibility and evaluation.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: carry out the design of airports
CO2: carry out the design of waterways
CO3: understand the factors that affect airport and waterways designing
CO4: understand the important features of airport and waterways designing

Books and References

1. Planning, Designing of Port and Marine Terminals by Aegerschou, Lundgren et. al., John Wiley and Sons.
2. Port Engineering and Operations: Proc. Conference of British Ports, New Castle upon Tynes, Thomas Telford, London.
3. Hennes and Eske, Fundamentals of Transportation Engineering, McGraw-Hill Book Co.

Course Name: **Geotechnical Investigations**
Course Code: **CE-777**
Course Type: **Programme Elective II**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about geotechnical properties of site soil
- To introduce the fundamental concepts pf geotechnical investigations
- To enable the students to understand the effect of geotechnical properties on pavement performance

Course Content

Introduction – Methods of Geotechnical Investigations Boring and Ground Water Observation Sampling Techniques for Geotechnical Investigation Various Tests – Penetration Tests: SPT, Direct Cone Penetration Test (DCPT), Shear Cone Penetration Test (SCPT), Load Tests, In-situ Shear Tests, Dynamic Tests, In-situ Permeability Tests, Odometer tests, Shear Box Tests, Triaxial Tests Critical evaluation of India Standard Codes on site investigations and in-situ testing Planning of Investigations and testing program for different types of infrastructural projects. Case histories of failure Testing and design techniques for geotechnical investigations of rural infrastructure projects.

Course Outcomes

Upon successful completion of the course, the students will be able to
CO1: carry out various geotechnical experiments
CO2: understand the fundamental concepts pf geotechnical properties
CO3: understand the factors that affect geotechnical properties
CO4: understand why geotechnical investigations are important for pavement performance

Books and References

1. Penetration testing – Institution of Civil Engineers by Thomas, Tolford, London.
2. Alam Singh, Soil Engineering in Theory and Practice, Geotechnical Testing and Instrumentations, Asia Publishing House (P) Ltd., New Delhi.
3. Principles of Geotechnical Engineering by Braja M. Das, Thomson.

Course Name : **GIS and its application in civil engineering**
Course Code : **CE-718**
Course Type : **Programme elective II**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- Understanding the need of CAD and GIS,
- Understanding map projection and working with coordinate systems,
- Understanding vector-based and raster-based data data analysis,
- Review of application areas of GIS in Civil Engineering, and
- Understanding basic principles of remote sensing.

Course Content

Basics of remote sensing: Introduction to Remote Sensing, data acquisition and processing, Electromagnetic Radiation (EMR) and its characteristics, Radiation principles, prosperities of solar radiant energy, atmospheric windows. Interaction in the atmosphere, nature of atmospheric interaction, atmospheric effects of visible, near infra-red thermal and microwave wavelengths, interaction at ground surface, interaction with soils and rocks, effects of soil moisture, organic matter, particles, size and texture, interaction with vegetation, spectral characteristics of individual leaf, vegetation canopies, effect of leaf pigments, radiation geometry.

Introduction with GIS: Def. of GIS, Difference between GIS and CAD worlds, utility of GIS, various GIS packages and their salient features, essential components of a GIS, scanners and digitizers.

Map projection and coordinate systems: Introduction, geographic Grid, Map projection, Coordinate systems.

Vector data models and Analysis: vector data and its representation, topological data structure, non-topological vector data structure, TIN, Region, vector data editing and analysis.

Raster data models and Analysis: acquiring and handling of raster data storage, function of raster based GIS data analysis.

Engineering applications of GIS: applications of GIS in civil engineering.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the principles of remote sensing,
CO2: Understand the principles of geographic information systems,
CO3: Apply remote sensing and GIS to solving problems of Civil Engineering,
CO4: Maximize the efficiency of planning and spatial decision making, and
CO5: Integrate geographically referenced data and develop queries to generate usable information.

