**M. TECH. DEGREE**

**TRANSPORTATION ENGINEERING**

**DEPARTMENT OF CIVIL ENGINEERING**

**UNIVERSITY OF ENGINEERING & MANAGEMENT, JAIPUR**

**SYLLABUS**

**FOR**

**CREDIT BASED CURRICULUM**

**(With effect from 2018 - 2019)**

**SEMESTER- I**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Code** | **Course of Study** | **L** | **T** | **P** | **C** |
| TCE101 | Advanced Engineering Mathematics | 3 | 1 | 0 | 4 |
| TCE102 | Highway Materials | 4 | 0 | 0 | 4 |
| TCE103 | Traffic Engineering | 4 | 0 | 0 | 4 |
| TCE104 | Pavement Analysis and Design | 3 | 1 | 0 | 4 |
| TCE105 | Elective – I | 4 | 0 | 0 | 4 |
| TCE191 | Highway Material Testing Laboratory | 0 | 0 | 3 | 2 |
| TCE192 | Seminar-I | 0 | 0 | 2 | 1 |
|  |  | 16 | 2 | 5 | 23 |

**Elective -I**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Code** | **Course of Study** | **L** | **T** | **P** | **C** |
| TCE105(A) | Ground Improvement Technique | 4 | 0 | 0 | 4 |
| TCE105(B) | Modeling and Simulation in Transportation | 4 | 0 | 0 | 4 |
| TCE105(C) | Traffic Flow Theory | 4 | 0 | 0 | 4 |

**SEMESTER-II**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Code** | **Course of Study** | **L** | **T** | **P** | **C** |
| TCE201 | Urban Mass Transportation System | 4 | 0 | 0 | 4 |
| TCE202 | Transportation Planning | 3 | 1 | 0 | 4 |
| TCE203 | Statistical Methods in Transportation Engineering | 4 | 0 | 0 | 4 |
| TCE204 | Pavement Maintenance and Management System | 3 | 1 | 0 | 4 |
| TCE205 | Elective –II | 4 | 0 | 0 | 4 |
| TCE291 | CAD in Transportation Engineering | 0 | 0 | 3 | 2 |
| TCE292 | Seminar-II | 0 | 0 | 2 | 1 |
|  |  | 16 | 2 | 5 | 23 |

**Elective -II**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Code** | **Course of Study** | **L** | **T** | **P** | **C** |
| TCE205(A) | Human Resource Management | 4 | 0 | 0 | 4 |
| TCE205(B) | Transportation-Environment Interaction and Analysis | 4 | 0 | 0 | 4 |

**SEMESTER-III**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Code** | **Course of Study** | **L** | **T** | **P** | **C** |
| TCE301 | Teaching in Research Methodology | 4 | 0 | 0 | 4 |
| TCE381 | Project Work – Phase I (Dissertation) | 0 | 0 | 24 | 12 |
|  | Total | 4 | 0 | 24 | 16 |

**SEMESTER-IV**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Code** | **Course of Study** | **L** | **T** | **P** | **C** |
| TCE481 | Project Work – Phase II | 0 | 0 | 24 | 12 |
|  | Total | 0 | 0 | 24 | 12 |

**SYLLABUS**

**SEMESTER I**

**Title of Course:** Advanced Structural Analysis

**Course Code:** TCE101

**L-T Scheme:** 3-1 Course

**Credits:** 4

**Course Content:**

**Statistic:** Elements of statistic, frequency distribution; Concept of mean, median, mode and different types of distribution;Standard deviation and variance; Curve fitting by least square method; Correlation and Regression, Testing of Hypothesis;Basic type of factorial design and Analysis of Variance.

**Matrix operation:** Matrix operation Eigen value and Eigen vector by iterative methods. Diagonalisation and square matrix.

**Laplace transform, Fourier transform Fourier integral and their applications.**

**Numerical method:** Interpolation by Polynomial, Error analysis, Solution of system of linear equation by Gauss Seidaliterative method, Newton Raphson method Numerical Integration by Gauss quadrature, Solution of ordinary differentialequation by Rayligh-Ritz method**.**

**Ordinary Differential Equation:** i) 2nd order homogeneous equation ii) Euler Cauchy’s equation iii) Non homogeneouslinear equation.

**Partial differential equation:** i) Wave equation – one and two dimension ii) Heat equation- one dimensionand two dimension

**REFERENCE BOOK:**

1) Introductory Methods of Numerical Analysis by S. S. Sastry (PHI)

2) Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S. R. K. Lyengar, R. K. Jain (NewAge)

 3) An Outline of Statistical Theory, Vol. I, II by A. M. Goon, M. K. Gupta, B. Dasgupta (The World Press Pvt. Ltd.)

