

**DEPARTMENT OF CIVIL ENGINEERING
NIT PATNA, PATNA-800005**

M. Tech

In

Civil Engineering
Specialization: Transportation Engineering

Course Structure

&

Detailed Syllabus

Effective From 2020-2021

COURSE STRUCTURE OF M.TECH. IN CIVIL ENGINEERING

SPECIALIZATION: TRANSPORTATION ENGINEERING

FIRST SEMESTER:

Prog.	CCMT Code	Group	Sem	Course code	Course Title	L	T	P	Credits	FM
CEPG	CETE	Core	1	PGCE1401	Transportation Planning	3	0	0	3	100
CEPG	CETE	Core	1	PGCE1402	Pavement Materials	3	0	0	3	100
CEPG	CETE	El-1	1	PGCE14XX	Elective-I	3	0	0	3	100
CEPG	CETE	El-2	1	PGCE14XX	Elective-II	3	0	0	3	100
CEPG	CETE	El-3	1	PGCE14XX	Elective-III	3	0	0	3	100
CEPG	CETE	Lab	1	PGCEL1401	Highway Material Lab	0	0	6	4	100
Total Credits						15	0	6	19	600

SECOND SEMESTER:

Prog.	CCMT Code	Group	Sem	Course Code	Course Title	L	T	P	Credits	FM
CEPG	CETE	Core	2	PGCE2401	Traffic Engineering & Management	3	0	0	3	100
CEPG	CETE	Core	2	PGCE2402	Pavement Analysis and Design	3	0	0	3	100
CEPG	CETE	El-4	2	PGCE24XX	Elective – IV	3	0	0	3	100
CEPG	CETE	El-5	2	PGCE24XX	Elective – V	3	0	0	3	100
CEPG	CETE	El-6	2	PGCE24XX	Elective – VI/Open Elective (IPR)	3	0	0	3	100
CEPG	CETE	Lab	2	PGCEL2401	Traffic Engineering Lab	0	0	6	4	100
Total Credits						15	0	6	19	600

THIRD SEMESTER:

Prog	CCMT Code	Group	Sem	Course code	Course Title	L	T	P	Credits	FM
CEPG	CETE	Lab	3	*PGCE3401	Seminar and Technical Report Writing(work to start in the end semester break-summer)	0	0	3	2	100
CEPG	CETE	El-7	3	PGCE34XX	Online Course (MOOCs/NPTEL/SYAYAM)	3	0	0	3	100
CEPG	CETE	Lab	3	PGCE3402	Dissertation (to be continued in 4 th Sem)				8	100
Total Credit						3	0	3	13	300

***Evaluation to be done in the beginning of 3rd Semester**

FOURTH SEMESTER:

Prog	CCMT Code	Group	Sem	Course code	Course Title	L	T	P	Credits	FM
CEPG	CETE	Lab	4	PGCE4401	Dissertation				12	100
Total Credits									12	100

Cumulative Total Credits									63	1600
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LIST OF ELECTIVES (Elective : I-II)

L-T-P: 3-0-0 (3 Credits)

First Semester Electives

1. PGCE1410: Airport Planning and Design
2. PGCE1413: Remote Sensing & GIS and their Applications
3. PGCE1416: Intelligent Transportation Systems
4. PGCE1417: Advanced Highway Design
5. PGCE1418: Traffic Flow Theory
6. PGCE1419: Highway Subgrade and Foundation
7. PGCE1311: Optimization Techniques in Civil Engineering
8. PGCE1424: Environmental Impact Assessment
9. PGCE1204: Ground Improvement Techniques
10. PGCE1430: Rural Roads Planning and Design

Second Semester Electives

1. PGCE2411: Highway Economics
2. PGCE2412: Railway Engineering
3. PGCE2414: Highway Construction Practices & Maintenance
4. PGCE2415: Multi-modal Transportation System Planning and Design
5. PGCE2420: Applied Probability and Statistics
6. PGCE2421: Urban Transportation Planning
7. PGCE2422: Pavement Management System
8. PGCE2426: Bridge Engineering
9. PGCE2427: Highway Project Management
10. PGCE2428: Hill Road Engineering
11. PGCE2429: Pavement Mechanics

PGCE1401 Transportation Planning

L-T-P: 3-0-0

Credits: 3

Prerequisite: Basic course in Transportation Engineering at B-Tech level.

Objectives: To introduce the transportation policy, transportation surveys, planning process, travel demand analysis and land use.

DETAILED COURSE OUTLINE:

	Lectures
1 Transportation planning process: Transport and socio-economic activities, Historical Development of Transport.	2
Urban transportation system planning: Travel demand forecasting process, Problem and solutions, Evaluation and choices, Implementation activities involved in Transport Analysis, Definition of study area, Zoning, types of	
2 Movements, types of Surveys, Home-Interview Survey, Commercial Vehicle Survey, Intermediate Public Transport Survey, Public Transport Survey, Roadside- Interview Survey, Cordon- Line Survey, Post-Card Questionnaire Survey, Registration- Number Survey, Tag-on-Vehicle Survey.	4
3 Trip Generation Analysis: Trip Classification, Trip production and attraction Analysis & Modelling, Category Analysis, Multiple regression analysis.	8
Trip Distribution Analysis: Presentation of Trip-Distribution Data, PA Matrix to OD Matrix, Basis of Trip Distribution, Gravity Model of Trip Distribution,	
4 Calibration of Gravity Model, Singly and Doubly Constrained Gravity Models, A case Studies, Growth Factor Methods of Trip Distribution, Uniform Factor Method, Fratar Growth-Factor Method, Disadvantage of Growth Factor Method.	6
Mode Choice Modelling: Influencing Factors, Earlier Modal Split Models, Trip-End Type Modal Split Model, Trip- Interchange Modal Split Model,	
5 Disaggregate Mode-Choice Model, Logit Model of Mode choice, Binary choice Situations, Multinomial Logit Model, Model calibration, Case studies.	6
Route Assignment: Description of Transport Network, Route Choice Behavior, the Minimum Path Algorithm, Route Assignment Techniques, All-or-Nothing Assignment, Multipath Traffic Assignment, Capacity- Restrained	
6 Traffic.	10
Transport Related Land-Use Models: Development of land- use models, The Lowry Model, Application of Lowry Model; Urban Activity Systems, Urban Movement Hierarchies, Types of Urban Structure Centripetal-Type Urban	
7 Structure, Grid- Type Urban Structure, Linear-Type Urban Structure, Directional Grid Urban Structure; Classification of Urban Goods Movements, Methodology of Approach to Analysis of Goods Movement, Modelling Demand for Urban Goods transport.	4