Books and References

1. Remote Sensing and Image Interpretation by T.M. Lillensand and R.W. Keifer, Wiley Publisher.
2. Principles of Remote Sensing by P.J. Curren, Longman Scientific & Technical - Technology & Engineering.
3. Concept and Techniques of Geographical Information systems by C.P. Lo and Albert K.W.Yeung, Pearson Prentice Hall.
4. Introduction to Geographical Information systems by Kang-tsung Chang, McGraw-Hill.
5. Geographical Information systems- A Management Perspective by Stan Aromoff, WDL Publications.

Course Name: **Disputes and Arbitration in Engineering Projects**
Course Code: **CE-719**
Course Type: **Programme Elective II**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about avoidance of disputes and conflicts and wastage of time and Resources
- To enable students to be involved in the process of Conflict avoidance, management and Dispute resolution in construction projects.
- To understand range of dispute resolution techniques including Adjudication and Arbitration proceedings.
- To enable the student to understand conflict management and dispute resolution procedures including negotiation, mediation and conciliation, adjudication, arbitration and litigation.

Course Content

Project cost estimation, rate analysis, overhead charges, bidding models and bidding strategies. Owner's and contractor's estimate.
Pre-qualification of bidders and enlistment of contractors.
Tendering and contractual procedures, Indian Contract Act 1872, Definition of Contract and its applicability, Types of contracts, International contracts, FIDIC, Conditions and specifications of contract.
Contract administration, Duties and responsibilities of parties Claims, compensation and disputes, Dispute resolution techniques, Arbitration and Conciliation Act 1996, Arbitration case studies, Negotiation

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the underlying causes of most conflicts and disputes and demonstrate knowledge and understanding the techniques used to avoid Conflicts and manage them.
CO2: Apply the basic principles of Dispute Resolution expeditiously.
CO3: Be involved in range of dispute resolution techniques including Adjudication and Arbitration proceedings.
CO4: Display knowledge about conflict management and dispute resolution procedures including negotiation, mediation and conciliation, adjudication, arbitration and litigation.

Books and References

1. A Guide to Quantity Surveyors, Engineers Architects and Builders(Vol I: Taking off quantities, Abstracting & Billing; Vol II: Analysis of Prices) by Kharb, K.S. Sushila Publications.
2. Construction Contracts by Keith Collier, Reston Publishing Company, Inc, Reston,Verginia.
3. Building and Engineering Contracts by Patil, B.S., Mrs. S.B. Patil, Pune.
4. Construction Contracts - Law and Management by John Murdoch & Will Hughes, Spon Press, Taylor & Francis Group.
5. Law relating to Building and Engineering Contracts in India by Gajerai, G.T., Butterworths.
6. Govt of India, Central Public Works Department, "CPWD Works Manual 2003."
7. Govt of India, Central Public Works Department, "Analysis of Rates for Delhi (Vol 1 & 2)." and "Delhi Schedule of Rates."
8. Govt of India, Central Public Works Department, "CPWD 7/8: General Conditions of Contracts."
9. Govt of India, Military Engineer Services, "IAFW 2249: General Conditions of Contracts.

Course Name: **Planning and scheduling of linear projects**
Course Code: **CE-781**
Course Type: **Programme Elective III**

Contact Hours/Week**: 4L** Course Credits: **04**

Course Objectives

- To impart knowledge about planning and scheduling of linear projects like highway construction
- To introduce the fundamental concepts pf planning linear projects
- To enable the students to understand the factors that differentiate linear projects from others because of which their planning has to be different

Course Content

Development of activity-based planning and scheduling systems: Activity-based methods, CPM model, PERT model, float and criticality

Development of location-based planning and scheduling systems: Line of balance scheduling, flowline method, repetitive scheduling method

Location-based planning theory: Location breakdown structure, location-based quantities, computation of task durations, resource leveling, splitting

Location-based management system: components of LBMS, location-based reporting, location-based quality management, location-based financial control

Planning and control of linear projects: Mass haul optimization, planning linear projects, monitoring linear projects, visualization.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: plan and schedule linear projects like highway construction

CO2: understand the fundamental concepts pf planning linear projects

CO3: understand the factors that differentiate linear projects from others

CO4: understand why planning of linear projects has to be different from other building construction projects

Books and References

1 Location-based Management for Construction by Russell Kenley and Olli Seppanen, Spon press, NY.

2 Construction Project Management, Planning scheduling and controlling by Chitkara, K.K. Tata McGraw-Hill Education.

3 Project Management with CPM and PERT and precedence diagramming by Moder J.J. Philips, C.R. and Davis, E.W. New York.

4 Project Management with CPM and PERT, and precedence diagramming by Moder J.J. Philips, C.R. and Davis, E.W. , Blitz Publishing Company.