4) The Design of Experiments to Find Optimal Conditions by Yu. P. Adler, E. V. Markova, Ylu V. Granovsky (MIR,1975, Moscow)

5) Advanced Engineering Mathematics by Erwin Kreyszig (John Wiley & Sons, Inc)

6) Advanced Engineering Mathematics by Stanley Grossman & William R. Derrick (Harper & Row Publishers).

**Title of Course:** Highway Materials

**Course Code:** TCE102

**L-T Scheme:** 4-0 Course

**Credits:** 4

**Course Content:**

**Aggregates:** Classification, physical and strength characteristics, Proportioning of aggregates,

Aggregate texture and skid resistance, polishing of aggregates.

**Soil:** Classification, Structural and Constructional problems in soil subgrade, Identification and

strength tests, Soil-moisture movement, Sub-soil drainage, Soil stabilization, Characteristics and

use of Fly Ash, Bottom ash and Pond Ash.

**Bitumen:** Bitumen sources and manufacturing, Bitumen constituents, structure and Rheology,

Mechanical and engineering properties of bitumen, Tests on bitumen, Emulsions, Tar –

Properties, types, modifications, Durability of bitumen, Adhesion of bitumen, Modified bitumen.

**Bituminous Mixes:** Desirable properties of mixes, Design of bituminous mixes, Tests on

bituminous mixes, Fillers, Theory of fillers and specifications. Marshall, Hubbard Field &

Hveam Methods.

**Cement Concrete:** Constituents and their requirements, Physical, plastic and structural

properties of concrete, Factors influencing mix design, Design of concrete mixes for DLC and

PQC with appropriate admixtures like flyash and high range water reducing admixtures etc.

**REFERENCE BOOK:**

1. Krebs, Robert D. And Walker, R. D., “*Highway Materials*”, McGraw Hill Book Co., New York
2. Her Majesty’s Stationery Office, “*Soil Mechanics for Road Engineers*”,Ministry of Transport, Road Research Laboratory, UK
3. Her Majesty’s Stationery Office, “*Bituminous Materials in Road Construction*”, Ministry of Transport, Road Research Laboratory, UK
4. Her Majesty’s Stationery Office, “*Concrete Roads Design and Construction*”, Ministry of Transport, Road Research Laboratory, UK
5. Read, J. And Whiteoak, D., “*The Shell Bitumen Handbook*”, Fifth edition,Shell Bitumen, Thomas Telford Publishing, London
6. Relevant IRC and IS codes

**Title of Course:** Traffic Engineering

**Course Code:** TCE103

**L-T Scheme:** 4-0 Course

**Credits:** 4

**Course Content:**

**Scope of Traffic Engineering & Study of its elements:** Introduction, Objectives and Scope of Traffic Engineering; Components of Road Traffic – Vehicle, Driver and Road; Road User and Vehicle Characteristics and their effect on Road Traffic; Traffic Manoeuvers. Traffic Stream Characteristics- Relationship between Speed, Flow and Density

**Traffic Engineering Studies and Analysis:** Sampling in Traffic Studies, Adequacy of Sample Size; Objectives, Methods of Study, Equipment, Data Collection, Analysis and Interpretation (including Case Studies) of (a) Speed (b) Speed and Delay (c) Volume (d) Origin and Destination (e) Parking (f) Accidents.

**Design of Traffic Engineering Facilities:** Control of Traffic Movements through Time Sharing and Space Sharing Concepts; Design of Channelising Islands, T, Y, Skewed, Staggered, Roundabout, Mini-roundabout and other forms of AT-Grade Crossings including provision for safe crossing of Pedestrians and Cyclists; Grade Separated Intersections, their Warrants and Design Features; Bus Stop Location and Bus Bay Design, Design of Road Lighting

**Traffic Control Devices: Traffic Signs,** Markings and Signals; Principles of Signal Design, Webster's method of Signal Design, Redesign of Existing Signals including Case Studies; Signal System and Coordination.

**REFERENCE BOOK:**

1. Pignataro, L., Traffic Engineering – Theory & Practice, John Wiley, 1973.

2. Kadiyali, L.R., Traffic Engineering and Transport Planning, Khanna publishers, 2007.

3. The Institute of Transportation Engineers, Transportation and Traffic Engg. Hand Book, Prentice

Hall (1982) Chapters 8, 17, 21, 23 and 24.

4. O’Flaherty C A, Highways- Traffic Planning & Engineering, Edward Arnold, UK, 2002

5. McShane W R & Roess R P, Traffic Engineering, Prentice-Hall, NJ, 2010

6. IRC-SP41: Guidelines for the Design of At-Grade Intersections in Rural & Urban Areas

7. Salter, R J., Highway Traffic Analysis and Design, ELBS, 1996.

8. Matson, Smith and Hurd, Traffic Engineering, Mc-Graw Hill Book Co, 1955.

**Title of Course:** Pavement Analysis and Design

**Course Code:** TCE104

**L-T Scheme:** 4-0 Course

**Credits:** 4

**Course Content:**

**Introduction** : Components of pavement structure, importance of sub-grade soil properties on pavement performance. Functions of sub-grade, sub-base, base course and wearing course.