EXPECTED OUTCOME:

The students will be able to forecast travel demand and analyse the trip route distribution, modal split and traffic assignment.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	30 Marks
End Semester Examination	:	60 Marks

Text Books:

1. Kadiyali, L. R., Traffic Engineering and transport planning, Khanna Publishers, New Delhi.
2. Papacostas, C. S., Fundamentals of Transportation Engineering, Prentice Hall of India, New Delhi.
3. Khistey C.J. & Lall B.K., Transportation Engineering –An introduction, 3rd Edition, PHI Pvt. Ltd, New York (Indian edition also available)

Reference Books:

1. Prakash Rao and Sundaram, Regional Development Planning in India, Vikas Publishing House.
2. B.G. Hutchinson, Introduction to Urban Transportation Systems Planning, McGraw Hill.
3. Vukan R. Vuchic, Urban Public Transportation Systems and Technology, Prentice Hall Inc., N.J.

PGCE1402 Pavement Materials

L-T-P: 3-0-0

Credits: 3

Prerequisite: Course of highway engineering is required.

Objectives: To teach about highways materials generally used and recently used in highways practices.

DETAILED COURSE OUTLINE:

	Lectures
1 Highways Materials: Introduction to types and uses of highways materials	3
2 Soil: Characterizations, Resilient modulus, Poisson's ratio, permeability, shear strength, plate load test, CBR, stabilization (mechanical and chemical)	7
3 Road making aggregates: source, classification, Characterization, tests on aggregates, aggregate gradation and adjustment, blending of an aggregate	10
4 Bituminous Materials: Classification, Source, Composition, Characterisation, Tests on bituminous binders, other forms of bitumen (tar, cutback, emulsion), Modified bitumen, SUPERPAVE (in brief), Rheology of bituminous binders	8
5 Design of bituminous paving mixtures: Marshall Method and Haven stability method, Viscoelastic, Fatigue properties, Resilient Modulus and dynamic modulus of bituminous mixtures	8
6 Geosynthetics: Types and its application in road construction	3
7 Cement concrete Mix: Design of cement concrete mixes as per latest IS Codes and IRC Codes for concrete pavement	3

EXPECTED OUTCOME:

The students would be able to understand about Highways Materials, Road making aggregates, Bituminous Materials, Design of bituminous paving mixtures, Geosynthetics, and Cement concrete Mix.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Khanna, S. K. and Justo, C. e. G., Highway Engineering, Nemchand Bros., Roorkee.
2. Kadiyali, L. R., Pr. and design of pavements, Khanna Publishers, New Delhi.
3. Das A and Chakroborty P, Principles of Transportation Engineering, PHI Pvt. Ltd. New Delhi

Reference Books:

1. Wright, P. H., Highway Engineering, John Wiley and Sons, New York
2. Yoder E.J. and Witczale M.W., Principles of pavement design, John Wiley & Sons, Inc, New York
3. Kreb R.D. \$ Walker, Highway materials, McGraw Hill, New York

PGCEL1401 Highway Material Lab

L-T-P: 0-0-6

Credits: 4

Prerequisite: The knowledge of highways materials are required.

Objectives: To provide skill of testing of advance experiments on highways materials.

- 1 Method of aggregate blending
- 2 Bituminous Mix design by marshal stability method
- 3 Striping test
- 4 Dynamic cone penetration test/CBR test
- 5 Viscosity test
- 6 Rheological properties of bituminous mixtures
- 7 Measurement of axle load using portable weigh bridge
- 8 Field control of compaction
- 9 Field Test

EXPECTED OUTCOME:

The students would be able to aware about advanced testing of materials that is generally used in highway construction.

SCHEME OF EXAMINATION:

Class performance	:	15Marks
Lab Record	:	15Marks
Internal Viva-voce	:	10Marks
External Viva –voce	:	60 Marks

Reference Books:

1. Khanna, S. K. and Justo, C. e. G., Manual for Highway testing manuals, Enchant Bros., Roorkee.
2. IS and IRC code, MORTH specification

PGCE2401 Traffic Engineering and Management

L-T-P: 3-0-0

Credits: 3

Prerequisite: Students should have successfully completed the course Transportation Engineering - I.

Objectives: To introduce the elements related to traffic engineering and management. The knowledge of traffic surveys, traffic capacity, traffic operations and controls, traffic regulations, traffic safety.

DETAILED COURSE OUTLINE:

	Lectures
1 Introduction: Elements of traffic engineering, issues for traffic engineers; road users, vehicles, highways and control devices, modelling concepts. Traffic stream characteristics: Traffic stream parameters, Time space diagram, relationship among q, k, u , Macroscopic Fundamental diagrams (MFD), Microscopic Models of Traffic flow, Queuing theory, Shock wave theory	4
2 Traffic studies: Traffic volume studies, speed, travel time and delay studies, parking studies, accident data collection and pedestrian studies.	5
3 Traffic design: Capacity analysis concepts- urban streets and rural highways, design of parking facilities, street design.	6
4 Statistical application in Traffic Engineering: Overview of Probability Functions and Statistics, Normal distribution and application Confidence Bounds, Sample size, Binomial Distribution, Hypothesis testing.	6
5 Road Safety Audit, Accident Analysis, Pedestrian movement.	4
6 Management techniques: Congestion and Road users pricing; priority movements; traffic regulations and control system; use of intelligent system	8
7 Design of traffic signals, rotaries, Introduction of Grade separation.	4

EXPECTED OUTCOME:

The students should be able to design traffic facilities and conduct traffic surveys, should be able to determine the capacity, level of service and safety performance of highways, design intersection controls and be aware of traffic management.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Kadiyali, L. R., Traffic Engineering and transport planning, Khanna Publishers, New Delhi.
2. Khistey C.J. & Lall B.K., Transportation Engineering –An introduction, 3rd Edition, PHI Pvt.Ltd, New York (Indian edition also available)
3. William R. Mcshane and Roger P. Roess, “Traffic Engineering”, Pearson (4th Edition). 2013
4. C A O’Flaherty, Ed, “Transport Planning and Traffic Engineering”, Butterworth Heinemann, Elsevier, Burlington, MA 2006
5. May, A.D., “Fundamentals of Traffic Flow”, Prentice Hall, Inc. 2nd Ed. 1990
6. Carlos F. Daganzo. “Fundamentals of Transportation and Traffic Operations”, Pergamon 1997

7. Simon P. Washington, Matthew G. Karlaftis and Fred L. Mannering, "Statistical and Econometric Methods for Transportation Data Analysis", 2nd Edition, CRC Press 2011

Reference Books:

1. McShane W R and Roess R P, Traffic Engineering, Prentice hall Inc, New Jersey

PGCE2402 Pavement Analysis and Design

L-T-P: 3-0-0

Credits: 3

Prerequisite: Idea about pavement Engineering is required.