Course Name: **Road Safety Evaluation**
Course Code: **CE-782**
Course Type: **Programme Elective III**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To enable the students to learn how to evaluate the traffic safety at a particular site
- To make the students understand the pedestrian-crossing behavior
- To make the students aware of different safety aspects of public transportation
- To make the students aware of different accident prevention strategies

Course Content

Safety Indicators: Safety audit, Accident reporting, Crash data collection, Black spot analysis, Crash Statistics, Crash rate, Mortality rate, Factors influencing the mortality rate, Critical factors, Risk indicators, Models of accident frequency and severity, Interpretation of collision and condition diagrams.

Pedestrian crossing behaviour: Vehicle-pedestrian interaction, Measurement of gap and lag, critical gap, gap acceptance behaviour, surrogate measures of safety. Urban Safety and Mobility: Features of safe urban roads, Infrastructure for pedestrians and non-motorized vehicles, Features of safe signalized/unsignalized intersection and roundabout. Safety aspects of Public Transport: Importance of public transport accessibility, Disabled person accessibility, Safety aspects of e-rickshaw. Accident Prevention: Strategies of accident preventions, Traffic Calming, Traffic calming measures, Benefits of traffic calming, Accident prevention measured for intersection, Injury control, Post-injury management.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Identify the critical locations by black spot analysis

CO2: Model accident frequency and severity over varying time and space

CO3: Evaluate pedestrian safety while crossing

Books and References

1. Transport Planning & Traffic Safety by Tiwari, G. and Mohan, D., CRC Press.
2. Traffic Safety and Human Behaviour by Shiner, D., Emerald Publishing.

Course Name: **Disaster Management**
Course Code: **CE-723**
Course Type: **Programme Elective III**

Contact Hours/Week: **3L+1T** Course Credits: **04**

Course Objectives

- To impart knowledge about the disaster Management
- To introduce the fundamental concepts relevant to various aspect of disaster
- To enable the students to understand the factors that causes the disaster.
- To be able to assess risk and vulnerability for natural and man made hazard

Course Content

Introduction to Natural & Man-made Disasters : Understanding Disasters, Geological and Mountain Area Disasters, Wind and Water Related Natural Disaster, Man Made Disasters

Technologies for Disaster Management Role of IT in Disaster Preparedness, Remote Sensing, GIS and GPS, Use and Application of Emerging Technologies, Application of Modern Technologies for the Emergency communication, Application and use of ICST for different disasters.

Rehabilation, Reconstruction and Recovery: Introduction and basic concept

Disaster Response And Management: Introduction to Response Essential Components, Stakeholders Co-ordination in Disaster Response, Human Behaviour and Response Management and Relief Measures

Behaviour and Response Management and Relief Measures

Disaster Mitigation : meaning and concept, Disaster Mitigation Strategies, Emerging Trends in Disaster Mitigation, Mitigation management, Role of Team and Coordination

Course Outcomes

After learning the course the students should be able to:

CO1: Understand disasters, disaster preparedness, role of IT, remote sensing, GIS and GPS,

CO2: Understand Rehabilitation, Reconstruction And Recovery,

CO3: Apply knowledge Disaster Response And Management, Risk Assessment and Vulnerability Analysis,

CO4: Understand Disaster Mitigation.

Books and References

1. Natural Hazards by Bryant Edwards, Cambridge University Press, U.K.
2. Disaster Management by Carter, W. Nick, Asian Development Bank, Manila.
3. Disaster Mitigation Experiences and Reflections by Sahni, Pardeep et.al., Prentice Hall of India, New Delhi.
4. Space Technology for Disaster management: A Remote Sensing & GIS Perspective by Roy, P.S., IIRS (NRSA) Dehradun.
5. Natural Disaster by Sharma, R.K. & Sharma, G., APH Publishing Corporation, New Delhi.
6. Disaster Management in the Hills by Singh Satendra, Concept Publishing Company, New Delhi.