**Stresses in Flexible Pavements:** Stresses in homogeneous masses and layered systems, deflections, shear failures, equivalent wheel and axle loads.

**Elements in Design of Flexible Pavements :** Loading characteristics-static, impact and repeated loads, effects of dual wheels and tandem axles, area of contact and tyre pressure, modulus or CBR value of different layers, equivalent single wheel load, equivalent stress and equivalent deflection criterion, equivalent wheel load factors, climatic and environmental factors.

**Design Methods for Flexible Pavements:** California bearing ratio (CBR) , U.S. Navy method. Triaxial method, Mcleod method, Boussinesq’s and Burmister’s analysis and design method, IRC method for Flexible Pavement Design.

**Rigid Pavements:** Wheel load stresses, Westergaard’s analysis, Bradbury’s approach Arlington test, Pickett’s corner load theory and charts for liquid, elastic and soil of finite and infinite depths of subgrade. IRC Method of rigid pavement design.

**Temperature Stresses:** Westergaard’s and Thomlinson’s analysis of warping stresses,Combination of stresses due to different causes, Effect of temperature variation on Rigid Pavements.

**Reinforced Concrete Slabs:** Prestressed concrete slabs-general details. Design of Tie Bars and Dowel Bars.

**Road Construction:** Bituminous road construction procedures and specifications, Quality control requirements. Concrete Road construction: Construction methods, Quality control requirements, Joints in cement concrete pavements, reinforced cement concrete road construction. IRC & MORTH recommendations for construction of Bituminous and Concrete roads. Present practices being followed for quality assurance and speedy construction in the country like by NHAI.

Pavement analysis, design and construction without joints and in integral bridges, case studies of such construction adopted in the country including that in Delhi Metro.

**REFERENCE BOOK:**

1. Yoder and Witczak, *Priniciples of Pavement Design*, John Wiley and Sons
2. Yang. H. Huang, *Pavement Analysis and Design*, Second Edition, Prentice Hall Inc.
3. Rajib B. Mallick and Tahar El-Korchi, *Pavement Engineering* *–* *Principles and Practice*, CRC Press (Taylor and Francis Group)
4. W.Ronald Hudson, Ralph Haas and Zeniswki , *Modern Pavement Management*, Mc Graw Hill and Co
5. Relevant IRC Codes

**Title of Course:** Ground Improvement Technique

**Course Code:** TCE105A

**L-T Scheme:** 4-0 Course

**Credits:** 4

**Course Content:**

**Introduction:** Typical situations where ground improvement becomes necessary, Historical review of methods adopted in practice, Current status and the scope in the Indian context

**Methods of Ground Improvement**: Mechanical compaction, Dynamic compaction, Impact loading, Compaction by blasting, Vibro-compaction; Pre-compression, Dynamic consolidation, Design aspects of stone columns; Use of admixtures, Injection of grouts; Design guidelines and quality control, Design examples on preloading with sand drains, Road designs with Geo-synthetics

**Reinforced Earth:** Basic mechanism, Constituent materials and their selection; Engineering applications – Shallow foundations on reinforced earth, Design of reinforced earth retaining walls, Reinforced earth embankments structures, Wall with reinforced backfill, Analysis and design of shallow foundations on reinforced earth

**Geo-textiles:** Selection and engineering applications, Design examples, Stabilisation/Improvement of ground using Geo-membranes, Geo-cells, Geonets Geosynthetic walls.

**Soil Nailing :** Construction of underground structures, Landslide controls, Deep vertical cuts, contiguous piles

**Problematic Soils:** Use of ply soils, Improvement of saline soils, Improvement of black cotton soils, Collapsible soil, Dune Sand.

**REFERENCE BOOK:**

1. Moseley, M. P. and Kirsch K., ”Ground Improvement”, Spon Press, Taylor and Francis

2004

2. Mittal, Satyendra, “Ground Improvement Engineering”, Vikas Publishing House 2010

3. Koerner, R.M., ”Designing with Geosynthetics”’ Prentice Hall 1990

4. Saran, S., “Reinforced Soil and Its Engineering Applications”, I.K. International 2005

5. Rao, G.V., Geosynthetics – An Introduction, Sai Master Geoenvironmental Services

(P) Ltd. 2007

6. Jones, CJFP, “Earth Reinforcement and soil structure”, Thomas Telford 1996

7. Shukla, S.K., Yin, Jian-Hua, “Fundamentals of Geosynthetic Engineering”, Taylor & Francis

**Title of Course:** Modeling and Simulation in Transportation

**Course Code:** TCE105B

**L-T Scheme:** 4-0 Course

**Credits:** 4

**Course Content:**

**Introduction:** Transportation simulation & modeling, decision making, issues in transport modeling, structure of transport models