Objectives: To impart knowledge of pavement material characteristics, analysis and design based on recent IRC/AASHTO codes.

DETAILED COURSE OUTLINE:

	Lectures
Introduction: Definition of pavement, Function of pavements, their components and its functions, difference between flexible and rigid pavements, and choice of pavement type, composite pavement	6
Factors affecting pavements Design: Traffic – Traffic volume, wheel configuration, axle load, VDF, LDF, contact area and tyre inflation pressure, ESWL, Repetitions of load and impact, Material characteristics- CBR, Modulus of subgrade reaction, Resilient Modulus of materials, elastic modulus, poisons ratio, sub grade soil condition, dispersal qualities of paving materials, Visco-elastic behavior of bituminous mix, Environmental condition-rainfall, moisture and climate variation etc.	8
Analysis of flexible/bituminous pavement structures: Elastic half-space solution, layered elastic solution, multilayer solution and mechanistic approach etc.	8
Analysis of concrete/rigid pavement: Slab on elastic foundation, stresses in concrete pavement, load stress, temperature stress	8
Flexible pavement design: Design of flexible pavement using IRC-37 and AASHTO method	6
Rigid pavement design: Design factor, Westergaards theory of local stresses, Bradbury's equation, critical combination of stresses in cement concrete pavement, design of joints in concrete pavements, design of dowel bars, IRC method, AASHTO method	6

EXPECTED OUTCOME:

The students would be able to understand about highways pavement analysis and design.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. IRC:37 AND IRC:58 Codes
2. Kadiyali, L. R., Pr. and design of pavements, Khanna Publishers, New Delhi
3. Das A and Chakraborty P, Principles of Transportation Engineering, PHI Pvt.Ltd. New Delhi

Reference Books:

1. Yoder E.J. and Witczale M.W., Principles of pavement design, John Wiley & Sons, Inc, New York
2. Huang, Y. H., Pavement analysis and Design. Prentice Hall, Englewood Cliffs, New Jersey
3. Khanna, S. K. and Justo, C. e. G., Highway Engineering, Nemchand Bros., Roorkee

PGCEL2401 Traffic Engineering Lab

L-T-P: 0-0-6

Credits: 4

Prerequisite: Basic knowledge of traffic Engineering at UG/PG level.

Objectives: To provide knowledge and skills of conducting traffic studies and analysis in field.

DETAILED COURSE OUTLINE:

- 1** Traffic Volume Study
- 2** Spot Speed Study
- 3** O&D Study
- 4** Parking Survey
- 5** Accident Analysis
- 6** Road Safety Audit
- 7** Questionnaire Development, Evaluation and Testing
- 8** Introduction to Relevant Software

EXPECTED OUTCOME:

The students will be aware about traffic studies and software that are used in practice for planning and design of transportation facilities.

SCHEME OF EXAMINATION:

Class performance	:	15Marks
Lab Record	:	15Marks
Internal Viva-voce	:	10Marks
External Viva –voce	:	60 Marks

Reference Books:

1. IS and IRC Codes
2. Khanna, S. K. and Justo, C. e. G., Manual for Highway testing manuals, Nemchand Bros., Roorkee.

PGCE1410 Airport Planning & Design

L-T-P: 3-0-0

Credits: 3

Prerequisite: Not required.

Objectives: To introduce the elements related to airport planning and design. The subject knowledge of airport configurations, geometric design, design of terminal area, structural design of airfield pavements, airport lighting and markings and air traffic control.

DETAILED COURSE OUTLINE:

	Lectures
Aircraft characteristics related to airport design; Airport configuration -	
1 Runway configurations, Relation of terminal area to runways, Runway orientation, Wind rose diagram	8
2 Geometric design of the airfield: ICAO and FAA design standards, Runways, Taxiways, Holding aprons and aprons	12
3 Planning and design of the terminal area: Site Selection, Air travel demand forecasting, Apron-gate system, Size and number of gates, Aircraft parking configurations, Passenger terminal system	6
4 Structural design of flexible and rigid pavements, Drainage	8
5 Hangers Airport lighting and marking	4
6 Visual aids, STOL and VTOL airports	4

EXPECTED OUTCOME:

The students should be able to plan and design the airports.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Khanna and Arora, Airport planning and design, Dhanpat Rai & Sons, New Delhi.
2. Rangwala S.C., Airport Engineering, Charotar publishing house, Anand

Reference Books:

1. Saxena S.C., Airport planning and design, CBS Publications
2. Rao, G.V, Airport planning and design, TMH
3. Horonjeff .R and Francis X.McKelvey, Mc Grow Hill, New York

PGCE2411 Highway Economics

L-T-P: 3-0-0

Credits: 3

Prerequisite: Students should have a basic knowledge of highway Engineering.

Objectives: The course provides an outline of demand and supply side concepts and their application to transport policy and planning issues.

DETAILED COURSE OUTLINE:

	Lectures
1 Basic Economic Analysis, Economic significance of transport, Demand for transport-influencing factors, Temporal and spatial variations, Elasticity of demand, Supply of transport costs-long term and short term, Costs-variable, Fixed and marginal, Pricing of services	10
2 Definition and concept of road user services, Road user benefits, Annual cost, Capital cost, Maintenance and operation costs	10
3 Evaluation of transport projects: cost-benefit ratio, First year rate of return, Net present value and internal – rate of return methods	6
4 Indirect costs and benefits of transport projects, Highway Finance and Taxation	4
5 Annual cost formulae applicable to highway Calculation of cost of highway, calculation of cost of highway facilities, Probable life and analysis life, motor vehicle operation cost,	12

EXPECTED OUTCOME:

It is expected that the students will gain sound concept of highway economics.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Manual of Economic Analysis for highways projects, IRC, New Delhi
2. Kadiyali, L. R., Traffic Engineering and Transportation Planning. Khanna Publishers, New Delhi.