Course Name: **Finite Element Method**
Course Code: **CE-724**
Course Type: **Programme Elective III**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To learn basic principles of finite element analysis procedure.
- To To learn the theory and characteristics of finite elements that represent engineering structures
- Learn to model complex geometry problems and solution techniques
- To learn and apply finite element solutions to Structural Engineering problem

Course Content

Approximate methods of Analysis, Introduction, Steps in finite element, Different approaches in FEM- Direct, Variational, Energy, Weighted residual,1-D FE Analysis- bar element, truss element, Beam element and Frame element, 2-D FE Analysis-CST element for plane stress and plane strain, Axis symmetry case,4-node rectangular element, langrangian interpolation function, 3-D FE Analysis- brick element, Assembling, iso-parametric formulations, Use of Symmetric and anti-symmetric condition.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understand the concepts various approaches in FEM.
CO2: Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements, and 3-D element
CO3: Apply FEM in different fields like, seepage proble, heat transfer etc.
CO4: Develop element level equation and generate global stiffness equation for the engineering problem

Books and References

1. Finite Element Analysis: Theory and Programming by C.S. Krishnamoorty, Tata McGraw-Hill Education
2. Introduction to Finite Elements in Engineering by T. R. Chandrupatla, A. D. Belegundu, Pearson Education Limited
3. Fundamentals Of Finite Element Analysis by D. V.Hutton, Tata McGraw-Hill Education
4. Finite element methods, Vol I & Vol II by O.C. Zienkiewicz and R.L. Taylor, McGraw Hill.
5. Finite element procedures by K. J. Bathe, PHI Ltd.
6. Concepts and applications of finite element analysis by R.D. Cook, D.S. Malkus and M.E. Plesha, Third edition, John Wiley and Sons.

Course Name: **Public Transportation**
Course Code: **CE-785**
Course Type: **Programme Elective IV**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart the knowledge of different modes of public transportations and their services
- To make the students learn how the cost of public transportation functions
- To make the students understand different aspects of planning and operation of public transportations

Course Content

Modes of public transportation and application of each to urban travel needs; comparison of transit modes and selection of technology for transit service; transit planning, estimating demand in transit planning studies, demand modeling, development of generalized cost, RP & SP data and analysis techniques; functional design and costing of transit routes, models for planning of transit routes, scheduling; management and operations of transit systems; integrated public transport planning; operational, institutional, and physical integration; models for integrated planning; case studies.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Model the travel demand of different modes of public transportation

CO2: Estimate the cost of transit routes

CO3: Fix the schedule and the operational frequency for public transportation

Books and References

1. Urban Transit: Operations, Planning and Economics by Vuchic Vukan R., Prentice Hall.
2. Public Transportation by Gray G. E., and Hoel L. A., Prentice Hall.
3. Accessibility and the Bus System – Concepts and Practice by Tyler N., Thomas Telford.
4. Urban Transport for Growing Cities – High Capacity Bus System by Tiwari G., MacMillan India Ltd.

Course Name: **Transportation Environment Interaction**
Course Code: **CE-786**
Course Type: **Programme Elective IV**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart the knowledge of how transportation facilities affecting the environment
- To make the students understand the noise sources and its mitigation for urban and non-urban transportation
- To make the students understand different vehicle emission parameters, pollution standards and its mitigation strategies

Course Content

Transportation Safety: Pre-crash, Crash and Post-crash models; Roles of vehicle, roadway, traffic, driver and environment; Crash and injury causations Modes of Transportation, Mixed Traffic Flow, Transport Related Pollution, Technology Vision-2020, Urban and Non-urban Traffic Noise, Noise Sources, Noise Level Factors, Effects of Traffic Noise, Noise Standards. Measurement and Prediction, Control Measures, Noise Studies, Road Transport related air pollution, Sources of air pollution, effects of weather conditions, Vehicular emission parameters, Pollution standards, measurement and analysis of vehicular emission, Mitigative measures, EIA requirements of Highway Projects, procedures, Ministry of Environment and Forests (MOEF)/World Bank/IRC/UK Guidelines, EIA Practices in India.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Map traffic noises