**Multivariate Data Analysis Techniques:** Types of Data, Basic Vectors and Matrices Sample Estimate of Centroid, Standard Deviation, Dispersion, Variance and Covariance, Correlation Matrices, Principal Component, Factor Analysis, Manova and Cross Classification Procedure in Multivariate Data Analysis and Application to Problems in Traffic and Transportation Planning, Best fit analysis, Distribution analysis.

**Simulation:** Elements and attributes, Random number generation, Pseudo random number generation, Cycle repeatability, Feedback & evaluation, Evaluation of system performance, Marginal & corridor simulation, Gaming simulation.

**Data and Spacing:** Sampling theory, Errors in modeling and forecasting, Data collection

methods, Network and zoning system

**Discrete Choice Models:** Theoretical framework, specification and functional form of models, statistical estimation and validation of models, binary choice, multinomial and nested logit models, modeling with stated preference data, model aggregation, updating and transferability.

**Simplified Transport Models:** Sketch planning method, Model estimation from traffic count.

**Time Series Analysis:** Basic Components of Time Series – Stationary and Non-Stationary

Process – Smoothing and Decomposition Methods – Correlation and Line Spectral Diagrams –Auto Correlations and Moving Averages.Study of large scale simulation models such as VIT, Transyt, Sigop etc.

**REFERENCE BOOK:**

1) Ortuzar de D.O. & Willumsen, L.G., “Modelling Transport”, John Wiley & Sons. 1993

2) Banks, J., Carson, J.S. and Nelson, B.L., “Discrete Event System Simulation”, Prentice-Hall of India. 1998

3) Ben-Akiva, Moshe and Lerman, S. R., ‘Discrete Choice Analysis: Theory and Application to Travel demand’, MIT Pressserie3s in Transportation Studies, USA 1985

4) Hutchinson, B.G. “Principles of Urban Transport Systems Planning”,

SCRIPTA Book Company. 1974

5)Joseph F. Hair, Jr., William C. Black, Barry J. Babin and Rolph E. Anderson, ‘Multivariate Data Analysis’, Prentice Hall. 2010

**Title of Course:** Traffic Flow Theory

**Course Code:** TCE105C

**L-T Scheme:** 4-0 Course

**Credits:** 4

**Course Content:**

**Traffic stream parameters -** Fundamental diagram of volume-speed-density surface. Discrete and continuous probability distributions. Merging manoeuvres - critical gaps and their distribution.

**Macroscopic models**- Heat flow and fluid flow analogies - Shock waves and bottleneck control approach.

**Microscopic models** - Application of queuing theory - regular, random and Erlang arrival and service time distributions - Queue discipline - Waiting time in single channel queues and extension to multiple channels.

**Linear and non-linear car following models** - Determination of car following variables - Acceleration noise.

**Geographical Information System** – Global Positioning System – Intelligent Transportation Systems - Area Traffic Control – Automatic Toll Collection – Smart Cards – Collision Detection System.

**REFERENCE BOOK:**

1. Drew, D.R., Traffic Flow Theory and Control, McGraw Hill., 1978.
2. TRB, Traffic Flow Theory - A Monograph, SR165, 1975.
3. Burrough P.A. and Rachel A. McDonell, Principles of Geographical Information Systems, Oxford Publication, 2004.
4. Sussman, J. M., Perspective on ITS, Artech House Publishers, 2005.

**Title of Course:** Highway Material Testing Laboratory

**Course Code:** TCE191

**L-P Scheme:** -0-3 Course

**Credits:** 2

**Course Content:**

**List of Experiments**

1. Identification tests on soils ; Heavy compaction test on subgrade soil
2. Triaxial test on pure subgrade soil
3. California Bearing Ratio test
4. Tests on aggregates – Determination of Deleterious substance as per IS code
5. Aggregate polishing and skid resistance test (demonstration); GSB mix design
6. Test for aggregate durability; Preparation of mix for BC/DBC/ SDBC
7. Tests on flyash, pondAsh and bottomash- gradation and other engineering properties required for use as embankment material
8. Tests on Bitumen – Penetration Test and Ductility test.
9. Tests on Bitumen – Softening point test and Thin Film Oven test
10. Elastic recovery/recovery test on binder
11. Marshall Bituminous Mix design, Bitumen viscosity test (Rotational viscometer); Retained stability test
12. Benkelman Beam test on road
13. Concrete Mix design – Sample preparations for DLC and PQC with proper ingredients and admixtures for economy.
14. Concrete Mix design – Testing of samples and statistical inferences.