Reference Books:

1. Srivastava U.K., CPM and PERT, Galgotia Publication, New Delhi
2. Wintrey R, Economic analysis for highways, ITC, Scranton
3. Heggie I.A., Transport Engg. Economics, Mc Graw Hill, Book Company, London

PGCE1413 Remote Sensing & GIS and their Applications

L-T-P: 3-0-0

Credits: 3

Prerequisite: Soft computing knowledge is essential.

Objectives: To trend the students in the field of data gathering through using remote sensing, to work on GIS platform and to handle GPS.

DETAILED COURSE OUTLINE:

	Lectures
1 Remote sensing: Physics of remote sensing, Ideal remote sensing system, Remote sensing satellites and their data products, Sensors and orbital characteristics, Special reflection curves, Resolution and multi-concept, FCC, Interpretation of remote sensing images	9
2 Digital image processing: Satellite image-characteristics and formats, Image histogram, Introduction to image rectification, Image enhancement, and land use and land cover classification system	9
3 Geographical information system (GIS): Basic concept of geographic data, GIS and its components, Data acquisition, Raster and vector formats, Topography and data models, Spatial modelling, Data output, GIS applications	9
4 Global positioning system (GPS): Introduction, Satellite Navigation System, GPS-space segment, Control segment, user segment, GPS satellite signals, Receivers, static, Kinematics and differential GPS	7
5 Application in transportation engineering: Creation of thematic maps for transportation applications, Route planning, Road network planning, and Collecting road inventory, Travel demand modelling, Urban transport planning, Accident studies, Transport system management	8

EXPECTED OUTCOME:

The students would be able to understand about Remote sensing, GIS and GPS.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Fundamentals of Remote Sensing (2nd Edition)by George Joseph, University Press
2. Geographical Information Science by Panigrahi Narayan, University Press

Reference Books:

1. Remote sensing and Image Interpretation by LILLESAND & KIEFER
2. Principles of GIS by P A Burrough & Ramcponnel
3. Getting started with GIS by K.C. CLARKE
4. NASA website

PGCE1416 Intelligent Transportation Systems

L-T-P: 3-0-0

Credits: 3

Prerequisite: Not required.

Objectives: To provide knowledge about application of Intelligent in Transportation systems.

DETAILED COURSE OUTLINE:

Lectures

- | | | |
|---|---|----|
| | Introduction to intelligent transportation systems (ITS): Definition of ITS and identification of ITS objectives, Historical background, benefits of ITS, | |
| 1 | ITS collection techniques - detectors, automatic vehicle location (AVL), automatic vehicle identification (AVI), Geographic Information system (GIS), Video data collection | 8 |
| 2 | Telecommunication in ITS: Importance of telecommunications in the ITS system, Information management, Traffic management Centers (TMC), Vehicle - road side communication, Vehicle Positioning system | 7 |
| 3 | ITS functional areas: Advanced traffic management system (ATMS), Advanced traveller information systems (ATIS), Commercial vehicle operations (CVO), Advanced vehicle control system (AVCS), Advanced Public transportation system (APTS), Advance rural transportation systems (ARTS) | 10 |
| 4 | ITS user needs and services: Travel and traffic management, Public transportation management, Electronic payment, Commercial vehicle operations, Emergency management, Advanced vehicle safety systems, Information management | 7 |
| 5 | Automated highway systems: Vehicles in platoons, Integration of automated highway systems, ITS programs in the world, Overview of ITS implementations in developed countries, ITS in developing countries | 10 |

EXPECTED OUTCOME:

The students would be able to understand about Introduction to intelligent transportation systems, Telecommunication in ITS, ITS functional areas, ITS user needs and services and automated highway systems.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text/Reference Books:

1. Sussman, J.M., Perspective on ITS, Artech House Publications, 2005
2. ITS Hand book 2000: Recommendations for world road association (PIARC) by Kan Paul Chen, John Miles

PGCE1417 Advanced Highway Design

L-T-P: 3-0-0

Credits: 3

Prerequisite: Course of highways engineering is required.

Objectives: To introduce about geometric design of highways and hill roads.

DETAILED COURSE OUTLINE:

	Lectures
Highway pavement- Introduction and importance of geometric designs.	
1 Geometric design of road cross-section elements, pavement widths (carriage way, shoulder, kerbs, traffic separators, formation width and land widths)	6
Pavement surface characteristics – friction, roughness, light reflecting characteristics, cambers. Sight distance considerations – Absolute minimum sight distance required on straights, curves and intersections, facilities to be provided on roads.	8
2 Geometric design of horizontal alignment: Super elevation, stability conditions against overturning, relation between super elevations, coefficient of friction and centrifugal ratio, effect of upper elevation on passengers and drivers, maximum and minimum allowable super elevation, attainment of super elevation in practice, absolute minimum and ruling validity horizontal curves, methods of introducing extra widening, set-back distances of clearances required at horizontal curves, factors affecting design, design of curves, types and length of transition curves, resistance and grade compaction at horizontal curves.	10
3 Design of vertical alignments: Gradient, vertical curves, length of vertical curves.	4
4 Intersections at grade: sight distance consideration and principles of design, channelization, mini-round about, layout of roundabouts	6
5 Interchanges: major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes	4
6 Geometrics of hill road: width of pavement, formation of land, camber, sight distance, super elevation, radius of horizontal curves, widening at curves, set back distance gradients, summits and valley curves, hair pin bends.	4

EXPECTED OUTCOME:

The students would be able to understand about Geometric design of horizontal alignment, Design of vertical alignments, Intersections at grade, Interchanges and Geometrics of hill road.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Khanna, S. K. and Justo, C. E G., Highway Engineering, Nemchand Bros., Roorkee.
2. Kadiyali, L. R., Pr. and design of pavements, Khanna Publishers, New Delhi.

Reference Books:

1. A policy on Geometric design of highways and streets, AASHTO, Washington D.C.

PGCE1418 Traffic Flow Theory

L-T-P: 3-0-0

Credits: 3

Prerequisite: Course of Traffic Engineering is required.

Objectives: To introduce about Traffic Flow Theories.

