M.TECH PROGRAMME IN TRANSPORTATION ENGINEERING

Cluster	**:**	*08*
Branch	**:**	*Civil Engineering*
Stream	**:**	*Transportation Engineering*
Year	**:**	*2017*
No. of Credits	**:**	*67*

Allotment of credits and examination scheme

SEMESTER I

Examination slot	Course Number	Name	L-T-P	Internal marks	End semester exam		Credits
					Marks	Duration (Hrs)	
A	08MA6201	APPLIED STATISTICS AND PROBABILITY	3-1-0	40	60	3	3
B	08CE6201	FUNDAMENTALS OF TRAFFIC ENGINEERING	3-0-0	40	60	3	3
C	08CE6203	PAVEMENT ANALYSIS AND DESIGN	3-0-0	40	60	3	4
D	08CE6205	URBAN TRANSPORTATION PLANNING	3-1-0	40	60	3	3
E	08CE62XX	ELECTIVE I	3-0-0	40	60	3	3
	08GN6001	RESEARCH METHODOLOGY	0-2-0	100	0	0	2
	08CE6291	SEMINAR -I	0-0-2	100	0	0	2
	08CE6293	PAVEMENT ENGINEERING LAB	0-0-2	100	0	0	2
		TOTAL	23	500	300	15	22

Total Contact Hours: 23

Total Credits: 22

ELECTIVE I

1.08 CE6211 AIRPORT INFRASTRUCTURE PLANNING AND DESIGN

2. 08 CE6213 MASS TRANSPORT PLANNING

3. 08 CE6215 ROAD SAFETY ENGINEERING

4. 08 CE6217 GROUND EXPLORATION TECHNIQUES

5. 08 CE6219 ENVIRONMENT IMPACT ASSESSMENT OF TRANSPORTATION PROJECTS

SEMESTER II

Examination slot	Course Number	Name	L-T-P	Internal marks	End semester exam		Credits
					Marks	Duration (Hrs)	
A	08CE6202	REGIONAL TRANSPORTATION PLANNING	3-1-0	40	60	3	3
B	08CE6204	PAVEMENT CONSTRUCTION, EVALUATION AND MAINTENANCE	3-0-0	40	60	3	3
C	08CE6206	ADVANCED TRAFFIC ENGINEERING	3-0-0	40	60	3	3
D	08CE62XX	ELECTIVE II	3-0-0	40	60	3	3
E	08CE62YY	ELECTIVE III	3-0-0	40	60	3	3
	08CE6292	MINI PROJECT	0-0-4	100			2
	08CE6294	TRANSPORTATION ENGINEERING LAB	0-0-2	100			2
		TOTAL	22	400	300	15	19

Total Contact Hours: 22

Total Credits: 19

ELECTIVE II

1. 08CE6212 GEOSYNTHETICS FOR HIGHWAY DESIGN
2. 08CE6214 GIS AND ITS APPLICATIONS IN TRANSPORTATION ENGINEERING
3. *08CE6216 OPERATIONS RESEARCH
4. 08CE6218 TUNNEL ENGINEERING
5. 08CE6220 PLANNING AND DESIGN OF FREIGHT TRANSPORTATION

ELECTIVE III

1. 08CE6222 ADVANCED SOIL MECHANICS
2. 08CE6224 INTELLIGENT TRANSPORTATION SYSTEM
3. *08CE6226 PROJECT MANAGEMENT
4. 08CE6228 ADVANCED TRAVEL DEMAND MODELING
5. 08CE6230 PLANNING AND DESIGN OF NON-MOTORISED TRANSPORTATION

SEMESTER III

Examination slot	Course Number	Name	L-T-P	Internal marks	End semester exam		Credits
					Marks	Duration (Hrs)	
A	08CE72XX	ELECTIVE IV	3-0-0	40	60	3	3
B	08CE72YY	ELECTIVE V	3-0-0	40	60	3	3
	08CE7291	SEMINAR II	0-0-2	100	0	0	2
	08CE7293	PROJECT (PHASE 1)	0-0-12	50	0	0	0
		TOTAL	20	230	120	6	8

Total Contact Hours: 20

Total Credits: 8

ELECTIVE IV

1. 08CE7201 HIGHWAY GEOMETRIC DESIGN
2. 08CE7203 PAVEMENT EVALUATION AND MANAGEMENT
3. *08CE7205 SOFT COMPUTING TOOLS
4. 08CE7207 WATERWAYS INFRASTRUCTURE PLANNING AND DESIGN
5. 08CE7209 LAND USE TRANSPORTATION PLANNING

ELECTIVE V

1. 08CE7211 SUSTAINABLE TRANSPORTATION
2. 08CE7213 TRANSPORTATION ECONOMICS
3. 08CE7215 TRANSPORTATION SYSTEM MANAGEMENT
4. 08CE7217 RAILWAY INFRASTRUCTURE PLANNING AND DESIGN
5. 08CE7219 LOW VOLUME ROADS

SEMESTER IV

Examination slot	Course Number	Name	L-T-P	Internal marks	End semester exam		Credits
NA	08CE7294	PROJECT (PHASE 2)	0-0-21	70	30	NA	18
		TOTAL	21				18

Total Contact Hours: 21

Total Credits: 18

Total Credits of the Programme: 67

SEMESTER I

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08MA6201	**APPLIED STATISTICS AND PROBABILITY**	3-1-0 (3)	

Course Objectives

To give the Student:-

1. Knowledge regarding the fundamental concepts, theories of Probability distributions.
2. Idea to evaluate a data sequence using the principles of time series analysis.
3. Ability to develop regression models for the statistical data
4. Ability to conduct statistical test for checking various hypothesis and derive conclusions.

Syllabus

Probability distributions-discrete and continuous-standard distributions-fitting of distributions-Sampling techniques-statistical inference-estimation and testing of hypothesis-regression analysis-Analysis of variance - Completely randomized designs -Randomized block designs. Latin Squares, Factorial experiments, Graphical presentation techniques. Time series models-covariance matrix and principal components

Course Outcome

1. Understand and Analyse probability distributions
2. Carry out multivariate data analysis and identify correlations
3. Develop Time Series Models
4. Estimate Parameters using appropriate techniques
5. Test hypothesis using goodness of fit measures
6. Apply the knowledge in conducting statistical analysis and drawing inferences

References

1. George C. Runger Douglas C. Montgomery, Applied Statistics and Probability for Engineers, 6ed, Wiley student edition, 2016
2. Gupta S.C. and Kapoor V.K, Fundamentals of Mathematical Statistics, Sultan Chand and Sons,1978.
3. Benjamin Jack R. and Comell C.Allin, Probability Statistics and Decision for Civil Engineers, Mc-Graw Hill, 1997
4. Richard A. Johnson, Miller and Freunds, Probablity and Statistics for Engineers, Prentice Hall of India, 2007
5. Dallas E Johnson, Applied multivariate methods for data analysis, Thomson & Duxbburg Press, Singapore, 2002
6. Jay L. Devore, Probability and statistics for Engineering and Sciences, Thomson and Duxbburg Press, Singapore, 2002
7. Richard A Johnson and Dean W. Wichern, Applied multivariate statistical analysis, Pearson Education, 2002
8. Irwin Miller& Marylees Miller: Mathematical Statistics :Pearson Education Inc 2004
9. Kadiyali L R, Traffic Engineering and Trasport Planning, Khanna Publishers

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08MA6201	**APPLIED STATISTICS AND PROBABILITY**	**3-1-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	Probability mass functions and probability density function, distribution functions mean and variance. Binomial, Poisson, Exponential, Gamma, and Normal distribution, Mean and variance-Fitting of distributions (brief overview only)-computing probability using the above distributions.	**7**	**15**
II	Statistical Inference: Sampling distributions- Interval estimation, Confidence interval for mean, variance and regression coefficients., test of significance of (i) Mean (ii) Mean of two samples (iii)Proportions (iv) Variance (v) Two variance (vi) Paired t-test (vii) Chi-square test of goodness of fit (viii) Chi-square test for independence	**7**	**15**
FIRST INTERNAL EXAM			
III	Linear regression and correlation, method of least squares, normal regression analysis, normal correlation analysis, multiple linear regression, multiple correlation co-efficient.	**7**	**15**
IV	Analysis of variance – One way designs, randomized block designs – Introduction to factorial experiments and model development. Graphical presentation techniques.	**7**	**15**
SECOND INTERNAL EXAM			
V	Time Series Models: Components of time series – smoothing – measuring forecasting accuracy – testing of ARIMA models.	**7**	**20**
VI	Multivariate Analysis: Co-variance matrix- correlation matrix-multivariate normal density function, principal components analysis (introductory level)	**7**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6201	**FUNDAMENTALS OF TRAFFIC ENGINEERING**	3-0-0 (4)	

Course Objectives

To give the Student:-

1. Basic concepts of the components of road traffic and its characteristics.
2. Idea to conduct, analyse and interpret various traffic surveys.
3. An understanding of rules and regulations related to road traffic.
4. Ability to design different traffic engineering control systems like signals and traffic islands.

Syllabus

Components and characteristics of Traffic stream: road traffic, vehicle and road user
Traffic stream parameters: Fundamental diagrams of traffic flow, PCU concepts
Traffic surveys-Data collection and analysis of various traffic parameters
Studies on parking, headway, pedestrian, accident and Congestion
Application of probability and statistics in traffic Engineering data analysis
Traffic controls and regulations, Design of intersections- signals, traffic management measures

Course Outcome

1. Ability to understand the various characteristics of elements in traffic engineering.
2. Ability to analyse and interpret the significant parameters in traffic scenario.
3. Awareness to various traffic control devices and how to implement traffic safety

References

1. Brian Wolshon, Anurag Pande, Traffic Engineering Handbook, Institute of Transport Engineers, 7th Edition, Wiley, 2016.
2. Coleman O'Flaherty, Transport Planning and Traffic Engineering, Elsevier, 1997.
3. Fred L. Mannering, Scott S. Washburn, Principles of Highway Engineering and Traffic Analysis, 5th Edn., Wiley 2012.
4. Roess R P, Mc Shane W R & Prassas E S, Traffic Engineering, Prentice Hall, 3rd edition 2004
5. Pignataro L J, Traffic Engineering, Theory and Practice 1983
6. A. D. May, Traffic Flow Fundamentals, Prentice Hall, 1990.
7. Kadiyali, L R., 'Traffic Engineering and Transport Planning', Khanna Publishers, 2011.
8. Matson, Smith and Hurd, 'Traffic Engineering', Mc GrawHill Book Co., 1955.
9. Wells, G R,'Traffic Engineering-An Introduction',Griffin, London 1970.
10. Chakraborthy Partha, Das Animesh,Principles of Transportation Engineering, PHI Learning Pvt.Ltd.,2009
11. R.J. Salter, Highway Traffic Analysis and Design, 2nd Edition, Macmillan, 1989.
12. IRC Publications

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE6201	**FUNDAMENTALS OF TRAFFIC ENGINEERING**	**3-0-0 (4)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Components of Traffic System**: Introduction, Human-vehicle-environment system, Characteristics of road users; Characteristics of vehicles; Characteristics of highways and traffic stream.	**5**	**15**
II	**Traffic Engineering Data Collection**: Sampling in Traffic Studies, Adequacy of Sample Size; Objectives, Methods of Study, Equipment, Data Collection, (a) Speed (b) Speed and Delay (c) Volume (d) Origin and Destination (e) Parking (f) Accident (g) Pedestrian and other Studies.	**6**	**15**
FIRST INTERNAL EXAM			
III	**Traffic Engineering Data Analysis** –Data exploration techniques, fitting of distributions, statistical analysis of traffic stream parameters.	**9**	**15**
IV	**Road safety improvement measures**- Traffic laws and ordinances-General regulations-Regulations on vehicles, drivers, pedestrians and traffic-regulations on speed-speed zoning-parking regulations-enforcement of regulations. Road furniture - street lighting, design and analysis -Road safety audit and safety measures, traffic management measures.	**10**	**15**
SECOND INTERNAL EXAM			
V	**Traffic control engineering** - Traffic Signs and Road Markings-design of at grade intersections-principles and design- channelization- design of rotaries-traffic signals-pre timed and actuated-design of signal settings (Webster and HCM methods)-phase diagrams, timing diagram- signal co ordination- other traffic control aids	**13**	**20**
VI	**Traffic Stream Characteristics** Microscopic and macroscopic flow characteristics; Time headways, temporal, spatial and flow patterns; Interrupted and un-interrupted traffic; Microscopic and macroscopic speed characteristics; Vehicular speed trajectories; Speed characteristics- mathematical distributions; Speed and travel time variations; travel time and delay studies; Introduction to microscopic and macroscopic density characteristics; distance headway characteristics.	**13**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6203	**PAVEMENT ANALYSIS AND DESIGN**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. Idea about various material used in pavement construction and their properties
2. An understanding of load distribution characteristics of flexible and rigid pavements
3. The concept of development of stresses and strains within the pavement system
4. Knowledge about pavement design methods

Syllabus

Pavement materials – Aggregates, bitumen and cement – properties, grading and testing - Introduction to pavements, sub systems- factors affecting pavement design - Failure criteria for design of pavements - Stresses and strains in flexible pavements, Burmister's layer theory

Design of flexible pavements: IRC Method, Asphalt Institute Method, AASHTO Method, Pavement drainage system - Stresses in rigid pavements, Design of rigid pavements: IRC, AASHTO and PCA method

Design of continuously reinforced concrete pavements, (IRC method). Introduction to softwares used for design of pavements.

Course Outcome

1. Select suitable materials required for flexible and rigid pavement construction.
2. Understand the fundamentals of stress distribution within a pavement system
3. Ability to analyse the stresses and design pavements with better performance and longer service life

References

1. Athanassios Nikolaides, Highway Engineering: Pavements, Materials and Control of Quality, CRC press, 2014.
2. Richard Kim Y, Asphalt pavements, CRC press, 2014.
3. Asphalt Institute. Mix Design Methods – For Asphalt Concrete and Other Hot-Mix Types,
4. Manual Series No. 2 (MS-2), Asphalt Institute, Kentucky, USA, 1997.
5. R. N. Hunter, Bituminous Mixtures in Road Construction, Thomas Telford Services Ltd 1995.
6. Atkins, H.N. Highway Materials, Soils, and Concretes, Reston Publishing Company, Virginia, USA, 4th edition, 2002.
7. Bland, D.R. The Theory of Linear Viscoelasticity, Pergamon Press, New York, USA, 1960.
8. Christensen, R.M. Theory of Viscoelasticity – An Introduction, Academic Press, New York, USA, 1971.
9. IRC:44-2008 Guidelines for Cement Concrete Mix Design for Pavements, The Indian Roads Congress, New Delhi, India, 2008.
10. Ministry of Road Transport and Highways. Specifications for Road and Bridge Works, Fifth Edition, Indian Roads Congress, New Delhi, India, 2013.
11. Manual for construction and supervision of Bituminous works, MoRTH 2001.
12. Yang H. Huang, Pavement Analysis and Design, 2nd Ed. Prentice Hall, 2003.
13. Yoder and Witczak, Principles of Pavement Design, John Wiley and sons, 2007.
14. Rajib B. Mallick and Tahar El-Korchi, Pavement Engineering – Principles and Practice, CRC Press, 2013.
15. Latest revisions of IRC codes: IRC: 37-2012and IRC: 58 - 2013.