**Title of Course:** Seminar- I

**Course Code:** TCE192

**L-P Scheme:** -0-3 Course

**Credits:** 1

**Course Content:**

The overall aim of the seminar series is to help develop an emerging field at the intersection of multi-disciplinary understandings of culture and education. It will build on the existing body of work on education and culture, but its aim is explore and develop new perspectives in this area. The objectives of the six exploratory seminars are:

* questions outlined above to showcase cutting edge research on education and culture from outstanding academic
* researchers from the UK and internationally to bring together seminar participants from different disciplines such as Sociology, Philosophy, Psychology, Human Geography, Media Studies as well as Education and to actively involve practitioners and users from each venue
* to encourage and financially support the participation of PhD students, Cultural Studies to use the seminars to develop links between academics and stakeholders in the arts,
* to engage a core group of policy makers
* library, media, community and educational sectors

**SEMESTER II**

**Title of Course:** Urban Mass Transportation System

**Course Code:** TCE201

**L-T Scheme:** 4-0 Course

**Credits:** 4

**Course Content:**

**Introduction**: Mass transit systems, Elements / components of transit systems; Urban Mass Transit systems- types, characteristics, suitability and adaptability of these systems; Evolution of urban transportation.

**Transit System Planning**: Planning needs; Short-range and long-range planning; Planning procedures and methodology, Data collection; Medium performance transit systems and high performance transit systems; trends in transit planning.

**Transit Demand Estimation and Evaluation:** Transit demand forecasting; transit mode evaluation; comparison and selection of most suitable transit mode.

**Transit System Operations:** Basic operational elements; transit travel characteristics; transit scheduling; transit line analysis – planning objectives, geometry, types and their characteristics, capacity of transit lines, system procedures for improving transit line capacity.

**Transit Networks and System Analysis:** Transit networks – types and their characteristics; transfers in transit networks; system analysis in transit – conceptual models, modeling procedures; terminal or station location planning – issues, objectives, station spacing decisions.

**Economics and Financing of Transit Systems:** Transit system performance and economic measures; transit fares – structure, collection and levels; financing of transit services; public and private integration of transit services

**Case studies of urban mass transportation systems adopted in India in recent years**

**including Delhi Metro, Jaipur Metro, metro bus service, mono rail etc.**

**REFERENCE BOOK:**

1. Vukan R. Vuchic, “Urban Transit – Operations, Planning and Economics”, John Willey and Sons, Inc., USA 2004
2. John W. Dickey and others, “Metropolitan Transportation Planning”, Tata McGraw-Hill Book Company Ltd., New Delhi 1980
3. C A O’Flaherty, ‘Transport Planning and Traffic Engineering’, Butterworth-Heinemann, Burlington 2006
4. C Jotin Khisty and B Kent Lall, “Transportation Engineering” Prentice- Hall of India Pvt Ltd., New Delhi 2003

**Title of Course:** Transportation Planning

**Course Code:** TCE202

**L-T Scheme:** 4-0 Course

**Credits:** 4

**Course Content:**

**Introduction to transportation planning:** Fields of transportation Engineering; System- Environment Ensemble; Transportation planning process; Transportation problems and problem solving process.

**Transportation data and survey methods:** Type of Transportation data and its sources, Data quantity and quality, Accuracy and Precision, Sampling techniques, sample sizes, Transportation Planning surveys – Documentation searches, Person surveys, Household surveys, In-transit surveys, Road-side surveys, etc.

**Transportation Modes and Technologies:** Technologies of Transport and System Components, Network Analysis; Minimum Path Algorithms, Path Characteristics, Path-Vehicle Interaction – Discrete Flows and Continuous Flows, Vehicle and its Performance, System Performance, Vehicle and Container, Weight to Volume relation, Terminal Planning, Operational Planning

**Four-stage Sequential Planning:** Urban transportation planning process; trip generation, correlation analysis and regression analysis; trip distribution, Growth factor methods and Synthetic methods; modal split models, first generation, second generation, behavioural models; minimum travel path computations; Trip assignments, route assignment, multiple assignment and network assignment.

**Land use–Transportation Planning:** Urban Forms, mobility and activity hierarchy; accessibility-based early-era models; Lowery’s model and its derivatives; Modern era models.