DETAILED COURSE OUTLINE:

	Lectures
1 Components of traffic flow system, traffic variables and parameters, vehicle and its static characteristics	2
2 Vehicle kinematics, non-uniform acceleration motion, vehicle dynamics, impact and collision, modern trend in vehicle research; driver, human factor engineering, stimulus-oriented approach, response-oriented approach, driver's error, driver simulation, amber period, dilemma zone	6
3 Road, classic system of design and modern trends in road research, circulation system, local street sub system, collector street sub system, expressway sub system, freeways	8
4 Criteria for evaluation of system performance, traffic research and mathematical modelling, traffic events continuous variable, development of traffic flow variables; queuing process	10
5 Fundamental definitions and relationship between queuing parameters, finite queue, multiple channel case car parking analysis; heat flow analogy, fluid flow analogy	6
6 Development of macroscopic models of traffic flow, car following method, queuing models, fundamentals and developments of queuing process, applications	6
7 Indices of level of service (LOS) as offered to road users, Traffic travelling through Navigational system	4

EXPECTED OUTCOME:

The students would be able to understand about Vehicle kinematics, traffic flow pattern, modelling and simulation.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Khistey C.J. & Lall B.K., Transportation Engineering –An introduction, 3rd Edition, PHI Pvt.Ltd, New York (Indian edition also available)
2. May A.D., Traffic flow fundamentals, Printice Hall, New Jersey

Reference Books:

1. Kadiyali, L. R., Traffic Engineering and transport planning, Khanna Publishers, New Delhi.
2. Papacostas, C. S., Fundamentals of Transportation Engineering, Prentice Hall of India, New Delhi.
3. Drew D.R., Traffic flow theory and control, McGraw Hill, New York

PGCE1419 Highway Subgrade and Foundation

L-T-P: 3-0-0

Credits: 3

Prerequisite: Course of soil mechanics is required.

Objectives: To impart knowledge of mechanical and chemical properties of soils.

DETAILED COURSE OUTLINE:

	Lectures	
1	Function of subgrade and its behaviour depending upon soil characteristics, importance of plasticity and cohesion, swelling, shrinkage and ground water movement with reference to subgrade, necessity of drainage of soil	4
2	Effects and detection of various organic matters and sulphates, and carbonates on subgrade, significance of pH, frost action	6
3	Stress-strain analysis of soil, Elastic Properties of soil, Strength evaluation of subgrade	8
4	Soil survey, Sampling and tests of subgrade	6
5	Stress determination and settlement analysis and compaction techniques of subgrade	4
6	Embankment design: Elements of embankment design, Selection of embankment dimensions, Analysis of stability, Stresses under an earth embankment, Total Settlement of an embankment resting on clay strata and rate of settlement, Special design features in problematic areas	10
7	Embankment construction: Selection of materials for embankment construction, Construction practices, Gabion structures	4

EXPECTED OUTCOME:

The students would be able to understand about Function of subgrade, Stress-strain analysis of soil, Soil survey, Embankment design and construction

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Soil Mechanics - Lambe and Whitman, Wiley Eastern Pvt. Ltd, New Delhi.
2. Basic and Applied Soil Mechanics – Gopal Ranjan and A. S. R. Rao, Wiley Eastern Ltd, New Delhi.
3. IS relevant codes

Reference Books:

1. A Text Book of Soil Mechanics and Foundation Engineering - V.N.S. Murthy, Saikripa Technical Consultants, Bangalore.
2. Geotechnical Engineering - S. K. Gulati et. al., TMH Publishing Co. Ltd, New Delhi.
3. Foundation Analysis and Design- J. E. Bowles, McGraw Hill Book co. New York.
4. Fundamentals of Soil Mechanics – Taylor, John Wiley and Sons Inc. New York

PGCE1311 Optimization Techniques in Civil Engineering

L-T-P: 3-0-0

Credits: 3

Prerequisite: Not required

Objectives: To provide knowledge of optimizations methods and techniques.

DETAILED COURSE OUTLINE:

	Lectures
System Engineering: Definition of a system, systems approach, linear, non-linear, deterministic and stochastic systems, Network Techniques, Transportation and trans-shipment assignment models	6
1	
2 Optimization: Introduction, definitions, system variables, objective functions, constraints	6
3 Linear programming formulations, standard form, graphical solution, simplex algorithm, matrix formulation of L.P. and revised simplex method, duality, primal-dual algorithm, Integer linear programming	8
4 Classical Optimization Techniques: Introduction single variable optimization, multi, variable optimization with no constraints, multivariable optimization with equality and inequality constraints. Direct method of constrained optimization, Lagrange Multipliers, Kuhn Tucker conditions	8
5 Non-linear programming, convex and concave functions unconstrained optimization, Quadratic Programming, uni-variate method, Powell's method, Gradient Method	8
6 Constrained problems by unconstrained optimization, interior and exterior penalty functions	2
7 Introduction to Dynamic programming, geometric and stochastic programming	4

EXPECTED OUTCOME:

The students would be able to understand about System Engineering, Optimization, and Linear programming formulations, Non-linear programming and Dynamic programming.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Taha, Hamdy A., Operation Research: An Introduction, Prentice Hall

PGCE1424 Environmental Impact Assessment

L-T-P: 3-0-0

Credits: 3

Prerequisite: Not required

Objectives: To introduce applications of environmental engineering in highways projects.

DETAILED COURSE OUTLINE:

	Lectures
1 Introduction: What is EIA, Purpose, and Project types, Inputs and how do environmental impacts arise	4
2 EIA: Process-stages, Project cycle	4
3 Environmental impact assessment (EIA): Environmental statement and target areas fixation, Scoping, Objectives, Air pollution transport models, Noise propagation models	14
4 Methods for carrying out EIA starting from feasibility studies, Case studies of EIA with special emphasis on development projects like highways	14
5 Preparation of environmental management plan (EMP) procedure for obtaining environmental clearance, sitting guidelines for industries, public participation in carrying out EIA and EMP	6

EXPECTED OUTCOME:

The students would be able to understand about EIA, Methods for carrying out EIA starting from feasibility studies and Preparation of environmental management plan.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Canter, Environmental Impact Assessment, McGraw Hill Inc.

Reference Books:

1. Kadiyali, L. R., Traffic Engineering and Transportation Planning. Khanna Publishers, New Delhi.
2. Environmental consideration in planning and design of highways in India, IRC, New Delhi

PGCE1204 Ground Improvement Techniques

L-T-P: 3-0-0

Credits: 3

Prerequisite: Not required

Objectives: To introduce about various methods of ground improvement techniques.