16. T. Papagiannakis, E. A. Masad, Pavement Design and Materials, John Wiley & Sons 2008.
17. David Croney and Paul Croney, The design and performance of Road Pavements, 3rd edition, McGraw-Hill Publishing Co, 1997.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE6203	**PAVEMENT ANALYSIS AND DESIGN**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Pavement materials:** **Aggregates** - requirements, properties and testing used, aggregate blending to meet specification. **Bitumen** - Types of bituminous binders. Tests on bitumen, physical properties, specifications for paving bitumen. Rheology of bituminous binders. Grading of bitumen. **Bituminous Mixes** - Design of bituminous mixes using Marshall method, and SUPERPAVE method. Types of bituminous mixes (HMA, WMA, SMA, etc.) and applications, Dynamic modulus, flow time, flow number, fatigue of bituminous mixes. **Cement-** grades, chemical composition, properties, admixtures, fibers, properties and testing of pavement quality concrete, high performance concrete	**6**	**15**
II	**Introduction to Pavements**: Types of pavements, Flexible and rigid pavements, Functions of individual layers, Highway and airport pavements **Variables Considered in Pavement Design:** Traffic factors, Material properties, Climatic effects **Traffic Analysis**: ADT, AADT, Truck Factor, Growth Factor, Lane Distribution and Vehicle Damage Factor	**6**	**15**
FIRST INTERNAL EXAM			
III	**Stresses and strains in flexible pavements**: Stress inducing factors in flexible pavements, Vehicle-Pavement interaction, Stresses and deflections in homogeneous soil mass, Load equivalency factor, Burmister's layer theory: Solutions for one, two and three layered pavement systems.	**6**	**15**
IV	**Methods of flexible pavement design**: Principles of Mechanistic- Empirical Pavement Design (MEPD), Methods of flexible pavement design: IRC Method, Asphalt Institute Method, AASHTO Method.	**8**	**15**
SECOND INTERNAL EXAM			
V	**Stresses in Rigid Pavements:** Westergaard's theory and assumptions, Types of stresses: Wheel load stresses,	**8**	**20**

	Temperature stresses, Critical combination of stresses. Rigid pavement design methods: IRC method, AASHTO method and PCA method.		
VI	**Design of reinforcements in cement concrete pavements** Types of joints in cement concrete pavements – functions and requirements Joint spacing – Design of dowel bars and tie bars (IRC method). Introduction to softwares for design of pavements	**8**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6205	**URBAN TRANSPORTATION PLANNING**	3-1-0 (3)	

Course Objectives

To give the Student:-

1. Concepts of the basic principles of transportation planning.
2. Information about latest developments taking place in transportation planning of urban areas and cities.
3. Better analytical skill and logical thinking of students

Syllabus

Urban Transportation Planning Process and concepts – transportation problems and solutions, Systems framework of planning

Methods of travel demand estimation - Sequential, Recursive and Simultaneous Process, zoning

Four stage planning process – Trip generation, trip distribution, mode split and route split

Land use Transportation Modeling

Course Outcome

1. Ability to plan a transportation system for an urban area, if the necessary input are given
2. Improvement in the contemporary knowledge of planning
3. Enhancement in analytical skill as well as problem solving and optimizing ability.

References

1. Khanna.S.K and Justo.C.E.G., Highway Engineering, 9th edition, Nemchand and Bros.2011.
2. Kadiyali, L R., 'Traffic Engineering and Transport Planning', Khanna Publishers, 2011.
3. Hutchinson B.G., Principles of Urban Transportation System Planning, Scripta Book Company, 1974.
4. Khisty C.J., B. Kent Lall, Transportation Engineering - An Introduction, Prentice Hall, 2003.
5. Bruton M.J., Introduction to Transportation Planning, Hutchinson of London.1975.
6. Papacostar, Fundamentals of Transportation Planning, Tata McGraw Hill
7. C. S. Papacostas, Panos D. Prevedouros, Transportation Engineering and Planning, Prentice Hall, 2001.
8. Dicky J.W., Metropolitan Transportation Planning, Tata McGraw Hill, 1980.
9. Mayer M and Miller E, Urban Transportation Planning: A decision oriented Approach, McGraw Hill Primis, 2010.
10. Prabir Kumar Sarkar, Vinay Maitri, G. J. Joshi, Transportation Planning Principles, Practices and Policies, PHI Learning Pvt. Ltd., Delhi, 2015.
11. D. Johnson Victor, S. Ponnuswamy, Urban Transportation: Planning, Operation and Management, Tata Mc Graw Hill, 2012.
12. Steven Avery Smith, Guidebook for Transportation Corridor Studies: A Process for Effective Decision Making, NCHRP Report 435, Transportation Research Board, National Academy Press 1999.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE6205	**URBAN TRANSPORTATION PLANNING**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Urban Transportation Planning Process & Concepts:** Role of Transportation and Changing Concerns of Society in Transportation Planning; Transportation Problems and Problem Domain; Objectives and Constraints; Flow Chart for Transportation Planning Process- Inventory, Model Building, Forecasting and Evaluation Stages, Planning in System Engineering Framework; Concept of Travel Demand and its Modelling based on Consumer Behaviour of Travel Choices- Independent Variables, Travel Attributes.	**8**	**15**
II	**Methods of Travel Demand Estimation**: Assumptions in Demand Estimation- Sequential, Recursive and Simultaneous Process - Introduction to Transportation Planning Practices; Definition of Study Area, Zoning. **Trip Generation Analysis:** Trip Generation Models- Zonal Models, Category analysis, Household Models, Trip Attractions of Work Centres & Commercial Trips.	**8**	**15**
FIRST INTERNAL EXAM			
III	**Trip Distribution Analysis:** Trip End and Trip Interchange Models; Trip Distribution Models - Growth Factor Models - Fratar and Furness models. Gravity Models, Opportunity Models and their calibration; Estimation of Travel Demand based on link volume philosophy.	**6**	**15**
IV	**Mode Split analysis**: Mode Split Analysis- Mode Choice Behaviour, Competing Modes, Mode Split Curves, Probabilistic Models and Two Stage Mode Split Analysis;	**6**	**15**
SECOND INTERNAL EXAM			
V	**Route Split Analysis**- Elements of Transportation Networks, Coding, Minimum Path Tress, Diversion Curves, All-or-Nothing Assignment, Capacity Restrained Assignment, Multipath Assignment	**6**	**20**
VI	**Traffic corridors:** Master plans, Selection of Corridor, Corridor Identification, Corridor deficiency Analysis	**8**	**20**

	Role of GIS in Land Use and Transportation Planning. Introduction to transport planning softwares.		
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08 CE6211	**AIRPORT INFRASTRUCTURE PLANNING AND DESIGN**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. Concept of planning and designing of airport
2. Knowledge of air traffic controlling measures and techniques
3. Engineering knowledge on structural and geometric design of airport

Syllabus

Aircraft characteristics
Air traffic management
Airport planning and forecasting
Airport lighting, markings and signs
Planning and design of terminal area
Structural design of airport pavement

Course Outcome

1. Analyze the effects of atmospheric variables on aircraft performance.
2. Fix the orientation of the runways.
3. Design the geometrics of the airport infrastructure.
4. Prepare structural designs of runway, taxiway, and apron-gate area.
5. Prepare a master plan for an airport.
6. Prepare a plan of the airport terminal area.

References

1. Robert Honjeff and Francis X.Mckelvey, "Planning and Design of Airports", McGraw Hill, New York, 1996
2. Robert Horonjeff, Francis McKelvey, William Sproule, Seth Young, Planning and Design of Airports, Fifth Edition, McGraw Hill Professional, 2010.
3. Richard De Neufille and Amedeo Odoni, "Airport Systems Planning and Design", McGraw Hill, New York, 2003
4. Airport Planning and Systems – http://airportssystems.com/Course/index-html
5. S.K.Khanna and M.G.Arora, "Airport Planning and Design", Nem Chand and Bros, 1999.
6. Norman.J.Ashford, Sakleh.A Mumayiz and Paul.H.Wright, "Airport Engineering Planning Design and Development of 21st Century Airports, 5th Edn. John Wiley and sons, New Jersey, 2011.
7. Subhash C. Saxena, Airport Engineering: Planning & Design, CBS Publishers & Distributors, 2008.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08 CE6211	**AIRPORT INFRASTRUCTURE PLANNING AND DESIGN**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Aircraft Characteristics**: Landing gear configurations, aircraft weight, engine types. Atmospheric conditions affecting aircraft performance: air pressure, temperature, wind speed and direction. Aircraft performance characteristics: speed, payload and range, runway performance, declared distances, wingtip vortices.	**6**	**15**
II	**Air Traffic Management**: Air traffic separation rules: vertical separation, flight altitudes, longitudinal separation, and lateral separation. Navigational aids: ground based systems, satellite based systems. **Airport Planning and Forecasting**: Airport planning studies: airport system plan, airport site selection, airport master plan, airport project plan. Forecasting methods: time series method, market share method, econometric modelling. Forecasting requirements and applications: airport system plan, airport master plan.	**8**	**15**
FIRST INTERNAL EXAM			
III	**Airport Lighting, Marking, and Signage**: Requirements of visual aids, approach lighting system configurations, visual approach slope aids, threshold lighting. Runway lighting, taxiway lighting. Runway and taxiway marking, airfield signage.	**6**	**15**
IV	**Planning and Design of the Terminal Area**: Passenger terminal system and its components. Design considerations: terminal demand parameters, facility classification, level of service criteria. Terminal planning process: overall space requirements, concept development, horizontal distribution concepts, vertical distribution concepts. Apron gate system: number of gates, ramp charts, gate size, aircraft parking type, apron layout, apron circulation, passenger conveyance to aircraft, apron utility requirements.	**6**	**15**
SECOND INTERNAL EXAM			
V	**Geometric Design of the Airfield**: Airport classification: utility airports, transport airports.	**8**	**20**

	Runways: runway configurations, runway orientation, wind rose, estimating runway length, sight distance and longitudinal profile, transverse gradient, airfield separation requirements, obstacle clearance requirements. Taxiways and taxilanes: widths and slopes, taxiway and taxilane separation requirements, sight distance and longitudinal profile, exit taxiway geometry, location of exit taxiways, design of taxiway curves and intersections, end-around taxiways. Aprons: holding aprons, terminal aprons and ramps, terminal apron surface gradients. Control tower visibility requirements.		
VI	**Structural Design of Airport Pavements**: Soil investigation and evaluation: CBR, plate bearing test, Young's modulus, effect of frost on soil strength, subgrade stabilization. FAA pavement design methods: equivalent aircraft method, cumulative damage failure method. **Design of flexible pavements:** CBR method, layered elastic design. Design of rigid pavements: Westergaard's analysis, finite element theory, joints and joint spacing, continuously reinforced concrete pavements. Design of pavement overlays.	**8**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08 CE6213	**MASS TRANSPORTATION PLANNING**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. An understanding of importance of Public Transportation and its planning concept
2. Contemporary knowledge about the components of Transit operations and its pricing
3. Ability to plan transit route network based on the passenger demand

Syllabus

Transit system: Types and characteristics, Estimation of transit demand, Bus route network planning, Scheduling, Mass transit corridor identification & planning, Mass transport management measures, Bus stops and terminal designs.

Course Outcome

1. Ability to estimate transit demand and plan and schedule public transport network
2. Ability to identify and plan transit corridors
3. Ability to propose suitableTransport management measures

References

1. Black, A. Urban Mass Transportation Planning, McGraw-Hill International Enterprises, Inc. 1995.
2. David A. Hensher, Bus Transport: Economics, Policy and Planning. Research in Transportation Economics Volume 18. Elsevier Publications, 2007.
3. G.E. Gray and CA Hoel: Public Transport Planning Operation and Management, Prentice Hall; 2nd Edition, 1992
4. P. Chakroborty and A. Das, Principles of Transportation Engineering, Prentice Hall of India Pvt. Ltd., 2003.
5. Simpson, Barry J., Urban Public Transport Today. Taylor & Francis Routledge Publisher, 2003
6. Susman, J. Introduction to Transportation Systems, Artech House Boston, London, 2000.
7. Tiwari G., Urban Transport for Growing Cities – High Capacity Bus System, MacMillan India Ltd., 2002
8. Tyler N., Accessibility and the Bus System – Concepts and Practice, Thomas Telford, 2002.
9. V.R. Vuchic, Urban Public Transport System and Technology, Prentice Hall Inc
10. Vuchic Vukan R., Urban Transit: Operations, Planning and Economics, Prentice Hall, 2005.
11. White, P., Public Transport: Its Planning, Management and Operation, Fourth Edition, London New York, 2002.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08 CE6213	**MASS TRANSPORTATION PLANNING**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Transit system:** Role of Transit - Types of Transit Modes - Buses - LRT, RTS - Air cushioned and Maglev System – S-Bahn Dual Mode Busses, Para Transit - Dial - a- Ride-Taxi- Jitney and Ridesharing – PRT Networks -DRTS Technological Characteristics – Resistances, acceleration & velocity Profiles – Operational characteristics speed, capacity & payloads – Route capacity – Comfort conditions - Performance relationships - Public and Private Operations - Modes for Intercity Transport.	**6**	**15**
II	**Estimation of transit demand:** Data requirements & Collection techniques, Conventional Methods - Destination Survey - Bus Stop Surveys and Analysis - Mode Split Models - Captive and Choice Riders - Attitudes of Travellers - Patronage Determination.	**8**	**15**
FIRST INTERNAL EXAM			
III	**Bus route network planning:** Route Systems - Route Location, Route Structure, Route Coding Techniques, Route Capacity - Planning of Transit Network - Different Types - Service Area Coverage - Evaluation - Selection of Optimal Network - Path Building Criteria - Integration with UTPS.	**6**	**15**
IV	**Scheduling:** Patterns of Bus Services - Frequency of Services - Special Services - Single Route Bus Scheduling - Fleet Requirement, Marginal Ridership Concept - Use of Optimisation Technique - Load Factor - Depot Location - Spacing of Bus Stops	**6**	**15**
SECOND INTERNAL EXAM			
V	**Mass transit corridor identification & planning:** Corridor identification - Network Compression Method - Planning of Rapid Transit System - System Selection - Supporting and Enclosing Structures - System Evaluation - Track Structures - Power Supply and Distribution - Signal System - Aesthetics and Noise Consideration - Cost of Construction - Station Arrangements - Platform Capacity - Fare Collection, Transit Marketing.	**8**	**20**
VI	**Mass transport management measures:** RTC Act -	**8**	**20**

	ASRTU System Efficiency and Effectiveness Measures - Performance Indicators – LOPTS - Preferential Treatment to HOV: Exclusive Bus Lanes - Bus Streets - Contra Flows - Reversible Lanes - Bus Bypass - Bus Pre-emption Signals for Bus Operations. **Bus stops and terminal designs:** Type Design – Bus stop capacities – Bus Parking patterns at Terminals and Wayside Stations – Integration.		
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08 CE6215	**ROAD SAFETY ENGINEERING**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. The concept of road safety management system
2. knowledge about road safety based design techniques
3. an understanding of methods of road safety audit and crash mitigation measures

Syllabus

Road safety management system
Analysis and interpretation of crash data
Road safety audits
Crash reconstruction
Crash mitigation measures

Course Outcome

1. Analyze the effect of driver characteristics, roadway characteristics, climatic factors on highway safety.
2. Plan and design a road safety improvement program.
3. Analyze accident data and suggest safety measures.
4. Conduct road safety audit.
5. Interpret accident data using statistical analysis.

References

1. Ezra Hauer, Observational Before-After Studies in Road Safety, Pergamon Press, 1997 (reprinted 2002).
2. Institute of Transportation Engineers (ITE), The Traffic Safety Toolbox: A Primer on Traffic Safety, ITE, 1999.
3. J. Stannard Baker, Traffic Collision Investigation, Northwestern University Center for Public Safety, 2002.
4. Leonard Evans, Traffic Safety, Science Serving Society, 2004.
5. Lynn B. Fricke, Traffic Accident Reconstruction, Northwestern University Center for Public Safety, 1990.
6. Ogden, K.W. Safer Roads: A Guide to Road Safety Engineering. Avebury Technical, 1996.
7. Popkess C.A, Traffic Control and Road Accident Prevention, Chapman and Hall, 1997
8. Rune Elvik and Truls Vaa, The Handbook of Road Safety Measures, Elsevier, 2009.
9. Simon Washington, Matthew Karlaftis, and Fred Mannering, Statistical and Econometric Methods for Transportation Data Analysis, Chapman & Hall/CRC Press, 2003.
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11. M. N. Shreehari, K. V. Ramesh, National Conference on Traffic Engineering and Road Safety in India: problems & prospects, Traffic Engineers & Safety Trainers, 2004.
12. Martin Belcher, Steve Proctor, Phil Cook, Practical Road Safety Auditing, I C E Publishing, 2015
13. Becky P. Y. Loo, Tessa Kate Anderson, Spatial Analysis Methods of Road Traffic Collisions, CRC Press, 2015.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08 CE6215	**ROAD SAFETY ENGINEERING**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Introduction to safety:** Road crashes, Trends, causes, Collision and Condition diagrams, Highway safety, human factors, Vehicle factors	**6**	**15**
II	**Road Safety Management System:** Multi-causal dynamic systems approach to safety, crash vs accident, road safety improvement strategies, elements of a road safety plan, Safety Data Needs.	**6**	**15**
FIRST INTERNAL EXAM			
III	**Statistical Interpretation and Analysis of Crash Data:** Before-after methods in crash analysis, Advanced statistical methods, Black Spot Identification & Investigations, Crash data modeling - Case Studies.	**6**	**15**
IV	**Road Safety Audits:** Key elements of a road safety audit, Road Safety Audits & Investigations, Crash investigation and analysis, Describe methods for identifying hazardous road locations, Case Studies. Crash risk assessment programs.	**6**	**15**
SECOND INTERNAL EXAM			
V	**Crash Reconstruction:** Describe the basic information that can be obtained from the roadway surface, Understand basic physics related to crash reconstruction, speed for various skid, friction, drag, and acceleration scenarios, variables involved in jump and flip crashes, variables involved in pedestrian crashes, Case Studies.	**10**	**20**
VI	**Mitigation Measures:** Crash prevention by better planning, and better design of roads, Crash Countermeasures, Highway operation and crash control measures, Highway Safety Measures during construction, Highway geometry and safety, Geometric Design Consistency and Safety.	**8**	**20**

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08 CE6217	**GROUND EXPLORATION TECHNIQUES**	3-0-0 (3)	

Course Objectives

Objectives: To equip students with techniques of exploration, testing and evaluation for soil parameters required for foundation choice and design

Syllabus

Principles of exploration – modern methods of exploration – various field test for soil exploration and its property estimation – sampling techniques – types of samples – methods of evaluation and equipments used in soil engineering – settlement and heave gauges

Course Outcome

1. To Understand The Importance Of Ground Exploration Techniques In Civil Engineering Construction Activities.
2. To Perform Any Modern Ground Improvement Design Including Soil Stabilization
3. Be Able To Plan And Design A Subsurface Exploration Program Based On Aniticpated Geologic Conditions And Potential Construction Problems.
4. Be Able To Log Rock Core And/Or Soil Samples And Prepare Boring Logs For Civil Engineering Projects.