**REFERENCE BOOK:**

1. B. G. Hutchinson, “Principles of Urban Transport Systems Planning” Script Book Co., Washington 1974
2. Anthony J. Richardson, Elizabeth S. Ampt and Arnim H. Meyburg, Survey Methods for Transport Planning” Eucalyptus Press, Australia 1995
3. Roy Thomas, “Traffic Assignment Techniques”, Avebury Technical, Aldershot, England, 1991
4. C A O’Flaherty, ed , “Transport Planning and Traffic Engineering”, Butterworth Heinemann, Elsevier, Burlington, MA, 2006
5. C Jotin Khisty and B Kent Lall, “Transportation Engineering – An Introduction”, Prentice Hall of India Pvt Ltd., New Delhi 2003

**Title of Course:** Statistical Methods in Transportation Engineering

**Course Code:** TCE203

**L-T Scheme:** 4-0 Course

**Credits:** 4

**Course Content:**

**Probability distributions:** Introduction to probability and random variables, Binomial distribution, Poisson distribution, Geometric distribution, Hyper Geometric distribution, Normal distribution, Log-Normal distribution, Uniform distribution, Exponential distribution, Gamma distribution, Beta distribution, and Weibull distribution.

**Parameter Estimation and hypothesis Testing:** Random samples, sampling distributions of mean and variance. Point estimators, the method of maximum likelihood, and the method of moments. Confidence interval. Statistical hypothesis tests, Operations characteristic curve. Tests of hypothesis on the mean of a Normal Distribution, Tests of hypothesis on the means of two Normal distributions, The paired t-test, Tests of hypothesis on one variance, Tests of hypothesis for the equality of two variances, The testing of goodness of fit.

**Design and Analysis of Experiments:** Fundamental assumptions of analysis of variance, single factor experiments, Latin square and Greeco-Latin square designs, Design of experiments with several factors- Two factor factorial experiments.

**Regression and Correlation Analysis:** Introduction, Bi-Variate Normal distribution and the associated marginal and conditional distributions, estimation and analysis of simple regression models, correlation coefficients, analysis of correlation coefficients, Hypothesis tests associated with regression and correlation coefficients, curvilinear regression models, Multiple regression models, multiple and partial correlation coefficients..

**REFERENCE BOOK:**

**References:**

1. Hines, W. W. and Montgomery, D. C., et. al.; “Probability and Statistics in Engineering and Management Science”, John Wiley and Sons, New York, (1990)
2. Freund, J. E.; “Mathematical Statistics”, PHI, New Delhi, (1998)
3. Montgomery, D. C.; “Design and Analysis of Experiments”, 5th edition, John Wiley and Sons, INC., New York. (2007).
4. Johnston, J. and Dinardo, J.; “Econometric Methods”, 4th edition, McGraw-Hill International Editions, (1997).
5. Benjamin, J. R. and Cornell, C. A.; “Probability Statistics and Decision for Civil Engineers”,McGraw-Hill, (1960).

**Title of Course:** Pavement Maintenance and Management System

**Course Code:** TCE204

**L-T Scheme:** 4-0 Course

**Credits:** 4

**Course Content:**

**Pavement Evaluation and Performance:** General concept of pavement evaluation, evaluation of pavement performance, evaluation of pavement structural capacity, evaluation of pavement distress, evaluation of pavement safety.

**Types of Distress:** Structural and functional, serviceability, fatigue cracking, pavement deformation and behaviour in flexible and rigid pavements. Low temperature shrinkage cracking., Factors affecting performance, relation between performance and distress**.**

**Pavement Evaluation & Measuring Equipments:** Functional & Structural Evaluation, Functions Parameters such as Roughness, Distress, Rutting, Skid Resistance etc. Structural Parameters such as Structural Capacity. Benkelman Beam, Bump Integrators of various types, dynaflect. Demonstration of equipments for dynamic testing of pavements. Digital ultrasonic concrete tester. Radiographic and infra red testing. Pavement skid resistance measuring equipments, fatigue testing equipments, on-site and on- line testing with sensors, strain-gages LVDTs and data acquisition system.

**Pavement Overlays:** Flexible overlays and determination of overlay thickness. Rigid overlays and determination of overlay thickness including thin toppings. Design of Overlay by Benkelman Beam and Falling Weight Deflectometer.

**Design Alternatives – Analysis, Evaluation and Selection:** Framework for pavement design, design objectives and constraints, Basic structural response models, characterization of physical design inputs, Generating alternative pavement design strategies. Economic evaluation of alternative pavement design strategies, analysis of alternative designstrategies. Predicting distress, predicting performance, selection of optimal design strategies.

**Pavement Management System:** Introduction to Pavement Management System (PMS) & Maintenance Management System (MMS), construction, maintenance and rehabilitation. Feedback data system. Examples of Working Design and Management Systems. Implementation of a pavement management system.