CO2: Model vehicle emission for given conditions

CO3: Design transportation facility ensuring less environmental impact as per standard guidelines

Books and References

1. Road Traffic Noise by Alexandra, A., Lamure, C. and Langdon, F.J., Applied Science Publishers Limited, London.
2. Highway Traffic Analysis and Design by Salter, R.J., Macmillan Press Limited, London.
3. Noise Control Management, Analysis and Control of Sound and Vibration by Wilson, C.E., Harper and Row Publishers, New York.
4. Environmental Factors in Urban Planning by Grand Jean, E., and Gilgen, A., Taylor and Francis Limited, London.

Course Name: **Optimization Methods**
Course Code: **CE-727**
Course Type: **Programme Elective IV**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- To impart knowledge about the optimization
- To impart knowledge about the multi-objective nature of Engineering Design
- To Apply optimization methods to solve the Engineering Design Problems

Course Content

Basics of engineering analysis and design, Need for optimal design, formulation of optimization problem, classical-simplex search, gradient search, Newton Raphson and global Optimization techniques-Introduction to GA, Constrained and Unconstrained optimization problems, Convex optimization, Sensitivity analysis, Numerical methods for nonlinear optimization problems.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Understanding the basic concepts of classical optimization
CO2: Analysis of optimization algorithms
CO3: Applications of optimization in Civil Engineering

Books and References

1. Optimization for engineering design: Algorithms and examples by K. Deb, PHI Pvt Ltd.
2. Introduction to optimum design by J.S. Arora, McGraw Hill International editions.
3. Elements of structural optimization by R.T. Hafta and Z. Gurdal, Kluwer academic publishers.
4. Engineering Optimization theory and Practice by S. S. Rao, New Age International.

Course Name : **Project Planning and Scheduling**
Course Code : **CE-728**
Course Type : **Programme elective IV**

Contact Hours/Week: **4L** Course Credits: **04**

Course Objectives

- Understanding the need of project planning,
- Understanding concept of bar-chart,
- Understanding planning and scheduling using critical path method,
- Understanding planning and scheduling using PERT and PDM, and
- Understanding scheduling of repetitive construction.

Course Content

Construction Planning: Objectives and functions, stages in construction, work breakdown structure, pre-tender stage planning, contract stage planning, methods of scheduling, bar charts, limitations of bar charts, milestone charts, preparation of material, equipment, labour, and finance schedule.

Critical Path Method (CPM): Network techniques, element of a network, rules for developing networks, development logics, numbering events, time computations, activity floats, network updating. Resources profile, resources smoothing and resources leveling. Cost versus time, direct cost, indirect cost, total project cost, optimum duration, contracting network for cost optimization.

Programme Evaluation and Review Technique (PERT): Probability concept in network, optimistic time, pessimistic time, most likely time, variance, standard deviation, slack, central limit theorem, probability of achieving completion time.

Precedence Diagram Method (PDM): Precedence networks fundamentals, advantages, logic and precedence networks applications, PDM versus CPM.

Line of Balancing (LOB) technique in the construction scheduling: Line of balance methods of scheduling repetitive construction.

Course Outcomes

Upon successful completion of the course, the students will be able to

CO1: Plan and schedule by bar-chart,
CO2: Understand the principles of critical path method,
CO3: Apply PERT and PDM to solving problems of Civil Engineering planning, and
CO4: Apply LOB to solving problems of repetitive construction planning

Books and References

1. Construction Project Management, Planning scheduling and controlling, Chitkara, K.K, Tata McGraw-Hill Education.
2. Project Management with CPM and PERT, and precedence diagramming by Moder J.J. Philips, C.R. and Davis, E.W.
3. Project Cost Control in Construction by Pilcher, R., Brien J.J. CPM in "Construction Management", Mc. Graw Hill.