References

1. Lambe, Soil Testing for Engineers, John Wiley, New York, 1951.
2. Goodman R.E., Rock Mechanics, John Wiley, New York, 1988.
3. Terzaghi, K. and Peek R.B., Soil Mechanics in Engineering Practice, 3rd edition, John Wiley, 1996.
4. Murthy V.N.S., Soil Mechanics and Foundation Engineering, CBS, 2009.
5. Coduto, Man-chu Ronald Yeung and William A. Kitch, Geotechnical Engineering Principles and Practices, Pearson Education, 2nd edition, 2010.
6. Joseph E., and Bowls, Foundation Analysis and Design, McGraw Hill, 2001.
7. Tomlinson M J., Foundation Design and Construction, Prentice Hall; 7 edition, 2001.
8. Hausmann, M.R., Engineering Principles of Ground Modification, McGraw – Hill International Editions, 1990.
9. Purushothama Raj, Ground Improvement Techniques, 2nd edition, Laxmi Publications, New Delhi, 2016.
10. Sharma. S. K., Priniciples, Practice and Design of Highway Engineering, S. Chand & Co. New Delhi, 2012.
11. Jones C. J. F. P, Earth Reinforcement and Soil Structures, Butterworths, London 1996.
12. J. Russell Boulding, "Subsurface Characterization And Monitoring Techniques", Diane Publishing, 1996.
13. Braja M. Das, Khaled Sobhan, "Principles of Geotechnical Engineering", SI Edition, 2016.
14. Muni Budhu, Soil Mechanics Fundamentals, Wiley Blackwell.2015.
15. Dante Fratta, Jennifer Aguettant, Lynne Roussel-Smith "Introduction to Soil Mechanics Laboratory Testing, CRC Press, 2017

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08 CE6217	**GROUND EXPLORATION TECHNIQUES**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	Principles of exploration; Modern methods of boring and drilling, exploration Techniques, non-displacement and displacement methods, drilling in difficult subsoil conditions, stabilization of boreholes Geophysical Methods – electrical method, seismic method.	**7**	**15**
II	Exploration Techniques Accessible exploration and Semi-direct methods, Test pits, Trenches, Shafts Bore holes – Drilling methods, equipments and applicable soil types – Auger boring, Wash boring, Rotary drilling, Percussion drilling Stabilization of boreholes	**7**	**15**
FIRST INTERNAL EXAM			
III	Field tests, penetration tests, procedures and methods, data interpretation, field vane shear, In-situ shear and bore hole shear test, pressure meter test, utility, correction and data interpretation, plate load test– monotonic and cyclic; field permeability test.	**7**	**15**
IV	Disturbed and undisturbed soil sampling, advanced sampling techniques, offshore sampling, types of samplers, design criteria for samplers, preservation and handling of samples	**7**	**15**
SECOND INTERNAL EXAM			
V	Methods and equipments – interpretation of offshore exploration, Instrumentation in soil engineering - strain gauges - resistance and inductance type.	**7**	**20**
VI	Load cells, earth pressure cells - settlement and heave gauges - piezometers and slope indicators - inclinometer, case studies, data and report preparation	**7**	**20**
END SEMESTE EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08 CE6219	**ENVIRONMENT IMPACT ASSESSMENT OF TRANSPORTATION PROJECTS**	3-0-0 (3)	

Course Objectives

1. Develop a balanced view of the relationship between environment and development
2. Provide an understanding of the basic principles and technical and social limitations of an EIA
3. Develop the skills to conduct an Environmental Impact Study

Syllabus

Introduction – Scope and definition of EIA -Legislations, laws and acts relevant to environmental protection in India – National Environment Protection Act - EIA methodologies - formation of EIA team – EIA processes –EIA acts - Application of EIA in Transportation - Assessment and prediction of Impacts on Water Environment, Air environment and noise - Socio-economic Impacts - Environmental Risk Analysis- Energy Impact Analysis- EMP for air and noise environments- – Case studies

Course Outcome

1. Students will be able to understand the existing environmental rules and legislations in our country
2. Students will gain basic knowledge and understanding of the role of EIA in environmental management for sustainable develop
3. Students will gain awareness regarding ecologically sustainable development and environmental friendly technologies and also the regulatory provisions for environmental protect

References

1. Canter .L.W., Environmental Impact Assessment, McGraw Hill New York 1996.
2. John. G. Rau and David .C. Wooten, Environmental Impact Analysis Hand Book, McGraw Hill, 1980.
3. Petts.J. Hand Book of environmental Impact Assessment, M Land "Blackwell Science London 1999.
4. Suresh K. Dhameja-Environmental Engineering and Management, S.K. Kataria & Sons, 2010.
5. Davis, M.L., and Cornell, D.A. Introduction to Environmental Engineering, Mc Graw Hill International Editions, 1998
6. United Nations. Economic and Social Commission for Asia and Pacific, Multistage Environmental and Social Impact Assessment of Road Projects Guidelines for comprehensive process, New York, 2001.
7. Organisation for Economic Co-operation and Development, Environmental Impact Assessment of Roads, 1994.
8. Betty Marriott, Environmental Impact Assessment: A Practical Guide, McGraw Hill Professional, 1997.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08 CE6219	**ENVIRONMENT IMPACT ASSESSMENT OF TRANSPORTATION PROJECTS**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Introduction** – Introduction to Environmental Impact Assessment (EIA)- Objectives and Needs- development of EIA - National Environmental Protection Act 1986 – Key features. Rapid EIA – Comprehensive EIA – Strategic EIA- procedure for EIA in India.	**6**	**15**
II	**EIA methodologies** –formulation of EIA team –inter disciplinary approach -Screening – Scoping - checklist, matrix and network methodologies - Identification of Impacts – Collection and documentation of baseline data –Need for Prediction and Mitigation Measures	**6**	**15**
FIRST INTERNAL EXAM			
III	**Application of EIA in Transportation**. Public participation in Environmental decision making - techniques for conflict management and dispute resolution in transportation projects. Role of GIS and RS in environmental impact assessment of transportation projects.	**6**	**15**
IV	**Assessment and prediction of Impacts on Water Environment**: Basic water quality, sources and effects of water pollution, assessment and prediction of impacts, Streeter Phelps equation and its application in EIA studies. Mathematical modelling for prediction of water pollution on account of transportation projects, mitigation measures, legislations.	**8**	**15**
SECOND INTERNAL EXAM			
V	**Assessment and prediction of Impacts on Air Environment**: air quality, sources and effects of air pollution, assessment and prediction of impacts, Gaussian distribution for air pollution for point and line sources, mitigation measures, legislations. **Assessment of Impacts of Noise** – Basic information, sources and effects of noise pollution, control measures, legislations	**8**	**20**
VI	**Socio-economic impacts in EIA studies** - Ecological impacts –Ecological foot-prints– Environmental Indices. Introduction to Environmental Management Systems - Cost Benefit Analysis - Environmental Audit - Life cycle	**8**	**20**

	Assessment – Environmental Risk assessment – Case studies from India		
END SEMESTER EXAM			

COURSE CODE	**COURSE NAME**	**L-T-P (C)**	**2017**
08GN6001	**RESEARCH METHODOLOGY**	0-2-0 (2)	

Course Objectives

To enable the students:

1. To get introduced to research philosophy and processes in general.
2. To formulate the research problem and prepare research plan
3. To apply various numerical /quantitative techniques for data analysis
4. To communicate the research findings effectively

Syllabus

Introduction to Research Methodology-Types of research- Ethical issues- Copy right-royalty-Intellectual property rights and patent law-Copy left- Open access-

Analysis of sample research papers to understand various aspects of research methodology:

Defining and formulating the research problem-Literature review-Development of working hypothesis-Research design and methods- Data Collection and analysis- Technical writing- Project work on a simple research problem

Course Outcome

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

1. Understand research concepts in terms of identifying the research problem
2. Propose possible solutions based on research
3. Write a technical paper based on the findings.
4. Get a good exposure to a domain of interest.
5. Get a good domain and experience to pursue future research activities.
6. Prepare a thesis or a technical paper, avoid fallacious arguments and present or publish them

References

1. C. R. Kothari, Research Methodology, New Age International, 2004
2. Panneerselvam, Research Methodology, Prentice Hall of India, New Delhi, 2012.
3. J. W. Bames, Statistical Analysis for Engineers and Scientists, Tata McGraw-Hill, New York.
4. Donald Cooper and Pamela Schindler , Business Research Methods, 12th edition, Tata McGraw-Hill, New Delhi, 2014.
5. Leedy P. D., Practical Research: Planning and Design, 11th edition, McMillan Publishing Co. 2016.
6. Day R. A. and Barbara Gastel, How to Write and Publish a Scientific Paper, Greenwood Press, 2011.
7. Manna, Chakraborti, Values and Ethics in Business Profession, Prentice Hall of India, New Delhi, 2012.
8. Sople, Managing Intellectual Property: The Strategic Imperative, Prentice Hall ofIndia, New Delhi, 2012.
9. Michael C Labossiere, "42 Fallacies", Create Space Independent Publishing Platform, ISBN :1482753936, 9781482753936, 2013.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08GN6001	**RESEARCH METHODOLOGY**	0-2-0 (2)	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	Introduction to Research Methodology: Motivation towards research - Types of research: Find examples from literature. Professional ethics in research - Ethical issues-ethical committees. Copy right - royalty - Intellectual property rights and patent law – Copy left- Open access -Reproduction of published material - Plagiarism - Citation and acknowledgement. Impact factor. Identifying major conferences and important journals in the concerned area. Collection of at least 4 papers in the area.	**5**	-
II	Defining and formulating the research problem - Literature Survey- Analyze the chosen papers and understand how the authors have undertaken literature review, identified the research gaps, arrived at their objectives, formulated their problem and developed a hypothesis.	**4**	-
FIRST ASSESSMENT			
III	Research design and methods: Analyze the chosen papers to understand formulation of research methods and analytical and experimental methods used. Study of how different it is from previous works. Thesis writing, reporting and presentation: significance of report writing-— principles of thesis writing- different steps in report writing - Interpretation in writing – techniques of interpretation – precautions in interpretation - avoiding logical fallacies - format of reporting - – layout and mechanics of research report - references – tables – figures – conclusions – oral presentation – preparation – making presentation – use of visual aids - effective communication - preparation for and presentation in seminars and conferences	**4**	-
IV	Data Collection and analysis. Analyze the chosen papers and study the methods of data collection used. - Data Processing and Analysis strategies used – Study the tools used for analyzing the data.	**5**	-
SECOND ASSESSMENT			
V	Technical writing - Structure and components, contents	**5**	-

	of a typical technical paper, difference between abstract and conclusion, layout, illustrations and tables, bibliography, referencing and footnotes- use of tools like Latex.		
VI	Identification of a simple research problem – Literature survey- Research design- Methodology –paper writing based on a hypothetical result.	**5**	**-**
END SEMESTER ASSESSMENT			

COURSE CODE	**COURSE NAME**	**L-T-P (C)**	**2017**
08CE6291	**SEMINAR – I**	0-0-2 (2)	

Course Objectives

To enable the students:

1. To Identify the current topics in the specific stream.
2. To Collect the recent publications related to the identified topics.
3. To Do a detailed study of a selected topic based on current journals, published papers and books.
4. To Present a seminar on the selected topic on which a detailed study has been done.
5. To Improve the writing and presentation skills

Approach

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study.

Course Outcome

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

1. Get good exposure in the current topics in the specific stream.
2. Improve the writing and presentation skills.
3. Explore domains of interest so as to pursue the course project.

COURSE CODE	COURSE NAME	L-T-P (C)
08CE6293	**PAVEMENT ENGINEERING LAB**	0-0-2 (1)

Course Objectives

To give the Student:-

1. Knowledge to conduct different test for testing the suitability of various sub-grade soil and aggregates used for pavement construction
2. Ability to test the properties of bitumen and various mix for use under different climatic conditions and type of pavement construction
3. Principles of design a bituminous mix and to assess the strength and flexibility of given mix.

Syllabus

Tests on soil, Tests on aggregates, Tests on cement concrete, Tests on bitumen and bituminous mixes, Pavement evaluation

Course Outcome

1. Knowledge about various properties required for different types of pavement constructions
2. Knowledge about selection of different pavement construction materials based on the properties.

References

1. S.K. Khanna & C.E.G. Justo. Highway Engineering 9th edition, New Chand & Brothers, 2011.
2. S.K. Khanna & C.E.G. Justo. Highway material Testing, 1969.
3. IRC: SP: 19; 2001, Manual For Survey, Investigation & Preparation of Road Projects.
4. IRC:81-1997, Guidelines for Strengthening of Flexible Road Pavement using Benkelman beam Deflection Technique.
5. Khanna, S.K., Justo, C.E.G. and A. Veeraragavan Highway Materials and Pavement Testing, Nem Chand and Bros, Roorkee, India, 2013.
6. Huang, Y.H. Pavement Analysis and Design, Pearson Prentice Hall, New Jersey, USA, 2004.
7. Duggal, Ajay K., Puri, Vijay P.," Laboratory Manual in Highway Engineering" New Age International (P) Limited, Publishers, New Delhi 1991.

List of Experiments

Sl No.	Name of Experiment
A	**Tests on soil**
1	Attenberg limits
2	Soil classification
3	Compaction test
4	California Bearing Ratio test
B	**Tests on Aggregates**
1	Shape test
2	Aggregate impact test
3	Los Angeles abrasion test
4	Stripping value
C	**Tests on Cement Concrete**
1	Normal Consistency Test
2	Sp. Gravity Test on Cement
3	Fineness test
4	Compressive strength of Cement
5	Tests on Fresh concrete-Workability
6	Tests on Fine Aggregates- Bulking of sand
D	**Tests on Bitumen**
1	Penetration test
2	Viscosity test
3	Softening point test
4	Specific Gravity
5	Flash and fire point test
6	Ductility test
7	Test on bitumen emulsion and cut back bitumen
E	**Test on bituminous Mixes**
1	Marshall Mix design and stability test
2	Indirect tensile strength test
3	Rut wheel test
4	Preparation and test on cold mixes
5	Bitumen extraction test
F	**Pavement evaluation**
1	Roughness measurement
2	Benkelman beam deflection studies and Analysis

SEMESTER II

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6202	**REGIONAL TRANSPORTATION PLANNING**	3-1-0 (4)	

Course Objectives

To give the Student:-

1. practice in developing forecasting models for demographic and employment opportunities
2. input for delineating regions in nation
3. awareness in influence of land use changes in transportation planning
4. knowledge in network planning and evaluation
5. ability to develop optimum bus route network and schedule

Syllabus

Demographic and Employment forecasting models

Theories of regional development and delineation of planning regions

Land use transportation planning and modeling

Regional travel demand estimation

Regional network planning

Urban bus transportation planning and evaluation

Course Outcome

1. Ability to delineate regions, estimate and forecast travel demand from regions accommodating land use.
2. Ability to generate and evaluate optimum network