**REFERENCE BOOK:**

1. Hass, R., Hudson, W.R. and Zaniewski, J. “Modern Pavement Management” Krieger. 1994
2. Fwa, T.F., “The Hand Book of Highway Engineering”, CRC Press, Taylor Francies Group. 2006
3. Shain, M.Y., “Pavement Management for Airports, Roads and Parking Lots”, Kluwer Academic Publishers Group. 2004
4. Khanna, S.K. and Justo, C.E.G., “Highway Engineering” Nem Chand & Bros, Roorkee (U.A.) 8th Ed. 2005
5. Hudson, W.R., Haas, R. and Uddin, W., “Infrastructure Management”, McGraw Hill. 1997 Hass R. & Hudson, W.R., “Pavement Management System”, Mc Graw Hill Company, Inc. New York 1978

**Title of Course:** Human Resource Management

**Course Code:** TCE205A

**L-T Scheme:** 4-0 Course

**Credits:** 4

**Course Content:**

**Human Resource Management :** Scope and Coverage, Structure and functions of HR Department, Role of HR Manager.

**Human Resource Planning :** Supply and Demand Forecasting methods, Manpower Inventory, Career Planning, Succession Planning, Personnel Policy, Human Resource Information System (HRIS)

**Recruitment and Selection :** Process, Sources, Methods of selection, Interviewing Method, Skills and Errors

**Performance Appraisal Systems** : Purpose, Methods, Appraisal instruments, 3600 Appraisal HR Score Card, Errors in appraisal, Potential Appraisal, Appraisal Interview.

**Human Resource Development** : Policy and Programmes, Assessment of HRD Needs, HRD, Methods : Training and Non-Training.

**Compensation Management** : Wages - Concepts, Components; System of Wage Payment, Fringe Benefits, Retirement Benefit.

**Industrial Relations in India :** Parties; Management and Trade Unions, Industrial Disputes : Trends, Collective Bargaining, Settlement Machineries, Role of Government , Labour Policy in India.

**Workers’ Participation in Management** : Concept, Practices and Prospects in India, Quality Circles and other Small Group Activities.

**Discipline Management** : Misconduct, Disciplinary action, Domestic Enquiry, Grievance Handling

**Strategic HRM :** Meaning, Strategic HRM vs Traditional HRM, SHRM Process, Nature of e-HRM, e- Recruitment & Selection, e-Performance Management, e-Learning

**REFERENCE BOOK:**

1. HRM, VSP Rao,
2. Agarwala T. - Strategic Human Resource Management, OUP
3. Aswathappa, K. - Human Resource Management, Tata McGraw Hill
4. Jyothi P. & Venkatesh, D.N. - Human Resource ,Management, OUP
5. Pattanayek, B. - Human Resource Management, PHI
6. Ramaswamy, E.A. - Managing Human Resources, OUP
7. Saiyadain, M.S - Human Resource Management : Tata McGraw Hill
8. Mondal Sabari & Goswami Amal - Human Resource Management: Vrinda Publications

**Title of Course:** Transportation-Environment Interaction and Analysis

**Course Code:** TCE205B

**L-T Scheme:** 4-0 Course

**Credits:** 4

**Course Content:**

**Introduction:** Interaction of transportation systems and facilities with surrounding environment, Impact of transportation on surrounding environment, impact of surrounding environment on transportation systems.

**Impact on Natural Environment:** Air quality impacts - sources of air pollutants, effects of air pollutants, key legislations and regulations, impact prediction approaches, identification and incorporation of mitigation measures; Noise Impacts - Basic information, key legislation and guidelines, impact prediction methods, identification and incorporation of mitigation measures, Noise barriers and their design; Ground water and marine pollution impacts; Environmental capacities of streets, Environmental Impact statements.

**Impact on Land Use and Value:** Conceptual approach for addressing socio-economic impacts; Visual impacts and criteria, scoring methodologies for visual impact analysis; Relocation impacts; Land value impacted due to transportation facility; Spatial reorganization and Regional Development impacts

**Environmental Impact Analysis:** Concepts of environmental impact analysis, key features of National environmental policy act and its implementation, screening in the EIA process, utility and scope of EIA process, Environmental protection acts EIA at national level, Conceptual approach for environmental impact studies, planning and management of impact studies, matrix and network methodologies for impact identification, description of the affected environmental – environmental indices; Public Participation – Objectives, and techniques for conflict management and dispute resolution, verbal communication in EIA studies .

**Energy Issues in Transportation:** Energy consumption, alternate transportation fuels, energy conservation, energy contingency strategies, energy analysis information and methods, Transportation alternatives.

**REFERENCE BOOK:**

1. CANTER, L.W., Environmental impact assessment, McGraw-Hill, 1997
2. Peter Morris & Riki Therivel, Methods of Environmental Impact Assessment, Routledge, 2001.
3. Denver Tolliver, Highway Impact Assessment, Greenwood Publishing Group, 1993.
4. Edward K Morlok, Introduction to transportation Engineering and Planning, Mc-Graw Hill Book Company, New Delhi
5. John W. Dickey and others, Metropolitan Transportation Planning, Tata McGraw-Hill Publishing Compant Ltd., New Delhi
6. C. Jotin Khisty and B Kent lall, Transportation Engineering – An introduction, Prentice-Hall of India Pvt Ltd, New Delhi.