DETAILED COURSE OUTLINE:

	Lectures
1 Need of ground improvement, Hollow compaction, Deep compaction, Preloading, Drainage, Vibro-floatation, Sand drains	6
2 Mechanical stabilization, Chemical stabilization, Thermal improvement methods, Stone columns, grouting	10
3 Geosynthetics applications in pavements construction, Types, Manufacturing methods, Functions and applications	6
4 Test and evaluation: Importance of testing, Test conditions, Sampling, Identification of sample, Preparation of samples	6
5 Use of Geosynthetics for unpaved roads, bituminous pavements and Soft soil embankment	10
6 Soil nailing, Improvement by confinement, Effect of environment on soil properties, Case histories	4

EXPECTED OUTCOME:

The students would be able to understand about various methods of stabilization, use of geosynthetics in road construction etc.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Rao G.V., An Introduction to Geosynthetics, TMH, New Delhi
2. An Introduction to Soil Reinforcement and Geosynthetics by GL Sivakumar Babu, University Press
3. MORTH specifications, 4th Edition, IRC, New Delhi
4. Khanna, S. K. and Justo, C. e. G., Highway Engineering, Nemchand Bros., Roorkee

Reference Books:

1. Basic and Applied Soil Mechanics – Gopal Ranjan and A. S. R. Rao, Wiley Eastern Ltd, New Delhi
2. Soil Mechanics- Lamb and Whitman, Wiley Eastern Pvt. Ltd, New Delhi

PGCE1430 Rural Roads Planning and Design

L-T-P: 3-0-0

Credits: 3

Prerequisite: Course of Transportation Engineering-I

Objectives:

1. Introduction to various factors affecting road alignment and planning.
2. Introduction to inputs required for pavement design.
3. Concepts of mechanistic empirical methods of flexible and rigid pavements.

DETAILED COURSE OUTLINE:

	Lectures
1 Introduction about Rural roads planning and Alignment: Importance of rural roads, classification of rural roads, terrain classification, socio-economic impact of rural roads, database for master plan, concept of network planning, rural roads plan, road alignment, governing factors for route selection, factors controlling alignment, special considerations while aligning hill roads, surveys, detailed project report, environmental issues	6
2 Geometric design: Introduction, design speed, basic principles of geometric design, elements of geometric design, horizontal and vertical alignment, alignment compatibility, lateral and vertical clearances	6
3 Road materials: General, Soil and material surveys, soil as road construction material, aggregates for pavement courses, materials for bituminous construction, materials for semi-rigid and rigid pavement, materials for special pavements, climatic suitability of concrete materials	6
4 Pavement Design and Specifications: Introduction, design parameters, pavement components, design of flexible pavement, design of semi-rigid pavement, design of rigid pavement, design of special pavements, drainage and shoulders	6
5 Construction of Rural roads: General, selection of construction materials, methodology, earthwork, sub-base, base course, bituminous constructions, semi-rigid pavement construction, concrete pavements, construction of special pavements, equipments required for different operations	6
6 Use of Waste materials in Rural road construction: Introduction, significance of green roads, fly ash for road construction, iron & steel and copper slags, lime-rice husk ash concrete, recycled concrete aggregate, other waste materials.	6
Quality control tests and maintenance: General, pre-requisite, specifications and codes of practice, quality control tests during construction, distresses/defects in pavements, definitions of maintenance activities, inventory of road and inspection, types of maintenance, classification of maintenance activities, maintenance norms of maintenance cost	6

EXPECTED OUTCOME:

1. Application of basic principles in pavement design for rural roads.
2. Assimilation of mechanistic principles for the pavement design.
3. Explain about appropriate quality control measures during construction and evaluation and maintenance measures.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	30 Marks

End Semester Examination : 60 Marks

Text Books:

4. "Highway Engineering", S.K. Khanna, C.E.G. Justo and A. Veeraraghavan, Nemchand & Brothers publications, 2014
5. "Introduction to Transportation Planning", M.J. Bruton, UCL Press, London, UK, 1992

Reference Books:

4. IRC: SP 20 - 2002, "Rural roads manual"
5. IRC: SP 72 – 2007, "Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads"
6. IRC: SP 62 – 2004, "Guidelines for the Design and Construction of Cement Concrete Pavements for Rural Roads"
7. IRC "Specifications for Rural Roads", MoRD, 2004
8. CRRI "Various reports on use of Waste Materials"

PGCE2412 Railway Engineering

L-T-P: 3-0-0

Credits: 3

Prerequisite: Not required.

Objectives: To provide basic idea about railways infrastructure and planning of railways in urban areas.

DETAILED COURSE OUTLINE:

	Lectures
1 Introduction: Role of railways in transportation system, railways and highways comparisons; classification of Indian railways, railway zones in India, railway gauges, creep, coning of wheels	4
2 Resistance and stresses in tracks, hauling capacity: Types of resistances to traction, stresses in different components of track, hauling capacity of locomotives, tractive efforts	4
3 Permanent ways: Rail & rail joints (welding of rails, LWR, SWR, CWR), Sleepers, Ballast, Formation and its drainage, track fitting and fastening, temporary ways	4
4 Geometric design of railway track: Alignment and grades, cross section and its elements (at filling & cutting), grade compensation, cant and cant deficiency, negative cant and widening of gauges on curves, curves used for railway track (horizontal and vertical curves), level crossing	10
5 Design of railway points and crossings, planning of railway stations and yards, Control systems: signals classification and their functions, train operation control systems –absolute, automatic block systems, centralized train control system, ATS, interlocking of tracks –principle of interlocking, types of interlocking, high speed track-track requirements, speed limitations, high speed technologies	10
6 Construction, drainage and maintenance of railway track (plate laying)	4
7 Railway System in the Urban Area: Surface railways, Elevated railways, Underground railway	4
8 Administration of Indian railways, Railways accidents and their prevention, Railways expenses, Rates and fares	2

EXPECTED OUTCOME:

The students would be able to understand about P-way design, metros and administration of Indian railways.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Agarwal, M. M., Indian Railway Track, Sachdeva Press, Mayapuri, New Delhi
2. Sexena, S.C. Arora, S. P., A text Book of Railway Engineering, Dhanpat Rai & Sons, New Delhi.

Reference Books:

1. Munday, J.S. Railway Track Engineering, Tata McGraw Hill, New Delhi.
2. Hay, W. W., Railroad Engineering, John Wiley and Sons, New York.

PGCE2414 Highway Construction Practices & Maintenance

L-T-P: 3-0-0

Credits: 3

Prerequisite: Course of Highway Engineering is essential

Objectives: To impart basics of construction procedures in Embankment, bituminous roads and concrete pavement.