References

1. Barra, T. D., Integrated Landuse and Transport Modelling: Decision Chains and Hierarchies, Cambridge University Press, 2005.
2. Bruton, M. J., An Introduction to Transportation Planning (The Living Environment), UCL Press, London, UK, 2000.
3. C.J. Khisty and B. Kent Lall, Transportation Engineering, Prentice Hall of India Pvt. Ltd., 2002.
4. C.S. Papacostas and P.D. Prevedouros, Transportation Engineering and Planning, Prentice Hall of India Pvt. Ltd., 2001.
5. Dicky J.W., Metropolitan Transportation Planning, Script Book Co., Washington, D.C., 1975.
6. John D. Edwards, Transportation Planning Handbook, Second Edition, Institution of Transportation Engineers, 1999.
7. Wilson, A.G., Regional and Urban Models in Geography and Planning, Wiley Press, 1974.
8. William R. Black, Transportation: A Geographical Analysis, Guilford Press, 2003.
9. Ashish Verma, T.V. Ramanayya, Public Transport Planning and Management in Developing Countries, CRC Press, 2014.
10. Norbert Oppenheim, Applied Models in Urban and Regional analysis, Prentice Hall, 1980.
11. Lo´ra´nt Tavasszy and Gerard de Jong, Modelling Freight Transport, Elsevier Publication.
12. Freight Transportation Planning: Models and Methods (Chapter 4) CRC Press LLC, 2003.
13. Quick Response Freight Manual II - Publication No. FHWA-HOP-08-010, Sept 2007.
14. Yosef Sheffi, Urban Transportation Networks – Equilibrium Analysis with Mathematical Programming Methods, Prentice Hall, 1985.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE6202	**REGIONAL TRANSPORTATION PLANNING**	**3-1-0 (4)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Demographic and Employment Forecasting Models**: Demographic Models - Linear, Exponential and Logistic Models; Cohort Survival Models - Birth, Aging and Migration Models; Employment Forecasting Models - Economic base Mechanism; Population and Employment Multiplier Models- Input and Output Models - Dynamic Models of Population and Employment – Multiregional Extensions	**8**	**15**
II	**Theories of Regional Development & Delineation of Transportation Planning Regions**: Concept of Region and Space – Types of Regions – Classification of Regions – Christaller's and Perouxian Theories of Regional Development - Delineation of Regions for Transportation Planning of a Nation.	**8**	**15**
FIRST INTERNAL EXAM			
III	**Landuse transportation models:** Classification of LUT Models, Economic Base Mechanism, Allocation Mechanism and Spatial Allocation and Employment Relationships, Garin Lowry Models, Contribution by Putman and Wilson, Issues Related to Landuse Transport - Interaction, Case Study Examples.	**9**	**15**
IV	**Regional Freight travel demand estimation**: Factors Affecting Goods Flows, Use of Mathematical Models to Estimate Freight Demand, Abstract Mode Models, Mode Specific Models, Direct Demand Models, IVF Models, IO Model, Case Studies, Truck Terminal location – planning	**9**	**15**
SECOND INTERNAL EXAM			
V	**Regional network planning**: Problems in Developing Countries, Network Characteristics - Circuity, Connectivity, Mobility, Accessibility and Level of Service Concepts - Network Structures and Indices – Network Planning – Evaluation - Graph Theory – Cut sets – Flows & Traversing – Optimum Network - Inter-modal Co-ordination.	**11**	**20**
VI	**Urban Bus Transportation Planning and Evaluation**: Introduction to Bus Network Design, Classification of	**11**	**20**

	Routes and their Alignment, Prediction of Transit Usage, Evaluation of Network, Accessibility Consideration in Route Frequency Analysis, Marginal Ridership for Dispatching Buses on Route, Scheduling of Buses and Minimum Wait Schedule.		
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6204	**PAVEMENT CONSTRUCTION, EVALUATION AND MAINTENANCE**	3-0-0 (3)	

Course Objectives

To give the student

1. Knowledge about recent developments in construction practices and equipment.
2. Awareness about the importance of pavement condition evaluation and prediction
3. An understanding of various types of distresses, causes and remedies
4. Awareness about various maintenance strategies.

Syllabus

Stabilization techniques, pavement construction equipments, preparation of each layer of flexible pavement, preparation of rigid pavement, superpaves, new types of pavements. Pavement evaluation - Pavement Performance, Serviceability concept, Pavement distresses, pavement condition index, roughness characteristics and its determination – structural evaluation – pavement maintenance.

Course Outcome

Students will be able to

1. Choose appropriate stabilization technique as per the site requirements.
2. Acquaint with new construction practices adopted in the construction of pavements
3. Ability to evaluate the pavement condition using functional and structural methods.

References

1. Mallick, R.B. and T. El-Korchi Pavement Engineering – Principles and Practice, CRC, Press, Taylor and Francis Group, Florida, USA, 2009.
2. Peurifoy, R.L., Construction, Planning, Equipment and Method - McGraw Hill Book Co.2010.
3. Shahin, M.Y, Pavement Management for Airports, Roads and Parking lots, Chapman & Hall, 2005.
4. Haas. R, Hudson. W. Zaniewsk John, Modern Pavement Management, Kreiger Publishing Company, 1994.
5. Sharma S. C., Construction Equipment and its Management", Khanna Publishers, 1995.
6. Relevant IRC Codes.
7. Kadiyali L R, Transportation Engineering, Khanna Publishers, 2016
8. Bruce K. Ferguson, Porous Pavements, CRC Press, 2005.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE6204	**PAVEMENT CONSTRUCTION, EVALUATION AND MAINTENANCE**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Soil stabilization of subgrade**: Types of stabilization, Selection of stabilizers, Stabilisation with pozzolanic materials and bitumen.	**8**	**15**
II	**Pavement Construction -** Construction equipments, Construction and preparation of subgrade soil, sub-base, base and surface layers – construction of cement concrete surface layers - MoRT&H specifications	**10**	**15**
FIRST INTERNAL EXAM			
III	**New types of pavement** - super pave concept, new materials like polymer modified bitumen, geo synthetics, interlocked pavements. Applications of geosynthetics in pavements.	**8**	**15**
IV	**Pavement evaluation**: Types of Surveys; Distress Surveys, condition survey; Pavement Distress Indices; Pavement Condition Survey -Pavement Condition Index(PCI) – Estimation of PCI by Shahin's Deduct value method- Pavement surface condition: Skid resistance	**8**	**15**
SECOND INTERNAL EXAM			
V	**Characterisation of roughness**- Equipments for measuring roughness, profile indices, International Roughness Index (IRI), Factors affecting pavement structural condition, Structural Capacity, Structural evaluation by Non- Destructive Tests, Types – Benkelman Beam Deflection (BBD) measurement	**12**	**20**
VI	**Pavement Maintenance:** Routine maintenance, periodic maintenance, special repairs. Responsive maintenance programme, rehabilitation and reconstruction.	**10**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6206	**ADVANCED TRAFFIC ENGINEERING**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. An introduction to the fundamentals of traffic operations at uninterrupted facilities, theories of traffic flow.
2. Ability to analyse the queuing behavior of vehicles at various traffic scenario
3. Introduction to simulation models and improve the knowledge in advanced theories of traffic flow.

Syllabus

Traffic Flow Modelling, Traffic flow characteristics, various traffic stream models, Car following, acceleration noise. Traffic flow modelling analogies, Shock waves and bottleneck. Lane changing models, Flow models under mixed traffic. Fundamentals of queuing theory. Capacity and Level of Service Simulation in Traffic Engineering

Course Outcome

The student will able to analyse and evaluate traffic stream performance.

1. Understanding the various traffic flow models, flow along bottle necks, shockwave phenomenon
2. Able to estimate demand service characteristics
3. Estimate the level of service of traffic infrastructure facilities.
4. Traffic simulation modeling

References

1. Wohl M and Martin, B.V., "Traffic System Analysis for Engineers and Planners", McGraw-Hill, 1967.
2. McShane W R & Roess R P, "Traffic Engineering", 4th Edition, Prentice-Hall, NJ, 2011.
3. May A. D., "Traffic flow fundamentals", Prentice Hall, NJ, 1990.
4. Drew D. R. "Traffic Flow Theory and Control", Mc. Graw Hill New York, 1968.
5. Highway Capaity Manual, Transportation Research Board, Washington, D.C., 2010.
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7. Neylor T. H. "Computer Simulation Techniques", John Wiley, 1966.
8. Traffic Flow Theory: A State-of-the-Art Report, TRB, Available for free download at http://www.tfhrc.gov/its/tft/tft.htm.
9. Wilhelm Leutzbach, Introduction to the Theory of Traffic Flow, Springer, 1988.
10. Gerlough, David L, Huber, Matthew J, Traffic Flow Theory, Transportation Research Board Special Report, Issue Number: 165, Transportation Research Board, 1976.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE6206	**ADVANCED TRAFFIC ENGINEERING**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Traffic Flow Modelling**: Traffic stream models: Traffic flow characteristics, Greenshield's model, Greenberg's logarithmic model, Underwood's exponential model, pipe's generalized model, multi-regime models;	**6**	**15**
II	Use of Counting, Interval and Translated Distributions for Describing Vehicle Arrivals, Headways, Speeds, Gaps and Lags; Fitting of Distributions, Goodness of Fit Tests.	**6**	**15**
FIRST INTERNAL EXAM			
III	Traffic flow modelling analogies: Fluid flow analogy, heat flow analogy, granular flow, Lighthill-Withams theory, Boltzman like behaviour of traffic. Flow concepts including shock waves and bottleneck. Flow models under mixed traffic. Car following, acceleration noise.	**6**	**15**
IV	Fundamentals of Queuing Theory, Demand Service Characteristics. Deterministic Queuing Models, Stochastic Queuing Models, Multiple Service Channels, Models of Delay at Intersections and pedestrian Crossings.	**6**	**15**
SECOND INTERNAL EXAM			
V	Highway capacity analysis: Capacity and level of service concepts; Factors affecting capacity and LOS; capacity of rural highways, Urban arterials; Capacity Analysis of Different Highway Facilities, Passenger Car Units, Problems in Mixed Traffic Flow.	**9**	**20**
VI	Simulation Models: Philosophy of Simulation Modelling, Formulation of Simulation Model, Methodology of System Simulation, Simulation Languages, Generation of Random Numbers, Generation of Inputs – Vehicle Arrivals, Vehicle Characteristics, Road Geometrics, Design of Computer Simulation Experiments, Analysis of Simulation Data, Formulation of Simulation Problems in Traffic Engineering and Validation.	**9**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6212	**GEOSYNTHETICS FOR HIGHWAY DESIGN**	3-0-0 (3)	

Course Objectives

1. To know about different types of geosynthetics used for pavement construction.
2. To study about various properties and testing of geotextiles
3. Identify potential areas of application in pavements, how it is applicable and its design

Syllabus

Introduction to geosynthetic, Geotextiles : Types, Manufacturing Methods, Functions, Basic Properties: Physical, Mechanical, Hydraulic, Constructabililty, Durability Testing and Evaluation: Test Condition, Sampling, Testing Methods Pavement Applications: Giroud and Noiray approach, Crack Control, Uses in paved roads Applications: Filtration and Drainage, Embankments, Retaining walls, Rigid and Flexible pavements, AASHTO design.

Course Outcome

1. Understand various types of geosynthetics
2. Understand potential areas of application of geotextiles, its testing standards.
3. Acquire capability for selection, design of geosynthetics for various applications

References

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2. G.V. Rao, PK Banerjee, J.T. Shahu, G.V. Ramana. Geosynthetics - New Horizons, Asian Books Private Ltd., New Delhi, 2004.
3. G. Venkatappa Rao, Geosynthetics-An Introduction, Sai Master Geo environmental Services Pvt Ltd., Hyderabad, 2011.
4. G. Venkatappa Rao & Goutam K. Pothal, Geosynthetics Testing-A Laboratory Manual, Sai Master Geoenvironmental Services Pvt Ltd., Hyderabad, 2008.
5. Rao G.V. & Rao G.V.S., "Text Book On Engineering With Geotextiles", Tata Mc Grawhill, 1990.
6. Rao G.V & Balan. K, Coir Geotextiles-emerging trends, Kerala state coir corporation Alappuzha, 2002.
8. J.N. Mandal, "Geosynthetics World", New Age International Private Limited, 1994.
9. G.L Siva Kumar Babu, "An Introduction to Soil Reinforcement and Geosynthetics", university press (India) private limited Hyderabad, 2006.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE6212	**GEOSYNTHETICS FOR HIGHWAY DESIGN**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	Historical background of reinforced soil, Principles of reinforced soil through Mohr circle analysis. Types of geosynthetics like geotextiles, geogrids, geonets, geocells, geo-composites, their manufacturing methods.	**6**	**15**
II	Geotextiles-overview, introduction, types including natural geotextiles, manufacturing methods, Functions of Geotextiles- fluid transmission, filtration, separation, protection, Sediment Control, Reinforcement, design principles and influencing factors	**8**	**15**
FIRST INTERNAL EXAM			
III	Basic Properties- physical(Mass per unit area, thickness, compressibility, apparent opening size, width and length), mechanical(Tensile strength, narrow strip tensile test, grab test, strip and wide width tensile test, seam testing, interface friction, creep resistance), hydraulic, constructability/survivability (puncture test, CBR push through test, trapezoidal tear test, diaphragm bursting strength test, cone drop test), durability (abrasion resistance, ultra-violet resistance, temperature stability, chemical stability)	**8**	**15**
IV	Testing and Evaluation- importance of testing, test conditions, sampling, testing methods- Techniques for testing of different index properties, strength properties, Apparent Opening Size, In-plane and cross-plane permeability tests, assessment of construction induced damage, extrapolation of long term strength properties from short term tests.	**6**	**15**
SECOND INTERNAL EXAM			
V	Pavement Applications- Paved Surface Rehabilitation, Reflective Crack Treatment for Pavements, Geotextiles for separation and reinforcement in flexible pavements, design by Giroud-Noiray, improvement of bearing capacity using geotextiles Use of geotextiles for construction of heavy container yards and railway lines. Applications in Bituminous Pavements- Model study on Geotextile Reinforced Asphaltic	**8**	**20**

	Concrete		
VI	Applications- Filtration and Drainage: geotextile filter requirements, drain and filter properties, design criteria. Embankments in soft soil: stability analysis, influence of reinforcement extensibility, relationships for design, settlement analysis; soil retaining walls: components, principles of design; Reinforcement design applications in rigid and flexible pavements, AASHTO design criteria; construction methods	**6**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6214	**GIS AND ITS APPLICATIONS IN TRANSPORTATION ENGINEERING**	3-0-0 (3)	

Course Objectives

1. Explain the basic concepts of GIS and different data models in GIS
2. Explain different data management and analysis techniques in GIS.

Syllabus

Coordinate systems, georelational vector data model, object based vector data model, raster data model, geometric transformations, Attribute data input and management, data exploration and vector and raster data analysis

Course Outcome

1. Practical knowledge in using GIS softwares like ArcGIS, MapInfo etc
2. Apply GIS techniques in different real world transportation engineering problems

References

1. Kang-Tsung Chang, Introduction to Geographic Information Systems, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2008.
2. Lo C.P. & Yeung A.K.W., Concepts and Techniques of Geographic Information Systems, Pearson; 2 edition, 2006.
3. De Mers, M.N., Fundamentals of Geographic Information Systems, 4th edition, John Wiley & Sons, New York, 2008.
4. Peter A. Burrough and Rachael A. McDonnell, Principles of Geographical Information Systems, Oxford University Press, 2005
5. Clarke, K., Getting Started with Geographic Information Systems, Pearson; 5 edition, 2010.
6. Geo Information Systems – Applications of GIS and Related Spatial Information Technologies, ASTER Publication Co., Chestern (England), 1992
7. Jeffrey, S. & John E., Geographical Information System – An Introduction, Prentice-Hall, 1990
8. Marble, D.F., Galkhs HW & Pequest, Basic Readings in Geographic Information Systems, Sped System Ltd., New York, 1984.
9. GIS for Urban & Regional Planning, Scholten & Stillwen 1990, Kulwer Academie Publisher.
10. Geographical Information System, Volume I: Principal and Technical Issues, Edited by P.A.Longley, M.F. Goodchild, D.J. Manguire, D.W. Rhino,John Wiley & Sons, 1999.
11. Geographical Information System: Volume II: Management Issues and Applications, Edited By P.A. Longley, M.F. Goodchild, D.J. Manguire, D.W. Rhino, John Wiley & Son, 2005.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE6214	**GIS APPLICATIONS IN TRANSPORTATION ENGINEERING**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Introduction:** Introduction to GIS,- definition– Components of GIS –Applications of GIS. **Types of Geo-Spatial Data**: Spatial and non-spatial data, Vector and raster data, Primary and secondary data, Characteristics and sources of spatial data, attribute data. **Map Projection:** Types of Projection–Cylindrical projection, Conical projection, Selection of a particular projection **Coordinate Systems**: Geometric models of earth, Geographic and projected coordinate system	**6**	**15**
II	**Data models**: Topological and non-topological vector data, Topology rules, georelational data model, object based data model, Interface- Encapsulation, Inheritance, Polymorphism **Data models for Composite features**; TIN, Region and Routes. Raster data model- nature and elements, types, data storage, data compression, Data conversion.	**8**	**15**
FIRST INTERNAL EXAM			
III	**Geometric transformation**- map to map and image to map transformations, transformation methods, Affine transformation, RMS error, Resampling, pyramiding, **Geospatial Data quality and standards**: Data quality- accuracy, precision, errors, uncertainty, sources of errors, components and assessment of data quality, Data standards- classification of standards in GIS, components, international geospatial data standards. Spatial data editing- errors, topological and non topological editing. Attribute data input and management- type of attribute data, Relational model, normalization, types of relationships, attribute data entry. (Exposure to GIS tools can be given through assignments or mini projects)	**6**	**15**
IV	**Data exploration and analysis:** Data exploration- descriptive statistics, graphics, attribute data and spatial	**6**	**15**

	data query, map manipulation. Vector data analysis- buffering, overlay, slivers, distance measurement, pattern analysis, Raster data analysis- Local operations- reclassification, neighborhood operations, zonal operations, physical distance measurement		
SECOND INTERNAL EXAM			
V	**Application of GIS in Transportation Planning:** Application of GIS in urban planning, Intelligent information system for road accessibility study, location of transport terminals and roadside facilities, bus stops, Decision support systems for land use planning, Applications of Aerial Photography and Satellite Imageries.	**8**	**20**
VI	**Application of GIS in Highway and Traffic Engineering:** GIS based Highway alignment, GIS based road network planning, GIS based traffic congestion analysis and accident investigation, – Route optimization – Bus route rationalization Utility management, GIS applications in environment impact assessment and environment monitoring, case studies	**8**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6216	**OPERATIONS RESEARCH**	3-1-0 (3)	

Course Objectives

1. To introduce the methods of Operations Research
2. Emphasize the mathematical procedures of linear and non linear programming

Syllabus

Introduction to Operations Research-Formulation of LPP--Simplex Method, Duality Theory- Sensitivity Analysis-parametric programming: Integer Programming-cutting plane method-mixed integer programming-branch and bound methods. Inventory models-Models with deterministic demand – Non linear programming-Langarange multiplier method- Kuhn Tucker conditions-Quadratic programming.