**Title of Course:** CAD in Transportation Engineering

**Course Code:** TCE291

**L-P Scheme:** -0-3 Course

**Credits:** 2

**Course Content:**

**Transportation Software** – Mx Road, REI heads, HDM4, KENPAVE, M-E design of pavements as per AASHTO, TRIPS, MIGRAN, VISSIM, CUBE

**GIS and Remote Sensing Packages** – ArcGIS, Geo-Concept, GRAM++, ENVI, ERDAS Imagine, GPS

**Computer Aided Drafting** - DBMS concepts - Civil Engineering Databases – Data entry & Reports. Spreadsheet concepts – Worksheet calculations in Civil Eng, - Regression & Matrix Inversion, SPSS.

**REFERENCE BOOK:**

1. Rajaraman, V., Computer Oriented Numerical Methods, Prentice – Hall of India, 1995
2. Chapra S.C., and Canale R.P., Numerical Methods for Engineers, McGraw – Hill, 2004
3. Software Manuals

**Title of Course:** Seminar- II

**Course Code:** TCE292

**L-P Scheme:** -0-3 Course

**Credits:** 1

**Course Content:**

The overall aim of the seminar series is to help develop an emerging field at the intersection of multi-disciplinary understandings of culture and education. It will build on the existing body of work on education and culture, but its aim is explore and develop new perspectives in this area. The objectives of the six exploratory seminars are:

* questions outlined above to showcase cutting edge research on education and culture from outstanding academic
* researchers from the UK and internationally to bring together seminar participants from different disciplines such as Sociology, Philosophy, Psychology, Human Geography, Media Studies as well as Education and to actively involve practitioners and users from each venue
* to encourage and financially support the participation of PhD students, Cultural Studies to use the seminars to develop links between academics and stakeholders in the arts,
* to engage a core group of policy makers
* library, media, community and educational sectors

**SEMESTER- III**

**Title of Course:** Teaching and Research Methodology

**Course Code:** TCE301

**L-T Scheme:** 4-0 Course

**Credits:** 4

**Course Content:**

**Instruction:** Introduction to content, Elements of instruction, Learning objectives, Roles of the teacher and the learner in instruction

**Teaching and Learning:** Application of theories of learning to teaching and learning, Sequence of learning and Strategies of learning, Teaching methods, their merits and demerits, Use of ICT in teaching & learning, Classroom management, Individual differences.

**Planning for teaching and learning:** Understanding the syllabus, Preparation of a scheme of work, Lesson plan preparation, Micro teaching.

**Assessment and Evaluation:** Define measurement, assessment, test, evaluation, Purpose of assessment and evaluation, Types of tests, Grading and reporting the results assessment. Evaluating teaching and learning

**Definition and explanation of research:** Types and Paradigms of Research, History and Philosophy of Research (esp. Philosophical evolution, pathways to major discoveries & inventions), Research Process decision, planning, conducting, Classification of Research Methods; Reflective Thinking, Scientific Thinking.

**Research problem formulation:** Literature review- need, objective, principles, sources, functions & its documentation, Problem formulation esp. sources, considerations & steps, Criteria of a good research problem, Defining and evaluating the research problem, Variables esp. types & conversion of concepts to variables. Research design esp. Causality, algorithmic, quantitative and qualitative designs, and various types of designs. Characteristics of a good research design, problems and issues in research design; Hypotheses: Construction, testing, types, errors; Design of experiments especially classification of designs and types of errors.

**Problem solving:** Understanding the problem- unknowns, data & conditions, conditions - satisfiability, sufficiency, redundancy & contradiction, Separation of parts of the problem and conditions, notations; devising a plan- connection between data and unknown, similar/related problems, reuse of previous solutions, rephrasing/transforming the problem, solving partial or related problem, Transforming data and unknowns; carrying out the plan- esp. correctness of each step in multiple ways; Evaluation of solution and method- checking correctness of solution, different derivations, utility of the solution

**Data & Reports:**

Infrastructural setups for research; Methods of data collection esp. validity and reliability, Sampling; Data processing and Visualization especially Classification; Ethical issues especially. bias, Misuse of statistical methods, Common fallacies in reasoning. Research Funding & Intellectual Property; Research reports: Research Proposal & Report writing esp. Study objectives, study design, problems and limitations; Prototype micro- project report implementing a major part of all the above (compulsory assignment

**REFERENCE BOOK:**

1. Kothari C.R., Research Methodology: Methods and Trends.
2. Stuart Melville and Wayne Goddard - Research Methodology: An Introduction for Science & Engineering Students.