DETAILED COURSE OUTLINE:

	Lectures
1 Embankment construction: formation cutting in soil and hard rock, preparation of subgrade, ground improvement, retaining and breast walls on hill roads, granular and stabilized, sub bases/bases, WBM, WMM, cement treated bases, dry lean concrete (DLC)	12
2 Bituminous construction: types of bituminous construction (BC, SDBC, BM, etc.) interface treatment, bituminous surfacing and wearing course for roads and bridge deck slabs, selection of wearing course under different climatic and traffic conditions, IRC Specifications, construction techniques and quality control	15
3 Concrete road construction: tests on concrete mixes, construction equipments, method of construction of joints in concrete pavements, quality control in construction of concrete pavements, construction of continuously reinforced, pre-stressed, steel fiber reinforced (SFRC) Pavement, IRC, MORTH, CIS specifications, AASHTO specifications, recycled pavements, nonconventional pavement, overlay construction	15

EXPECTED OUTCOME:

The students would be benefited for construction techniques generally or recently used in embankments, bituminous pavement and concrete pavements.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. MORTH Specifications, 4th Edition, IRC, New Delhi
2. Relevant IS & IRC codes and manuals

Reference Books:

1. Khanna, S. K. and Justo, C. e. G., Highway Engineering, Nemchand Bros., Roorkee.
2. Kadiyali, L. R., Pr. and design of pavements, Khanna Publishers, New Delhi

PGCE2415 Multimodal Transportation System Planning & Design

L-T-P: 3-0-0

Credits: 3

Prerequisite: Courses of all transportation engineering will be successfully cleared.

Objectives: To Provide knowledge of multimodal transportation planning and design.

DETAILED COURSE OUTLINE:

	Lectures
1	Transportation scenario, Technology vision-2020, Public transportation, Multi model transport technology, MRTS, LRT, Street car, Sky train, Multiple modes
2	Four stage planning, Behaviour analysis, Multinomial and nested logit models, Revealed and stated preferences
3	Planning of multi model transport system for Indian cities, Design of integrated network, parking facilities
4	Land use, Station area development; Operation strategy of public transport system, Case studies

EXPECTED OUTCOME:

The students would be able to understand about MRTS, LRT, Street car, Sky train, land use and planning of multimodal transport system.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Vukan R. Vuchic, Urban Public Transportation Systems and Technology, Prentice Hall Inc., N.J.
2. G.E. Gray and L.A. Hoel, Public Transportation Planning Operations and Management, Prentice Hall Inc

Reference Books:

1. Kadiyali, L. R., Traffic Engineering and transport planning, Khanna Publishers, New Delhi.
2. Papacostas, C. S., Fundamentals of Transportation Engineering, Prentice Hall of India, New Delhi.
3. Khistey C.J. & Lall B.K., Transportation Engineering –An introduction, 3rd Edition, PHI Pvt.Ltd, New York (Indian edition also available)
4. Prakash Rao and Sundaram, Regional Development Planning in India, Vikas Publishing House.
5. B.G. Hutchinson, Introduction to Urban Transportation Systems Planning, McGraw Hill.

PGCE2420 Applied Probability and Statistics

L-T-P: 3-0-0

Credits: 3

Prerequisite: Not required

Objectives: To impart knowledge of probability and statistics in engineering.

DETAILED COURSE OUTLINE:

	Lectures
1 Definition of Probability - classical, relative frequency and set theory definitions; conditional probability, Independent, dependent & mutually exclusive event.	5
2 Partition of events and marginal probability; Addition and multiplication theorems; Combinational analysis	5
3 Concept of a random variable Functions of one and two random variables; Sequence of random variables.	5
4 Density and distribution functions Moments of density functions; Mathematical expectation, variance, skew ness; Binomial, Poisson's, Normal and other distribution.	7
5 Elements of probability applied to statistics, Sampling and random samples, Law of large numbers; Chebyshev's inequality; Sampling distributions.	5
6 Correlation and regression.	5
7 Simple analysis of variance.	5
8 Curve Fitting and method of least squares.	5

EXPECTED OUTCOME:

The students would be able to understand about basics of probability and statistics and applications in engineering fields.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Meyer P.L., Introductory Probability and Statistical Applications, Oxford & IBH Publishing Co. Pvt. Ltd.
2. Trivedi K.S., Probability and Statistics with reliability, Queing and computer science applications, Prentice-Hall of India Pvt Ltd. New Delhi

Reference Books:

2. Kapoor V.K. and Gupta S.C., Fundamentals of mathematical Statistics, Sultan and Sons.

PGCE2421 Urban Transportation Planning

L-T-P: 3-0-0

Credits: 3

Prerequisite: Course of Transportation planning is required.

Objectives: To introduce the Urban Transportation Planning and Urban Mass Transit.

DETAILED COURSE OUTLINE:

	Lectures
1 Trends in Urban Transportation Planning, Overall urban transportation planning process, Long range urban transportation planning, Transportation system management, urban goods movement planning	6
2 Transportation demand forecasts, Aggregate sequential demand models, Aggregate direct demand model, Disaggregate behaviour	8
3 Transportation system evaluation, Pure Judgment, Engineering Economy, Willingness to pay concept, Cost-effective analysis	6
4 Urban Mass Transit: Mass transit planning, General Planning Concept, System performance evaluation, System Economics; Transit financing, Transit fare, Environmental consideration	6
5 Mass transit design & operation, System components of bus transit, Vehicles and operating characteristics, Rail transit-Types, Rail Guideway, Light rail transit guide way section, At grade section, Underground section and aerial section, Pedestrian/footpath, planning of vehicles in lanes.	8
6 Rail stations, Principles and standard rail vehicle control, Operating characteristics, Headway, Capacity and Safety, Operational Plans	4
7 Innovation in Transit Technology	4

EXPECTED OUTCOME:

The students would be able to understand about Urban Mass Transit, Mass transit design & operation and Innovation in Transit Technology.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Papacostas, C. S., Fundamentals of Transportation Engineering, Prentice Hall of India, New Delhi
2. Kadiyali, L. R., Traffic Engineering and Transportation Planning, Khanna Publishers, New Delhi.

Reference Books:

1. J.C. Yu, Transportation Planning
2. Institute of transportation Engineer's, Transportation and Traffic Engineering Handbook
3. Dickey J.W., Metropolitan Transportation Planning

PGCE2422 Pavement Management System (PMS)

L-T-P: 3-0-0

Credits: 3

Prerequisite: Course of Pavement Materials & Pavement Analysis and Design.