Course Outcome

1. Proficiency in tools in optimization
2. To enable the students to build models for simple problems in managerial decision making and utilise proper mathematical methods to solve these models

References

1. Bazaraa M S, Jarvis & herali H D, Linear Programming and Network flows, 4th edition, John Wiley & Sons, Singapore 2009.
2. Bazaraa M S, Sherali H D & Shetty, C. M, Non Linear Programming, Theory & Algorithms 2nd edition, John Wiley &Sons, Singapore 1995.
3. Goel B S and Mittal S K ' Operations Research', Pragati Prakashan, 2014.
4. Taha, Hamdy, Operations Research, 9th edition, Pearson, 2010.
5. Wayne L Winston, Operations Research: Applications and Algorithms, Indian University, 4th edition, 2004
6. Mitsuo Gen, Runwei Cheng, Genetic Algorithms and Engineering Optimization, John Wiley & Sons, 2000

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE6216	**OPERATIONS RESEARCH**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	Introduction to Operations Research: Basics definition, scope, objectives, phases, models and limitations of Operations Research. Linear Programming Problem – Formulation of LPP, Simplex Method, Artificial variables, Big-M method, two-phase method, degeneracy and unbound solutions.	**6**	**15**
II	Duality Theory, The Primal Vs- Dual-Solutions. Sensitivity Analysis: Changes in Objective-Function Sensitivity Analysis: Changes in RHS.- revised simplex method –parametric programming	**6**	**15**
FIRST INTERNAL EXAM			
III	Integer programming-relevance of integer variables and relevance of integer programming- formulation of problems with binary variables-cutting plane method-mixed integer programming-branch and bound methods.	**8**	**15**
IV	Inventory models. Inventory costs. Models with deterministic demand – demand rate uniform and production rate infinite - demand rate non-uniform and production rate infinite - demand rate uniform and production rate finite	**8**	**15**
SECOND INTERNAL EXAM			
V	Non linear programming-multi-variable optimisation with equality constraints- Langarange multiplier method-optimisation in the presence of inequality constraints-convexity and role in optimization- Kuhn Tucker conditions	**8**	**20**
VI	Quadratic programming-Wolf's method- Beale's method-Frank &Wolfe Method, Reduced Gradient method, Gradient projection method, convex simplex method,	**6**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6218	**TUNNEL ENGINEERING**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. Awareness about suitability of site for tunneling and method of tunneling that can be adopted
2. Knowledge about various methods of tunnel designing and support designing
3. Information regarding excavation and construction methods for different soil condition
4. Concept of planning and designing of tunnels with less hazards, with proper environment management

Syllabus

Geotechnical considerations of tunneling – site investigation

Design of tunnels – Empirical, observational, analytical and numerical methods

Construction and excavation methods – Hard rock, soft rock, shallow excavation and deep excavation

Tunnel support design – rock reinforcement, concrete and shortcrete lining, NATM

Health, safety and environment considerations – identification of hazards, types and mitigation measures, risk assessment, environmental management related to tunneling

Course Outcome

1. Ability to understand the type and method of tunneling required for different type of soil
2. Ability to plan and design tunnels and tunnel supports with consideration for health, safety and environment.

References

1. Z T Bieniawski, Rock Mechanics Design in Mining & Tunneling, A.A. Balkema,1984
2. Hoek, E, Brown, E T, Underground Excavations In Rock, Transport Research Laboratory, 1980.
3. John Olusegun Ogundare, Precision Surveying: Principles and Geomatics Practice,John Wiley & Sons, 2015.
4. Thomas R. Kuesel, Elwyn H. King, John O. Bickel, Tunnel Engineering Handbook, 2nd edition, Springer Science & Business Media, 2012.
5. Whittaker, B N, Frith, R C, Tunnelling: Design, Stability And Construction, Transport and Road Research Laboratory (TRRL), 1990.
6. Megaw, T M, Bartlett, J V, Tunnels. Planning, Design, Construction. Volume 1, Ellis Horwood, 1982.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE6218	**TUNNEL ENGINEERING**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Geotechnical Considerations of tunneling** - Geological, geotechnical and hydrological contexts, Planning a site investigation for a tunnel, Site investigation methods for tunnels in different ground conditions, Geophysical methods Hydrogeological investigation, Geological profiles, In situ and laboratory testing, Stress measurements, Determination of design parameters and preparation of Geotechnical Interpretative Reports (GIR) and Geotechnical Baseline Reports (GBR), Sustainability: reuse of materials, spoil and space.	**6**	**15**
II	**Design of Tunnels** – Empirical design Terzhagis Rock Load method, Application of Bieniawsky's System, Application of Barton's System. Observational Design Methods; Analytical Design Methods; Numerical Design Methods.	**8**	**15**
FIRST INTERNAL EXAM			
III	**Construction & Excavation methods** Types and purpose of tunnels; factors affecting choice of excavation technique; Methods - soft ground tunnelling, hard rock tunnelling, shallow tunnelling, deep tunnelling; Shallow tunnels – cut and cover, cover and cut, pipe jacking, jacked box excavation techniques, methods of muck disposal, supporting, problems encountered and remedial measures.	**6**	**15**
IV	Lighting, Ventilation of tunnels, tunnel utilities, drainage and pumping.	**6**	**15**
SECOND INTERNAL EXAM			
V	**Tunnel support design** Rock reinforcement - Rock dowels, rock bolts, rock anchors, mechanisms of support, physical aspects, , typical dimensions of rock bolt, face plates, bond characteristics, role played by time in rock reinforcement, installation technology, installation process. Concrete and shotcrete linings - Concrete Segmental Supports, Role of steel reinforcement of concrete	**8**	**20**

	segments, Design and application aspects of precast concrete segmental linings, Yielding properties of segmental concrete linings, Cast In Situ or Monolithic Concrete Linings, Waterproofing of Concrete Linings, Shotcrete technology: operational and range of application aspects, Shotcrete, General applications of shotcrete. New Austrian Tunnelling Method - Historical aspects of NATM, General Concepts of NATM, Principal historical developments of NATM, NATM: Soft Ground Tunnelling Applications, Achieving improved ground support control, Influence of stand-up time, Advantages of NATM for soft ground tunneling		
VI	**Health, Safety and Environmental Considerations** - Health and Safety Considerations at Concept Planning Stage for different tunnel types / uses, Reducing / eliminating Hazards to Health, Safety and the Environment by good planning and design, Identification of hazards, strategies to mitigate these hazards by good design practice, Occupational health risk during construction and its mitigation, Hazard types and safety measures (e.g. Fire, Ventilation, Transport, Machines, etc.), Risk assessment processes for design, construction, operation and decommissioning, Modern approach to the improvement of safety standards (including Behavioural Based Safety). Environmental management on a tunnelling site - noise, dust, vibration, emissions, odours, traffic and other nuisances, waste management, waste water management, ecology and archaeology, Sustainability	**8**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6220	**PLANNING AND DESIGN OF FREIGHT TRANSPORTATION**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. Concept of freight transportation demand estimation
2. Knowledge in contemporary planning issues related to freight transportation
3. Exposure to ITS and its application in freight transport

Syllabus

Characteristics of goods, problems in freight transportation, Freight Demand Estimation, Freight Transport Planning Issues, Distribution Management, Intermodal Freight Transport, ITS Applications in Freight Transport.

Course Outcome

1. Ability to estimate the freight transportation demand
2. Ability to plan freight transportation system

References

1. David Lowe, Intermodal Freight Transport, Elsevier Butterworth-Heinemann Publishers, 2005
2. Konstadinos G. Goulias, Editor, Transportation Systems Planning: Methods and Applications. CRC Press, 2003
3. Myer Kutz, Editor, Handbook of Transportation Engineering, McGraw-Hill Publishers, 2004
4. NCFRP Report 23, Synthesis of Freight Research in Urban Transportation Planning, TRB, Washington, 2013. http://onlinepubs.trb.org/onlinepubs/ncfrp/ncfrp_rpt_023.pdf
5. Blanchard S.Benjamen, "Logistics Engineering and Management", Pearson; 6 edition, 2003.
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7. Daganzo F.C and Newell FG, Physical Distribution from a Warehouse; Vehicle Coverage and Inventory Levels, Vol.19B, No.5, pp.397-407, Transportation Research, 1985.
8. Edwin Bacht J.A., "Geography of Transportation and Business Logistics", Wm C Brown Company Publishers, Dubuque, IOWA, 1970.
9. Herron P. David, "Managing Physical Distribution for Profit", Harvard Business Review, 1979
10. Khanna K.K., "Physical Distribution Management", Logistical Approach, Himalaya Publishing House, Bombay, 2007.
11. Planning Commission, Government of India, Total Transport System Study – Report on Commodity Flows, Railways, Highways and Coastal Shipping, (Interim) by RITES, New Delhi, 1987
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COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE6220	**PLANNING AND DESIGN OF FREIGHT TRANSPORTATION**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Introduction:** Goods Characteristics, operators, problems in freight transportation, regional vs. urban goods travel, intermodal freight travel issues	**6**	**15**
II	**Freight Demand Estimation:** Operations, Planning - purpose, process, Data, Freight Agents, costs, Planning Models and Methods-freight demand estimation and forecasting at regional and urban level, IO model, Performance, Case studies	**8**	**15**
FIRST INTERNAL EXAM			
III	**Freight Transport Planning Issues**: Freight supply – capacity issues; freight productivity and performance; freight impacts – safety and environmental issues	**8**	**15**
IV	**Distribution Management:** Supply Chain – Warehousing – Facility Location, Inventory – Mode Choice – Distribution System, Vehicle Routing and Scheduling	**6**	**15**
SECOND INTERNAL EXAM			
V	**Intermodal Freight Transport:** Rail freight operations, Intermodal Networks and Freight Interchanges, Intermodal Road and Rail Vehicles and Maritime Vessels	**8**	**20**
VI	**ITS Applications in Freight Transport:** Introduction to ITS, Role of ITS, ITS components applicable to Goods travel, case studies	**6**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6222	**ADVANCED SOIL MECHANICS**	3-0-0 (3)	

Course Objectives

To give the student

1. An introduction to critical thinking in the analysis and design of geotechnical systems
2. A firm theoretical background necessary in the design of geotechnical systems
3. The concept of the theory of stress path in the Geotechnical design
4. An idea of basic principles of soil engineering

Syllabus

Soil composition and structure - Permeability and Seepage - Compressibility and Consolidation - Behaviour of compacted soil - Slope instability - Reinforced earth

Course Outcome

1. Understand the soil characteristics and select suitable soil for pavement construction
2. Understand the various field and laboratory testing methods required for different subgrade materials.
3. Evaluate the soil condition and recommend suitable treatment.

References

1. Atkinson, J.H. An Introduction to the Mechanics of Soil and Foundations. McGraw Hill, 1993.
2. Bolton, M. A Guide to Soil Mechanics. MacMillan Education, 1987.
3. Mitchell, R.J. Fundamentals of Soil Behaviour. 3rd Edition, Wiley, 2005.
4. Wood, D.M., Soil Behaviour and Critical State Soil Mechanics. Cambridge University Press, 1988.
5. Braja M. Das, Advanced Soil Mechanics, Fourth Edition, CRC Press, 2013.
6. Charles W. W. Ng, Bruce Menzies, Advanced Unsaturated Soil Mechanics and Engineering, CRC Press, 2007.
7. V.N.S. Murthy, Geotechnical Engineering: Principles and Practices of Soil Mechanics and Foundation Engineering, CRC Press, 2002.
8. Mitchell, R.J,. Fundamentals of Soil Behaviour. 3rd Edition, Wiley, 2005.
9. Lambe T.W, Whitman R. V, "Soil Mechanics", John Wiley & Sons, 2008.
10. S. K. Khurana, Principles, Practice and Design of Highway Engineering.
11. Gopal Ranjan & A. S. Rao, Basic and Applied Soil Mechanics, New Age International Publishers – New Delhi, 2000.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE6222	**ADVANCED SOIL MECHANICS**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Soil composition and structure**: Soil formation: Types of soil, and their characteristics, particle size and shapes, their impact on engineering properties. Soil structure: Clay mineralogy, clay-water interaction - soil fabric. Clay mineral identification. X-ray and Differential Thermal Analysis.	**6**	**15**
II	**Permeability and Seepage**: Concept of Effective stress - permeability – seepage force and effective stress during seepage. Laplace equation of fluid flow for 1D, 2D and 3D seepage Flow nets – anisotropic and non-homogenous medium - Confined and unconfined seepage	**8**	**15**
FIRST INTERNAL EXAM			
III	**Compressibility and Consolidation**: Terzaghi 1 D consolidation theory– applications on different boundary conditions – Determination of coefficient of consolidation – normally and over consolidated soil- compression consolidation curve secondary consolidation –radial consolidation - settlement of compressible soil layers – methods for accelerating consolidation settlement	**8**	**15**
IV	**Behaviour of compacted soil:** surface compaction - Laboratory methods for determination of optimum moisture content and Maximum dry density – Field compression methods – effect of compaction on structure – swelling pressure, shrinkage, shear strength, pore water pressure - CBR – Lab and field methods to find CBR – Dynamic compaction test.	**6**	**15**
SECOND INTERNAL EXAM			
V	**Slope instability:** Stability analysis of slope – Finite and infinite – critical slip surface – sudden draw down condition – effective stress and total stress analysis – stability charts and stability number – methods for enhancing stability of unstable slopes	**6**	**20**
VI	**Reinforced earth:** principles – components – design	**8**	**20**

	principles – stability checks – soil nailing		
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P I	2017
08CE6224	**INTELLIGENT TRANSPORTATION SYSTEM**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. To provide a broad exposure to ITS
2. To understand the relevance, technological applications and strategies using ITS
3. To understand the recent development and application process of ITS

Syllabus

Intelligent Transportation System:- needs, standards, system architecture and components of ITS. Development of ITS worldwide and Indian context and role of traffic management centres.

Various advanced 60raveler information systems available and data collection techniques to support ATIS. Application of ITS like Incident management and parking management, Electronic payment systems, Access control systems etc. ITS system design, sensor technologies and positioning systems to support ITS applications. Automated Highway Systems: Evolution, trends, Integration, system configuration, Implementation, communication technologies and its impact on environment.Transportation planning and ITS, Emergency management systems and possibilities of ITS in India.

Course Outcome

1. Understand the need for ITS and the subsets of ITS.
2. To equip the students with practical case studies leading to ITS rather than conventional methods

References

1. Joseph M. Sussman, Perspectives on Intelligent Transportation Systems, Springer 2005.
2. Bob Williams, Intelligent Transportation Systems Standards, Artech House 2008.
3. Sumit Ghosh and Tony S. Lee, Intelligent Transportation Systems: Smart and Green Infrastructure Design, CRC press, 2010.
4. Mashrur A. Chowdhury and Adel Wadid Sadek Fundamentals of Intelligent Transportation Systems planning, Artech House 2009.
5. Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva and Ignacio Julio García Zuazola, Intelligent Transport Systems: Technologies and Applications, Wiley, 2015.
6. Petros A. Ioannou, Automated Highway Systems, Springer Science & Business Media, 2013

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P I	
08CE6224	**INTELLIGENT TRANSPORTATION SYSTEM**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**History of ITS**, ITS – Need, Standards and policy, System architecture, ITS Developments - Worldwide and Indian scenario, Metropolitan and Rural ITS. ITS user services: Traffic Management centers- Types and functions, Travel and traffic management, Public transportation operations, Commercial vehicle operations	**8**	**15**
II	**Advanced Traveller Information systems** :- Pre trip and En route information, Data collection techniques, Route Guidance Systems, Infrastructure based systems and its applications, Variable message signs, Vehicle to Center and Vehicle to Road side communication.	**6**	**15**
FIRST INTERNAL EXAM			
III	**Application of ITS**: Incident Management-, Parking management, Electronic payments, Electronic toll collection systems, Access controls: metering, Dynamic speed adaptation. Advanced traffic control systems, In-vehicle systems. Dynamic routing/scheduling.	**8**	**15**
IV	**ITS Design:** ITS system design- components and requirements, ITS for road network- System Design- Sensor technologies and data requirements for ITS. Positioning systems in ITS, GPS and Mobile phone locations and its potential on ITS applications. Telecommunication in ITS, Integration of GPS and GIS for ITS.	**6**	**15**
SECOND INTERNAL EXAM			
V	**Automated Highway Systems:** Evolution of AHS and new trends, Smart cars, Vehicle in platoons, Integration of AHS, System configuration, Implementation of AHS, Communication technologies for AHS, Control and sensor requirements in AHS, Effect of AHS on Environment.	**8**	**20**
VI	**Transportation planning and ITS:-** Relationships	**6**	**20**

	between problems, conventional approach and ITS approach.(Case studies), Operations and fleet management, Emergency management systems, Collision warning systems. Possibilities of ITS in India and Future of ITS.		
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6226	**PROJECT MANAGEMENT**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. The concepts of project formulation and capital investment
2. The idea regarding project costing and appraisal
3. The knowledge about various concepts of construction planning
4. The knowledge about construction scheduling and techniques
5. The concepts of quality control and safety concepts
6. The importance of organization and use of project information

Syllabus

Project formulation – Project costing and formulation – construction planning – Scheduling procedures and techniques – quality control and safety procedures during construction – organization and use of project information.

Course Outcome

1.The students able to get concepts of project formulation and capital investment
2.The students get the idea regarding project costing and appraisal
3. The students understand the knowledge about various concepts of construction planning
4. The students able to get the knowledge about construction scheduling and techniques
5. The students get the concepts of quality control and safety concepts
6. The students get the importance of organization and use of project information

References

1. Joseph Berechman, The Evaluation of Transportation Investment Projects, Routledge Advances in Management and Business Studies, 1st Edition, 2014.
2. Primary Corridor Transportation Project, Major Investment Study: Environmental Impact Statement, Volume 1, United States. Federal Transit Administration, 2003.
3. David Banister and Joseph Berechman, Transport Investment and Economic Development, UCL press, London, 2000.
4. Heroil Keenzer – Project Management – A system approach to planning, scheduling and controlling –CBS publishers distributers 1997.
5. K. Waker A. Teraih and Jose M Grevarn: Fundamentals of Construction Management & Organization, Reston Pub Co, 1985.
6. Ghattas and Mckee – Practical Project Management – Pearson Education 2002.
7. Seetharaman- Construction Engineering and Management – Umesh Publications 2012.
8. Shore. B Operations Managements Mc. Graw Hill 1973.
9. Heggie. I. G, Transport Engineering Economics, Mc Graw Hill Publishers, 1972.
10. Winfrey. R, Economic Analysis for Highways, International Text Book Company, 1st edition, 1969.
11. L.R Kadiyali, Traffic Engineering and Transport Planning, Khanna Publishers, 2011.
12. Road User Cost Study, CRRI, Journal of the Indian Roads Congress, Volume: 44, Issue Number: 1, Indian Roads Congress, 1983.
13. J.W. Dickey, Road Project Appraisal, for Developing Countries, John Wiley & Sons, 1984.

14. IRC: SP: 19; 2001, Manual For Survey, Investigation & Preparation of Road Projects.
15. IRC:SP: 30, Manual on Economic Evaluation of Highway Projects in India.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE6226	**PROJECT MANAGEMENT**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Project formulation:** Project Concepts - Capital investments - Generation and Screening of Project Ideas Project identification –Preliminary Analysis, Market, Technical, Financial, Economic and Ecological – Pre Feasibility Report and its Clearance, Project Estimates and Techno Economic Feasibility Report.	**6**	**15**
II	**Project costing and appraisal :** Project Cash Flows - Time Value of Money –NPV-BCR -IRR -ARR -Urgency - Pay Back Period -Assessment of Various Methods - Indian Practice of Investment Appraisal International Practice of Appraisal -Analysis of Risk -Different Methods -Selection of a Project and Risk Analysis in Practice	**6**	**15**
FIRST INTERNAL EXAM			
III	**Construction planning:** Basic Concepts in the Development of Construction- Plans Choice of Technology and Construction Method -Defining Work Tasks -Defining Precedence Relationships among Activities -Estimating Activity Durations -Estimating Resource Requirements for Work Activities	**6**	**15**
IV	**Scheduling procedures and techniques:** Construction Schedules -Critical Path Method -Scheduling Calculations -Float -Presenting Project Schedules -Use of Advanced Scheduling Techniques -Crashing and Time/Cost Trade-offs	**8**	**15**
SECOND INTERNAL EXAM			
V	**Quality control and safety during construction**: Quality and Safety Concerns in Construction -Organizing for Quality and Safety -Work and Material Specifications -Total Quality Control -Quality Control by Statistical Methods Safety.	**8**	**20**
VI	**Organization and use of project information:** Types of Project Information -Accuracy and Use of Information -Computerized Organization and Use of Information -Organizing Information in Databases- Relational Model of data bases -Other Conceptual Models of Databases -Centralized Database	**8**	**20**

	Management Systems		
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6228	**ADVANCED TRAVEL DEMAND MODELING**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. Awareness about various qualitative variables used in forecasting and the scaling techniques
2. Proficiency in developing travel demand models by appropriate modeling techniques
3. Ability to test the model aggregation and transferability

Syllabus

Role of qualitative variables in travel demand forecasting – scaling techniques – factor analysis – discrete choice analysis – stated preference methods – time use analysis – model aggregation and model transferability – simplified transport demand models and advanced models.

Course Outcome

Students will be able to

1. Assess qualitative variables
2. Develop discrete choice models
3. Develop travel demand models using Stated Preference data
4. Estimate Travel Demand using activity based analysis
5. Test model aggregation and transferability
6. Develop Travel Demand Models for small cities using Quick response techniques

References

1. Akiva, B., Discrete Choice Analysis: Theory and Application to Travel Demand, MIT Press, 1985.
2. Moshe Ben -Akiva and Michel Bierlaire, Discrete choice methods and their applications to short term travel decisions, Transportation Science Handbook, 1999.
3. Alan Geoffrey Wilson. Optimisation in Location and Transport Analysis, John Wiley & Sons, 1981 (Digitized: 31 March 2011)
4. Yaron Hollander, Transport Modelling for a Complete Beginner, Ctthink, 2016.
5. Harry Timmermans, Progress in Activity Based Analysis, Elsevier Science, 2005.
6. Michael A. Florian, Lecture Notes in Economics & Mathematical Systems: Traffic Equilibrium Methods, Proceedings of the International Symposium Held at the Université de Montréal, Springer, 1976.
7. Oppenheim, N., Urban Travel Demand Modelling: From Individual Choices to general Equilibrium, John Wiley and Sons, Inc., 1995 (Digitized 29 June 2011)
8. Orterzar, J., and Willumasen, L. G., Modelling Transport, Wiley Publishers, 2011.
9. Time use Analysis, Special Issue, Transportation, 26, Kluwer Academic Publishers, 1999

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE6228	**ADVANCED TRAVEL DEMAND MODELING**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Qualitaive variables:** Role of Soft variables in Travel Demand Forecasting; Attitudes; Psychometric scaling Techniques – One-dimensional Scaling – Multidimensional Scaling; Basic Rating Scales: Comparative Rating Scales, Non – Comparative Rating scale, Itemised rating scale, graphic rating scale; Specific Attitude scales; Successive Categories; Principal Components Factor Analysis; Attitudinal Models.	**6**	**15**
II	**Discrete choice analysis:** Utility Concept; Mode choice; Logit Models; Dogit Model; Nested Logit Model; Probit Model; Route Choice Modelling; Combined Travel Demand Modelling; Model Parameter Estimation – Maximum Likelihood and Maximum Entropy Estimates.	**8**	**15**
FIRST INTERNAL EXAM			
III	**Stated preference methods:** Stated preference vs. Revealed Preferences; Design Issues; Survey Methods, Conjoint Analysis; Functional Measurement; Trade off Analysis, Transfer Price Method. **Time use analysis:** Activity patterns; Activity scheduling; Activity Time Allocation studies; Activity Episode Analysis; Travel Duration Analysis	**6**	**15**
IV	**Model aggregation and Model Transferability:** Aggregation bias and forecasting; Aggregation Methods; Temporal Stability and geographical stability of Models; Transfer Model Updating Procedures – Transferring with Aggregate and Disaggregate sample data; Transferability Measures	**6**	**15**
SECOND INTERNAL EXAM			
V	**Simplified transport demand models:** Sketch planning Methods; Incremental Demand Models; Model estimation from traffic Counts; IVF Models, Marginal and Corridor Models; Gaming Simulation, Quick Response Techniques	**8**	**20**
VI	**Introduction to advanced Modeling techniques:** GO Models; Entropy Models; Equilibrium Assignment Techniques, Multipath Assignment – Dial's Algorithm,	**8**	**20**

	Knowledge Based Expert System; Neuro – Fuzzy Application; ANN Techniques; Genetic Algorithms; Object Oriented Programming; Decision Support Systems; Goal Programming		
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6230	**PLANNING AND DESIGN OF NON MOTORISED TRANSPORTATION**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. The concept of NMT and its benefits
2. Knowledge in planning and design of NMT facilities
3. Ability to evaluate and prioritize bicycle and pedestrian plans with safety considerations.

Syllabus

Transport planning process
Evaluation and prioritization of NMT by conducting various analysis
Planning process and standards for pedestrian and bicycle facilities
Implementation, operation and maintenance
Safety assessment

Course Outcome

1. Quantify the benefits of creating walkable and bikeable environments.
2. Design pedestrian and bicycle facilities.
3. Establish processes to create, implement, and evaluate bicycle and pedestrian plans.
4. Assess bicycle and pedestrian safety.
5. Prepare comprehensive plans for encouraging non-motorized transportation.

References

1. ADB, Guidelines for Non-Motorised Transport Measures: Policy and Options, Asian Development Bank, 2008. http://sti-india-uttoolkit.adb.org/mod5/se2/002.html
2. Sekadi Phayane, Marianne Vanderschuren, Gail Jennings, L. Newton–Reid, Non-Motorised Transport – Best Practice Manual, Department of Environmental Affairs, south Africa, 2014.
3. Fruin J. J., Pedestrian Planning and Design, McGraw Hill Publication, 1987.
4. Hudson .M, The Bicycle Planning, Open Books, 1982.
5. IRC codes for Design and Layout of Cycle Tracks and Pedestrian Facilities.
6. IRC 11-1962.
7. John Forester, Bicycle Transportation: A Handbook for Cycling Transportation Engineers, MIT Press, 1994.
8. Myer Kutz, Editor, Handbook of Transportation Engineering, McGraw-Hill Publishers, 2004.
9. Rodney Tolley, Editor, Sustainable Transport: Planning for walking and cycling in urban environments; CRC Press, 2003.
10. Yedla, Sudhakar, Urban Transportation and the Environment Issues, Alternatives and Policy Analysis, Springer India, 2015.
11. Planning and Design Guideline for Cycle ... - TRIPP (IIT Delhi) http://tripp.iitd.ernet.in/publications/other_pub/Planning%20and%20Design%20Guideline%20for%20Cycle%20Infrastructure.pdf
12. https://www.peelregion.ca/pw/construction/pdf/pedestrian-bicycle-facility-design-guidance.pdf

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE6230	**PLANNING AND DESIGN OF NON MOTORISED TRANSPORTATION**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Transport Planning Overview:** Planning Process; Measuring Current Non-motorized Travel; Predicting Potential Non-motorized Travel; Evaluating Existing Conditions and Prioritize Improvements	**6**	**15**
II	**Evaluation of Non-motorized Transportation:** Surveys, Demand Estimation and Analysis; Crash Data, Barrier Effect; Cycling Condition Evaluation Techniques; Pedestrian Condition Evaluation Techniques; Prioritizing Improvements and Selecting Preferred Options	**6**	**15**
FIRST INTERNAL EXAM			
III	**Planning for Pedestrians:** Types of pedestrians and Characteristics; Pedestrian facilities and planning; Pedestrian standards and improvements; Pedestrian facility Design, LOS; Pedestrian safety programs	**6**	**15**
IV	**Planning for Bicyclists:** Types of cyclists and Bikeways; Integrating cycling into roadway planning; Bicycle network planning; Accommodating cyclists on rural roads; Design of Bicycle boulevards/bike paths; Bicycle Parking/storage Facilities; Roadway maintenance for cyclists	**6**	**15**
SECOND INTERNAL EXAM			
V	**Safety Programs:** Safety education; Traffic law enforcement **Implementation Strategies and Tools:** Comprehensive plans; Road design, reconstruction and maintenance requirements; Major projects and site plan agreements; Land Use Connectivity, Urban Design exchange, Rural areas, utility corridors	**10**	**20**
VI	**Operations and Maintenance:** Operations and Maintenance Resources/Costs; Signs and Pavement Markings; Routine and Remedial Operations; Routine maintenance	**8**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE6292	**MINI PROJECT**	0-0-4 (2)	

Course Objectives

To give the Student:-

1. Capability for identifying, understanding and analyzing a transportation problem and to provide appropriate solutions.
2. Ability to explain and present the problem and its solution individually.

Approach

The student shall present two seminars and submit a report. The first seminar shall highlight the topic, objectives, methodology, design and expected results. The second seminar is the presentation of the work / hardware implementation. Conference/Publication and MOOC courses will be considered among the criteria for the final evaluation.

Course Outcome

Upon successful completion of the mini project, the student should be able to

1. Identify and solve various problems associated with designing and implementing a system or application.
2. Test the designed system or application.

COURSE CODE	COURSE NAME	L-T-P (C)
08CE6294	**TRANSPORTATION ENGINEERING LAB**	0-0-2 (1)

Course Objectives

To give the Student:-

1. Awareness about the practical problems on traffic engineering and road safety
2. An introduction to various analysis and planning softwares
3. Ability to conduct various traffic studies for design and management of road facilities.

Syllabus

Traffic Surveys: Volume count, Speed study, Parking study, Intersection turning movements, Speed and Delay study, Moving observer survey, Traffic noise measurement, Vehicle emission testing, Road lighting, Driver reaction time. Road side and house hold interviews.

Course Outcome

1. Knowledge on analysing and solving traffic engineering problems
2. Ability to work with transportation planning softwares

References

1. C. Jotin Khistyhttp://www.amazon.com/Transportation-Engineering-Introduction-3rd-Edition/dp/0130335606/ref=sr_1_1?s=books&ie=UTF8&qid=1339240659&sr=1-1 and, B. Kent Lall, Transportation Engineering: An Introduction, Prentice Hall; 3rd Edition, 2002.
2. Currin, Introduction to Traffic Engineering: Manual F/data Collect & Analysis, CL Engineering, 2nd Edition, 2012.
3. L.R. Kadiyali, Traffic Engineering and Transportation Planning, Khanna Publishers, 2011.
4. Pignataro LJ. Traffic Engineering: Theory and Practice; Prentice hall, Inc, 1973
5. Roger P. Roesshttp://www.amazon.com/Traffic-Engineering-4th-Roger-Roess/dp/0136135730/ref=sr_1_1?s=books&ie=UTF8&qid=1338960921&sr=1-1,
6. Elena S. Prassas and William R. McShane, Traffic Engineering, Prentice Hall, 4th Edition, 2010.

List of Experiments

A. Traffic Engineering Studies (Field Studies):

1. Volume Studies – Straight Roads and at Intersections 2. Origin and Destination Survey.
2. Parking Surveys and Parking Turnover Studies
3. Speed Studies - Spot Speed Studies by Stop Watch, Enosocpe and Radar Speed Meter
4. Journey Time and Delay Studies - Floating Car Method
5. Headway and Gap-acceptance studies.
6. Delay Measurement at Signalised and Unsignalised Intersections
7. Road Safety Audit.
8. Traffic noise measurement.

B. **Study of Driver Characteristics**:

1. Reaction Time
2. Visual Acuity
3. Glare Recovery.

C. Software lab:

1. GIS Software
2. TransCAD
3. EMME
4. HDM-4
5. Detailed drawings using CAD software
6. VISSIM

SEMESTER III

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE7201	**HIGHWAY GEOMETRIC DESIGN**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. Concept of various highway system elements and their characteristics
2. Expertise in the geometric design of highway alignments and intersections
3. Idea of evaluation measures of highway design consistency
4. Knowledge in designing road side infrastructure such as parking and bus bays.

Syllabus

Highway System – Classification, components, characteristics
Horizontal alignment of roads
Vertical alignment of roads
Consistency evaluation of highway geometry
Design of intersections
Design of road side infrastructure

Course Outcome

1. Ability to understand the highway system and design highway geometry
2. Ability to evaluate the geometric design in relation to safety
3. Ability to design required type of road intersections road side facilities.

References

1. L.R.Kadiyali and N.B.Lal, Principles and Practice of Highway Engineering, Khanna, 2007.
2. L.R.Kadiyali, Traffic Engineering and Transportation Planning, , Khanna Publications, 2007.
3. C.E.G.Justo and S.K.Khanna, Highway Engineering, Nem Chand and Brothers, 2015.
4. IRC Codes for Signs, Markings and Mixed Traffic Control in Urban Areas.
5. Gianluca Dell' Acqua, Fred Wegman, Transport Infrastructure and Systems: Proceedings of the AIIT International Congress on Transport Infrastructure and Systems (Rome, Italy, 10-12 April 2017), CRC Press, 2017.
6. United States Government Accountability, Transportation Infrastructure: Highway Pavement Design - Scholar's Choice Edition, 2015.
7. Lester A. Hoel, Nicholas J. Garber, Adel W. Sadek, Transportation Infrastructure Engineering: A Multimodal Integration, SI Version, Cengage Learning, 2010.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE7201	**HIGHWAY GEOMETRIC DESIGN**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Highway System:** Functional Classification of Highway System; Design Controls – Topography, Driver characteristics, Vehicle Characteristics, Traffic, Capacity and Level of Service, Design Speed. Objectives of Geometric Design, Cross Section Elements: Design specifications; Pavement Surface characteristics – Skid Resistance, Road Roughness; Camber, Objectives, design standards.	**6**	**15**
II	**Horizontal Alignment of Roads**: Sight Distances – Stopping Sight Distance, Overtaking Sight Distance and Intermediate Sight Distance ; Objectives of horizontal curves; Superelevation; Extra- widening on Curves; Transition Curves – Objectives and Design. Transition Curve setting methods, Introduction to MX Roads software.	**6**	**15**
FIRST INTERNAL EXAM			
III	**Vertical Alignment of Roads**: Gradients – Types of Gradients, Design Standards; Vertical Curves – Summit Curves, Valley Curves and Design criteria for Vertical Curves; Importance of Sight Distances for Horizontal and Vertical Curves ; Combination of Vertical and Horizontal Curves – Grade Compensation	**6**	**15**
IV	**Geometric Design Consistency**: Concept of consistency, Evaluation Measures, Existing criteria for evaluation of consistency. Correlation between highway safety and consistency.	**6**	**15**
SECOND INTERNAL EXAM			
V	**Geometric Design of Intersections** : Types of Intersections; Design Principles for Intersections; Design of At-grade Intersections – Channelization, Objectives; Traffic Islands and Design standards; Rotary Intersection – Concept, Advantages and Disadvantages; Grade separated Interchanges – Types, warrants and Design standards.	**10**	**20**
VI	**Miscellaneous Elements**: Requirements of Pedestrians; Pedestrian facilities on Urban Roads; Cycle Tracks – Guidelines and Design standards; Bus bays –Types and	**8**	**20**

	Guide lines; Design of On-street and Off street Parking facilities – Guidelines for lay out Design, Traffic Signs and Markings.		
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE7203	**PAVEMENT EVALUATION AND MANAGEMENT**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. The ability to measure the performance of pavements
2. The ability to evaluate the adequacy and life of pavements
3. The capability of maintaining and managing the pavements

Syllabus

Structural and functional requirements of pavements – serviceability – pavement distresses – pavement condition survey – pavement roughness – design of overlay – destructive testing – performance prediction models – pavement management system – priority programming – life cycle cost analysis – economic evaluation and optimization tools.

Course Outcome

1. Students will be able to evaluate structural and functional performance of pavements
2. Students will be able to conduct pavement condition survey
3. Students will be enabled to manage and prioritise various road construction processes.
4. Students will be able to use various optimization tools for economizing resources.

References

1. Shahin, M.Y, Pavement Management for Airports, Roads and Parking lots, Chapman & Hall, 2005.

2. Haas. R, Hudson.W. Zaniewsk John, Modern Pavement Management, Kreiger Publishing Company, 1994.

3. Yang H Huang, Pavement Analysis and Design, Prentice Hall, 2004.

4. Latest revisions of IRC codes: IRC: 81 and IRC: 82

5. Prithvi S. Kandhal, Mary Stroup-Gardiner, Flexible Pavement Rehabilitation and Maintenance, Issue 1348, ASTM International, 1998.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE7203	**PAVEMENT EVALUATION AND MANAGEMENT**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	Structural and functional requirements of flexible and rigid pavements, Pavement performance, Serviceability concept, Factors affecting pavement surface condition, Pavement distresses, Causes, Methods of measurement, Maintenance treatments.	**6**	**15**
II	Pavement Condition Survey -Pavement Condition Index(PCI) – Estimation of PCI by Shahin's Deduct value method- Pavement surface condition: Skid resistance	**6**	**15**
FIRST INTERNAL EXAM			
III	Characterisation of roughness- Equipments for measuring roughness, profile indices, International Roughness Index (IRI), Factors affecting pavement structural condition, Structural evaluation by Non- Destructive Tests, Types – Benkelman Beam Deflection (BBD) measurement	**6**	**15**
IV	Falling Weight Deflectometer, Design of overlay using BBD data (IRC method), Destructive structural evaluation, Structural Capacity Index, Pavement performance prediction models: Mechanistic–Empirical, Regression, Stochastic, Static and Dynamic models	**8**	**15**
SECOND INTERNAL EXAM			
V	Pavement Management System (PMS): Concept, Objectives, Components of PMS, PMS functions, General Structure, Types of pavement Maintenance actions: Preventive and Corrective maintenance, Maintenance policy, Pavement management levels: Network, Programme and Project level, Priority programming of maintenance and rehabilitation actions	**8**	**20**
VI	Life Cycle Cost Analysis, Heuristic Approach: Decision Matrix and Decision Tree based on Economic Evaluation and Optimisation, Tools for Pavement Management: HDM-4, Road Economics Decision Model	**8**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE7205	**SOFT COMPUTING TECHNIQUES**	3-0-0 (3)	

Course Objectives

To acquaint the students with soft computing methodologies such as neural networks, fuzzy logic, genetic algorithms and hybrid algorithms and enable the students to implement real time intelligent and adaptive systems.

Syllabus

Introduction to Fuzzy logic, Fuzzification, Defuzzification methods, Artificial Neural Networks concepts, Fundamentals of genetic algorithms and hybrid systems.

Course Outcome

The students will be able to apply soft computing methodologies to implement real time intelligent and adaptive systems.

References

1. S. Rajasekharan, G. A. Vijayalakshmi Pai, Neural Network, Fuzzy Logic and Genetic Algorithms Synthesis and Applications, Prentice Hall India, 2003.
2. S. N. Sivanandam, S. N. Deepa, Principles of Soft Computing, Wiley India, 2007.
3. Timothy J Ross, Fuzzy logic with Engineering Applications, 4TH Edition, McGraw Hill, 2016.
4. S. Haykins, Neural Networks a Comprehensive foundation, 2nd edition, Prentice Hall, 1998.
5. D. E. Goldberg, Genetic Algorithms in Search Optimisation and Machine Learning, Pearson Education, 1989.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE7205	**SOFT COMPUTING TECHNIQUES**	**3-1-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Introduction to Fuzzy logic**: Fuzzy sets- Fuzzy set operations- Fuzzy relations-Cardinality of Fuzzy relations- Operations on Fuzzy relations-Properties of Fuzzy relations-Membership Functions-Features of Membership functions- Fuzzification-Methods of Membership value Assignments- Fuzzy Rule Base-Defuzzification- Deffuzzification methods- Fuzzy logic controller(Block Diagram)	**8**	**15**
II	**Artificial Neural Networks:** Basic concepts-Neural network Architectures-Single layer feed forward network- Multilayer feed forward network.	**7**	**15**
FIRST INTERNAL EXAM			
III	**Recurrent Networks**-Characteristics of Neural Networks-Learning methods. Perceptron networks-Back Propagation networks-Radial base function network-Hopfield network- Kohonen Self	**7**	**15**
IV	**Fundamentals of genetic algorithms**: Basic concepts- working principle – encoding – different methods – Fitness function – reproduction-different methods. Genetic modelling-inheritance-Crossover mutation- Convergence of genetic algorithm	**6**	**15**
SECOND INTERNAL EXAM			
V	**Hybrid systems**: Neural network, fuzzy logic and genetic algorithm hybrids – Neuro fuzzy hybrids- neuro genetic hybrids-Fuzzy genetic hybrids	**7**	**20**
VI	**Genetic algorithm based back propagation network- Fuzzy back propagation networks** –fuzzy logic controlled genetic algorithms.	**7**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE7207	**WATERWAY INFRASTRUCTURE PLANNING AND DESIGN**	3-0-0 (3)	

Course Objectives

To give the student

1. Knowledge in planning and design of various waterway infrastructure facilities like harbor and docks
2. Ability to plan and design coastal protection works
3. Knowledge about various navigational aids
4. Awareness about potential of inland navigations

Syllabus

Harbour Planning – various harbor works – docks and repair facilities – port facilities – dredging and coastal protection – inland navigation and its potential

Course Outcome

Students will be able to

1. Plan and design harbour facilities
2. Estimate Traffic demand for harbour planning
3. Discriminate harbour works, berthing structures and transit sheds
4. Understand repair facilities, port facilities and cargo handling facilities required
5. Design coastal protection facilities
6. Understand navigational aids and inland navigation for safe operations.

References

1. Bindra, S.P. A Course in Docks and Harbour Engineering, Dhanpat Rai & Sons, New Delhi, India, 2012.
2. Seetharaman, S. Dock and Harbour Engineering, Umesh Publications, New Delhi, India, 1999.
3. Srinivasan, R., Harbour, Dock and Tunnel Engineering, Charotar Publishing House, Anand, India, 2009.
4. Bart Wiegmans, Rob Konings, Inland Waterway Transport: Challenges and Prospects, Routledge, 2016.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE7207	**WATERWAY INFRASTRUCTURE PLANNING AND DESIGN**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Harbour Planning:** Types of water transportation, water transportation in India, requirements of ports and harbours, classification of harbours, selection of site and planning of harbours, location of harbour, traffic estimation, master plan, ship characteristics, harbour design, turning basin, harbour entrances, type of docks, its location and number, Site investigations – hydrographic survey, topographic survey, soil investigations, current observations, tidal observations.	**6**	**15**
II	**Harbour Works:** Design and construction of breakwaters, berthing structures - jetties, fenders, piers, wharves, dolphins, trestle, moles, navigational aids, requirements of signals, fixed navigation structures, necessity of navigational aids, light houses, beacon lights, floating navigational aids, light ships, buoys, radar.	**8**	**15**
FIRST INTERNAL EXAM			
III	**Docks and Repair Facilities:** Harbor docks, use of wet docks, design of wet docks, repair docks, lift docks, dry docks, keel and bilge blocking, construction of dry docks, gates for dry docks, pumping plant, floating docks, slipways, locks, size of lock, lock gates, types of gates.	**6**	**15**
IV	**Port facilities:** Port development, port planning, port building facilities, transit sheds, warehouses, cargo handling facilities, container handling terminal facilities, shipping terminals, inland port facilities.	**6**	**15**
SECOND INTERNAL EXAM			
V	**Dredging and Coastal Protection:** Classification, types of dredgers, choice of dredger, uses of dredged materials, coastal erosion and protection, sea wall, revetment, bulkhead, coastal zone and beach profile.	**8**	**20**
VI	**Inland Navigation and its potential:** Inland waterways, Inland water transportation in India, classification of waterways, economics of inland waterways transportation, national waterways	**8**	**20**

END SEMESTER EXAM

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE7209	**LAND USE TRANSPORTATION PLANNING**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. Insight about the effect of land use in transportation planning
2. Knowledge about activity based modeling approach
3. Knowledge in modeling travel demand of people and goods

Syllabus

Land Use And Transportation Engineering, Land Use Transportation and Activity Models, General Travel Demand Models and Regional Transport Models, Regional Transport Models, Regional Network Planning, Advanced Spatial analysis Modelling

Course Outcome

1. Understand urban regional dynamics
2. Prepare integrated land use and transportation plans for a city
3. Estimate demand for both passenger and goods travel at regional level
4. Plan and evaluate regional transportation networks

References

1. Jhan De Dios Ortuzar. Luis E. Willumsen, Modelling Transport, 4TH EDITION, John Wiley& Sons. 2011.

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4. S. R. Chari, Land Use Transportation Planning Notes, REC Warangal.

5. A. G. Wilson, Entropy in urban and regional modelling, Pion, London 1970.

6. Michael Batty, Urban Modeling. Algorithms, Calibrations, Predictions, Cambridge University Press, 2010.

7. Peter R. Stopher Arnim. H. Meyburg, Behavioral Travel Demand Models, Lexington Books, 1976.

8. Morlok E K, Introduction to Transportation Engineering and Planning, McGraw Hill, 1978.

9. Yan Liu, Modelling Urban Development with Geographical Information Systems and Cellular Automata, CRC Press, 2008.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE7209	**LAND USE TRANSPORTATION PLANNING**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Land Use And Transportation Engineering**: Transportation modeling in Planning; Models and their role, Characteristics of Transport demand and supply, Equilibrium of supply and demand, Modeling and decision making, Issues in Transportation modeling and structure of the classic transport model.	**6**	**15**
II	**Land Use Transportation and Activity Models**: Introduction to Land Use Planning; Relation between Transportation and Land Use Planning; The economic base mechanism and allocation mechanism; Spatial allocation and employment interrelationship; Garin Lowry models.; Activity modeling	**8**	**15**
FIRST INTERNAL EXAM			
III	**General Travel Demand Models and Regional Transport Models**: Aggregate, Disaggregate models ; Behavioral models; Recursive and direct demand Models; Linear, Non-Linear models; Logit, discriminant and probit models; Mode split models - Abstract mode and mode specific models.	**8**	**15**
IV	**Regional Transport Models**: Factors affecting goods and passenger traffic; Prediction of traffic; Growth factor models; Time function iteration models; internal volume forecasting models.	**6**	**15**
SECOND INTERNAL EXAM			
V	**Regional Network Planning**: Problems in Developing Countries, Network Characteristics - Circuitry, Connectivity, Mobility, Accessibility and Level of Service Concepts - Network Structures and Indices – Network Planning – Evaluation - Graph Theory – Cut sets – Flows & Traversing – Optimum Network - Inter-modal Co-ordination. – Rural Road Network Planning.; User equilibrium concepts	**8**	**20**
VI	**Advanced Spatial analysis Modelling**: Applications of Artificial Neural networks, Cellular automata, Fuzzy logic systems, Genetic algorithms, artificial intelligence concepts to transportation Modelling	**6**	**20**

END SEMESTER EXAM

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE7211	**SUSTAINABLE TRANSPORTATION**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. Awareness about the importance of sustainability in transportation planning
2. Knowledge of various aspects of sustainable transportation
3. Ability to develop a transportation system which is sustainable
4. Knowledge about pricing policies related to transportation.

Syllabus

Problem of Sustainability in Transport, Pricing Transportation, Planning for Sustainability, Sustainable Policies, Sustainable Technology, Nationally Appropriate Mitigation Actions

Course Outcome

1. Ability to define sustainable transportation and differentiate sustainable transportation systems from non-sustainable transportation systems
2. Ability to develop a sustainable transportation system.
3. Ability to perform methods to improve sustainability in freight transportation.
4. Ability to suggest policies that improve the sustainability of transportation.

References

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2. Black, W.R., Sustainable transport: Problems and Solutions. Gulford Press, New York, 2010.

3. Cervero, R. Accessible Cities and Regions: A Framework for Sustainable Transport and Urbanism in the 21st Century. Center for Future Urban Transport, Institute of Transportation Studies, University of California, Berkeley, 2005

4. Mehrdad Ehsani, Fei-Yue Wang and Gary L. Brosch (Eds.) Transportation technologies for sustainability, 2013.

5. Preston L. Schiller, Eric C. Brunn and Jeffrey R. Kenworthy. An Introduction to Sustainable Transportation: Policy, Planning and Implementation, 2010.

6. Rodney Tolley, Editor, Sustainable Transport: Planning for walking and cycling in urban environments; CRC Press, 2003.

7. Tolley, R., Sustainable Transport: Planning for Walking and Cycling in Urban Environments, CRC Press, 2003

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE7211	**SUSTAINABLE TRANSPORTATION**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Problem of Sustainability in Transport:** Energy use in transport sector; Transport and climate change; Greenhouse gas emissions, urban air quality, Congestion and sustainability	**6**	**15**
II	**Pricing Transportation:** Full cost of transportation, pricing and taxation	**6**	**15**
FIRST INTERNAL EXAM			
III	**Planning for Sustainability:** Urban form, Indicator based planning, landuse transportation integration	**6**	**15**
IV	**Sustainable Policies:** Continuum of Policies, speed and speed limit policies, national policies, sustainable travel demand management; public awareness	**8**	**15**
SECOND INTERNAL EXAM			
V	**Sustainable Technology:** Telecommuting, Information and Communication technologies, E-commerce, Alternative Cleaner Fuels, vehicle technologies, fuel cells, Intelligent Transport Systems	**8**	**20**
VI	**Nationally Appropriate Mitigation Actions:** Mobility Management policies, Supporting Bicycling, Creating pedestrian friendly facilities, encouraging Public Transportation	**8**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE7213	**TRANSPORTATION ECONOMICS**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. The fundamental concepts and need for economics in transportation.
2. The ability to conduct economic analysis for different projects in transportation field.
3. Knowledge to apply the principles of economic theory in transportation planning process.

Syllabus

Fundamental concepts and overview of economic evaluation; Benefits due to Transport Improvements; Transport Costs, Accounting prices of goods and services; Economic Analysis: The generation and screening of project ideas; Application of economic theory in traffic assignment problem.

Course Outcome

The student will able to conduct economic analysis of transportation infrastructure projects.

References

1. David A. Hensher, Ann M. Brewer, “Transport: An Economics and Management Perspective”, Oxford University Press, 2001.
2. Emile Quinet, Roger Vickerman, “Principles Of Transport Economics”, Edward Elgar Publishing, 2005.
3. Road User Cost Study, Central Road Research Institute, 1983
4. Ian G. Heggie, Transportation Engineering Economics, McGraw Hill, 1972.
5. IRC:SP:30-1993, Manual on Economic Evaluation of Highway Projects in India
6. Kadiyali L.R., “Principles & Practice of Highway Engineering”, Khanna Publishers,2005
7. Khanna S.K., Justo C.E.G., “Highway Engineering”, Nem Chand & Bros., Roorkee, 2001
8. Woods, K.B., Berry, D.S. and Goetz, W.H., `Highway Engineering', McGraw Hill Book Co.
9. Winfrey R, Highway Economic Analysis, International Textbook Company.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE7213	**TRANSPORTATION ECONOMICS**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Introduction**- Significance of transport, Demand and supply of transport, Elasticity of demand and supply concepts and principles of highway engineering economy. Costs and Benefits Identification and measurements of transportation costs and benefits, Capital cost, Inflation cost Interest during construction, Maintenance cost, Road user costs, Fixed and operating costs.	**8**	**15**
II	**Benefits due to transport improvements**: Direct benefits- Reduced vehicle operation cost, value of travel time savings, value of increased comfort and convenience, cost of accident reduction, reduction in maintenance cost. Negative impacts due to increased noise and air pollution, Indirect benefits: increased land value, increased development and demand.	**6**	**15**
FIRST INTERNAL EXAM			
III	**Transportation costs**: fixed and variable cost, cost of improvement, maintenance cost and other related cost, cost estimation methods, accounting for inflation, theory of transport supply and road planning.	**8**	**15**
IV	Accident cost, Methodology for monetary evaluation of passenger's travel time, Value of increased comfort and convenience, Congestion cost and pricing, Consumer's surplus and social surplus criteria, Fare policy for bus transit.	**6**	**15**
SECOND INTERNAL EXAM			
V	**Economic analysis** – the generation and screening of project ideas. Different methods of economic analysis – capital budgeting. Case studies.	**6**	**20**
VI	**Application of economic theory in traffic assignment problem** – user optimal assignment and system optimal assignment. Economic analysis of projects – financing of road projects, methods of financing – PPP, toll collection. Economic variability of Build-Operate-Transfer schemes – Risk analysis.	**8**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE7215	**TRANSPORTATION SYSTEM MANAGEMENT**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. An understanding of different methods of data collection for transportation system management.
2. Knowledge to analyse traffic problems and plan transportation system management actions.
3. Fundamentals of management systems for parking and non-motorised transport

Syllabus

Fundamental concepts of Methodology & Data Collection; Area wide data collection methodology, corridor data collection methodology; TSM Actions; Public transportation & HOV treatment; Priority at ramp terminals; Demand management, Traffic Operations Improvement; Parking Management

Course Outcome

1. Understand TSM, the need for TSM and the objectives of TSM.
2. Apply a strategy based on a TSM goal or objective.
3. Recommend methods to manage a transit system to improve its management efficiency.
4. Recommend a detailed transportation demand management strategy for a transportation system based on a goal or objective.

References

1. D. Arlington, Transportation System Management in 1980: State of the Art and Future Directions, Transportation Research Board, 1980.
2. Manheim M, “Fundamentals of Transportation system approach”, MIT press, Cambridge, MA, 1985.
3. Institute of Transportation Engineers, Transportation and Traffic Engg. Hand Book, Prentice Hall, 1982
4. John G Schoon, “Transportation system and service policy”, Chapman and Hall, New York, 1996.
5. Meyer Michael D and Eric J Miller, “Urban Transportation Planning – A Decision Oriented Approach”, Mc Graw Hill, New York, 2001.
6. Michael D. Meyer, Transportation Planning Handbook: Institute of Transportation Engineers, John Wiley & Sons, 2016.
7. Piyushimita (Vonu) Thakuriah and D. Glenn Geers, Transportation and Information Trends in Technology and Policy, Springer New York, 2013.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE7215	**TRANSPORTATION SYSTEM MANAGEMENT**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Methodology & Data Collection:** Methodological frame work, objectives and problems, conflicts resolution, strategic categories and action elements. **Impact of TSM**: Travel behaviour impact and response time, TSM actions combinations and interactions, impact assessment and evaluation, monitoring and surveillance	**6**	**15**
II	**Area wide data collection** methodology, corridor data collection methodology. **TSM Actions**: Study of following TSM actions with respect to problems addressed, conditions for applications, potential implementation problems, evaluation & impact analysis	**8**	**15**
FIRST INTERNAL EXAM			
III	**Public transportation & HOV treatment** - Toll discounts for car pools during peak periods, park and ride, car pooling, exclusive lanes. Priority at ramp terminals, bus transfer stations, limited and skip-stop bus services, shared ride.	**6**	**15**
IV	**Demand Management**: Staggered work hours, flexible work hours, high peak period tolls, shuttle services, circulation services, extended routes	**6**	**15**
SECOND INTERNAL EXAM			
V	**Traffic Operations Improvement**: On-street parking ban, freeway ramp control & closure, travel on shoulders, one-way streets, reversible lanes, Traffic calming, Right turn phase, right turn lanes, reroute turning traffic.	**8**	**20**
VI	**Parking Management**: Short term reserved parking, increased parking rates, time duration limits, expanded off-street parking, Non Motorized Transport- pedestrian only streets, Dial a ride for elderly & handicapped.	**8**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE7217	**RAILWAY INFRASTRUCTURE PLANNING AND DESIGN**	3-0-0 (3)	

Course Objectives

To give the Student:-

1. Understanding of railway track, its components and purpose.
2. Understanding of planning and design of ordinary and high speed rail way tracks.
3. Awareness of rolling stock and measures to avoid rail accidents

Syllabus

Alignment of railway track, Permanent way, track maintenance and rehabilitation, Railway accidents, Rolling stock, Railway stations and yards, Signaling and interlocking, design of tracks for high speed.

Course Outcome

1. Ability to align and design a new track and associated facilities
2. Ability to plan, design and analyze the railway track system and signal system with the available methods.
3. Maintain the railway track and apply remedial measures.

References

1. Agarwal, M.M. Indian Railway Track, 19th edition, Prabha & Co., New Delhi, India, 2017.
2. Chandra S. and M.M. Agarwal Railway Engineering, Oxford University Press, New Delhi, India, 2007.
3. Gupta, B.L and B.L.Gupta. Railway Engineering, Standard Publishers, New Delhi, India, 2005.
4. Rangwala, S.C. Principles of Railway Engineering, Charotar Publishing House, Anand, India, 2014.
5. S.C. Saxena and S.P. Arora, A text book of Railway engineering, Dhanpat Rai, 2011.
6. Satish Chandra and M. Agrawal, Railway Engineering, Second Edition, Oxford University Press, 2013.
7. J. S Mundrey, Railway Track Engineering, Mc Graw Hill, 2009.

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE7217	**RAILWAY INFRASTRUCTURE PLANNING AND DESIGN**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Alignment of Railway Lines:** Modes of transportation, developments in railways, classification of railway lines, rail transportation in India, railway track gauges, choice of gauge, uni-gauge policy, ideal alignment, need for construction of new railway lines, traffic survey, reconnaissance survey, preliminary surveys, and engineering surveys, geometric design, gradients, grade compensation, speeds of trains, curves and superelevation, extra clearance on curves, widening of gauge on curves, cutting rails on curves.	**6**	**15**
II	**Permanent Way:** Requirements, capacity, cross-sections, forces acting on the track, coning of wheels, tilting of rails, function of rails, types of rails, rail wear, defects in rails, creep of rails, rail fixtures and fastenings, ballast, functions, types, sizes, physical properties, subgrade and formation, slopes of formation, switches, tongue rails, crossing, angle of crossing, turnouts, inspection and maintenance, track junctions and track layouts, symmetrical split, three-throw switch, double turnout, diamond crossing, scissors crossover, gauntleted track, gathering line, triangle, double junctions.	**6**	**15**
FIRST INTERNAL EXAM			
III	**Track maintenance and Rehabilitation:** Maintenance tools, maintenance of rail surface, track drainage, maintenance in track circuited lengths, track tolerances, mechanized method of track maintenance, off-track tampers, shovel packing, directed track maintenance, classification of renewal works, through sleeper renewals, mechanized relaying, track renewal trains.	**6**	**15**
IV	**Railway accidents:** Train accidents, derailments and its causes, restoration of traffic, safety measures, disaster management, classification of level crossings, accidents at level crossings, remedial measures, and maintenance of level crossings. **Rolling Stock:** Types of traction, locomotives and other	**8**	**15**

	rolling stock, brake systems, resistance due to friction, wave action, wind, gradient, curvature, starting, Tractive effort of a locomotive, hauling power of a locomotive.		
SECOND INTERNAL EXAM			
V	**Railway stations and yards:** Purpose, site selection, facilities, requirements, classification, platforms, building areas, types of yards, catch sidings, ship sidings, foot over bridges, subways, cranes, weigh bridge, loading gauge, end loading ramps, locomotive sheds, ash-pits, water columns, turntable, triangles, traverse, carriage washing platforms, buffer stop, scotch block, derailing switch, sand hump, fouling mark.	**8**	**20**
VI	**Signaling and interlocking:** Objectives, classification, fixed signals, stop signals, signaling systems, mechanical signaling system, electrical signaling system, systems for controlling train movement, interlocking, modern signaling installations. **Design of tracks for high speeds:** Modernization of railways, effect of high speed track, vehicle performance on track, high speed ground transportation system, ballastless track, elevated railways, underground and tube railways.	**8**	**20**
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE7219	**LOW VOLUME ROADS**	3-0-0 (3)	

Course Objectives

To give the student

1. The concept of rural road network planning
2. Ability to do the geometric design of rural roads keeping the standards.
3. Ability to do the structural design of rural road pavements
4. Knowledge regarding different materials that can be used in the pavement construction

Syllabus

Planning of low volume roads – geometric design – materials and use of waste materials for road construction – design of pavements – road construction – quality control in construction and maintenance.

Course Outcome

Students will be able to

1. Plan the rural road network.
2. Determine the sight distance, horizontal curvature, super elevation, grades, visibility on vertical curves, cross section elements.
3. Justify the geometric design standards adopted for low volume roads.
4. Plan surveys, and prepare survey forms.
5. Design both flexible and rigid pavements for low volume roads.

References

1. Veeraragavan, S.K Khanna and C.E.G. Justo, Highway Engineering, Nem Chand & Brothers, 2014.
2. Bruton, M. J., Introduction to Transportation Planning, UCL press, London, UK, 1992.
3. Robert A. Douglas, Low-Volume Road Engineering: Design, Construction, and Maintenance, CRC Press, 2017.
4. Ethiopian Roads Authority, Design Manual for Low Volume Roads, Parts A-G: http://www.icafrica.org/knowledge-publications/article/design-manual-for-low-volume-roads-parts-a-g-116/
5. Gordon Keller & James Sherar, Low-Volume Roads Engineering: Best Management Practices – Field Guide, USDA Forest Service/USAID, 2003.
6. IRC manual for rural roads. Special publication – 20(2002)
7. HMSO, Soil Mechanics for rural Engineers in, London
8. IRC related code books
9. NRRDA – guidelines and code books

COURSE PLAN

COURSE CODE	COURSE NAME	L-T-P (C)	
08CE7219	**LOW VOLUME ROADS**	**3-0-0 (3)**	
Modules	**Content**	**Contact Hours**	**Semester Exam Marks (%)**
I	**Planning of Low volume roads**: Introduction to planning of low volume roads, concepts of network planning, selection of roadway alignment, factors affecting rout selection, engineering surveys for new road location.	**6**	**15**
II	**Geometric design parameters**: basic principles of geometric design, design of horizontal alignment, curves, super elevation, design of vertical alignment, summit curve, and valley curve standard of design of low volume road.	**8**	**15**
FIRST INTERNAL EXAM			
III	**Materials:** Road materials for pavement construction, soil-subgrade, road aggregate, binder, test on soil, test on aggregates and test on bitumen, bituminous mix design, marshal stability method for mix design. **Waste material for pavement construction**: introduction, fly ash for road construction, design & construction, design &construction of fly ash embankment lime fly ash and stabilized soil, lime fly ash pavements, control of compaction, concrete stabilized fly ash with admixtures.	**6**	**15**
IV	**Design of pavement:** Factors affecting pavement design function of pavement components- Empirical and mechanistic empirical design procedures - design of flexible pavement by CBR method, Burmister layer and IRC method (IRC37-2012). Design of rigid pavement by using IRC method.	**6**	**15**
SECOND INTERNAL EXAM			
V	**Road construction:** Specifications of material and construction of sub grade, subbase, base and surface layer, construction of non bituminous road, construction of bituminous roads, equipment required for construction, maintenance of low volume roads.	**8**	**20**
VI	**Quality Control in Construction and Maintenance**: Introduction, Pre-requirements, organizational setup, specification and code of practice, Laboratory equipment, Earth and granular layers, bituminous courses, semi- rigid and rigid pavements, special requirements, recovered of quality control data. Distresses/Defects in rigid and flexible	**8**	**20**

	pavements, Maintenance and evaluation, inventory roads and inspections, types of Maintenance Activities, Maintenance		
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE7291	**SEMINAR – II**	0-0-2 (2)	

Course Objectives

To enable the students:

1. To Identify the current topics in the specific stream.
2. To Collect the recent publications related to the identified topics.
3. To Do a detailed study of a selected topic based on current journals, published papers and books.
4. To Present a seminar on the selected topic on which a detailed study has been done.
5. To Improve the writing and presentation skills

Approach

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study.

Course Outcome

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

1. Get good exposure in the current topics in the specific stream.
2. Improve the writing and presentation skills.
3. Explore domains of interest so as to pursue the course project.

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE7293	**PROJECT (PHASE I)**	0-0-12 (6)	

Course Objectives

To enable the students:

1. To do an original and independent study on the area of specialization.
2. To explore in depth a subject of his/her own choice.
3. To start the preliminary background studies towards the project by conducting literature survey in the relevant field.
4. To broadly identify the area of the project work, familiarize with the tools required for the design and analysis of the project.
5. To plan the experimental platform, if any, required for project work.

Approach

The project work can be a design project/experimental project and/or computer simulation project on any of the topic related to the stream of specialization. The project work is chosen individually on different topics. Work of each student shall be supervised by one or more faculty members of the department.

Phase I of the project is to be done in the Third semester and is continued in Fourth semester. Phase I includes identification of the topic, literature review, preliminary report and scope of the work which is to be completed in the 4th semester. Conference/Publication and MOOC courses will be considered among the criteria for the final evaluation.

Course Outcome

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

1. Get good exposure in the current topics in the specific stream.
2. Improve the writing and presentation skills.
3. Explore domains of interest so as to pursue the course project.

COURSE CODE	COURSE NAME	L-T-P (C)	2017
08CE7294	**PROJECT (PHASE II)**	0-0-21 (12)	

Course Objectives

To continue and complete the project work identified in project phase 1.

Approach

There shall be two seminars (a mid term evaluation on the progress of the work and pre submission seminar to assess the quality and quantum of the work). An original thesis has to be submitted on completion of the project work. At least one technical paper has to be prepared for possible publication in journals / conferences based on their project work. Conference/Publication and MOOC courses will be considered among the criteria for the final evaluation.

Course Outcome

Upon successful completion of the project phase II, the student should be able to

1. Get a good exposure to a domain of interest.

2. Get a good domain and experience to pursue future research activities.