Objectives: The course will enable students to –

1. Understand the structural and functional requirements of pavements and also to carry out the structural and functional evaluation of both flexible and rigid pavements.
2. To evaluate new pavement materials through various approaches such as model pavement studies, test track studies etc.
3. To develop the pavement performance prediction models, ranking & optimization methodologies.

DETAILED COURSE OUTLINE:

	Lectures
1 Introduction: General nature and applicability of systems methodology, Basic components of pavement management system, Planning pavement investments, and pavement research management	6
2 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	10
3 Basic structural response model, Characterization of physical design inputs, Pavement deterioration modelling, Structural and Roughness deterioration modelling	8
4 Highway design and maintenance (HDM-4) models, Predicting distress, Predicting performance, Selection of optimal design strategies	10
5 Implementation of a pavement management system, Construction, Maintenance and Rehabilitation	8

EXPECTED OUTCOME:

1. Understand the failure mechanism in pavements and suggest suitable corrective measures.
2. Analyse and evaluate structural and functional adequacy of pavement.
3. Analyse and apply alternate strategies for assessment of pavement distress using pavement management principles.
4. Apply PMS and use expert system analysis to manage road construction, performance evaluation of pavements.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Huss and Hudson, Modern Pavement Management system, McGraw Hill
2. Shahin M.Y., Pavement management for roads, airport and parking lots, KLUWER ACADEMIC PUB, Boston/London

Reference Books:

1. Khanna, S. K. and Justo, C. e. G., Highway Engineering, Nemchand Bros., Roorkee
2. Kadiyali, L. R., Pr. and design of pavements, Khanna Publishers, New Delhi.
3. Yoder E.J. and Witczale M.W., Principles of pavement design, John Wiley & Sons, Inc,

- New York
4. Huang, Y. H., Pavement analysis and Design. Prentice Hall, Englewood Cliffs, New Jersey.

PGCE2426 Bridge Engineering

L-T-P: 3-0-0

Credits: 3

Prerequisite: Design of Concrete structures, Hydrology, Soil investigations and Highway Engineering

Objectives: To impart knowledge on important types of bridge structures, their selection and planning, structural configurations, assessment of loads and perform design.

DETAILED COURSE OUTLINE:

	Lectures
Introduction: Definition and basic forms, Components of bridge, Bridge classification, History of bridge development, Site selection, Soil exploration for site, Hydraulic factors in Bridge design, General arrangement drawing	4
Standard specification for Road Bridges: Width of Carriageway, Clearances, Loads on bridge – Dead load and IRC standard live loads, Impact effect, Wind load, Longitudinal forces, Centrifugal forces, Horizontal forces due to water currents, Buoyancy effect, Earth pressure	4
Solid Slab Bridges: Introduction, general design features, effective width method, Simply-supported and Cantilever slab bridge, Analysis and design	8
Box Culverts: Introduction to analysis, design and detailing; Loading conditions (detailed design not expected)	
Beam and Slab Bridges: Introduction, Design of interior panel of slab, Pigeaud's method, Calculation of longitudinal moment, Courbon's theory, Design of longitudinal girder, design example and Reinforcement detailing	8
Pre-stressed Concrete Bridges: Introduction (design concepts only), Determination of Minimum Section Modulus, Pre-stressing force and eccentricity (derivation not required)	6
Substructures: Analysis and Design of Abutments and Pier-detailing	
Bridge bearings: Forces on bearings, Design of Elastomeric bearings, basics for selection of Bearings	6
Foundations: Types of foundations; Well foundation – Open well foundation, components of Open well foundation; Pile foundations (design not included) – only detailing	6

EXPECTED OUTCOME:

The students would be able to use IRC standards and design the deck slab; analyze, design and detail box culverts for the given loading; design and detail T-beam bridges; design and check the stability of piers and abutments; design bridge bearings; detail bridge foundations and prepare the bar bending schedule.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	20 Marks
End Semester Examination	:	70 Marks

Text Books:

1. Jagadish T.R. and M.A. Jayaram, "Design of Bridge structures", 2nd edition, 2009
2. Johnson Victor D, "Essentials of Bridge Engineering", 7th edition, Oxford, IBH publishing company ltd., 2006
3. N. Krishna Raju, "Prestressed concrete bridges", CBS publishers, 2012

Reference Books:

1. Krishna Raju N., “Design of Bridges”, 4th edition, Oxford, IBH Company publishing limited, 2008.
2. Ponnuswamy, “Bridge Engineering”, 4th edition, McGraw-Hill publication, 2008.
3. Swamy Saran, “Analysis and Design of substructures”, 2nd edition, Oxford IBH publishing company ltd., 2006

PGCE2427 Highway Project Management

L-T-P: 3-0-0

Credits: 3

Prerequisite: Pavement Materials, Design and Construction

Objectives: To introduce the concepts related to construction planning and management.

- The students are expected to understand the principles and techniques of various methods of pavement construction.
- Understand the quality control methods and techniques for flexible and rigid pavements.

DETAILED COURSE OUTLINE:

Lectures

- 1 Construction Planning and Management:** Need and significance of Highway construction planning, Role of labour and machinery in construction; Time, cost and resource management of projects for planning, scheduling, Control and forecast using networks with Bar chart, Critical Path Method (CPM), PERT; Personal, material and finance management, Safety Engineering. Various types of equipment for excavation, grading and compaction - their working principle, advantages and limitations; Cement Concrete and Bituminous concrete plants. 14
- 2 Quality Control:** Introduction, Requirements of a Highway Project, Prerequisite, Specifications and Code of Practice, Quality assurance, Quality Control - ISO 9000, Elements of Quality Assurance System, Distinguish Quality Assurance & Quality Control, Sampling techniques, Tolerance & Controls related to profile and compaction, methods in quality control. 10
- 3 Project Cost Estimation:** Approximate cost, detailed cost estimates, administrative approval and expenditure sanctions, rate analysis by client and contractor, bidding processes and strategies, Pre-qualification of bidders, construction equipment, equipment economics, various items of construction: Earthwork, Excavation. 10
- 4 Contract:** Elements, Types of Contract, Condition of contract, Arbitration, Termination of contract, Miscellaneous terms in contract
Preparation of DPR design details, estimates, BOQ, drawings and detailed project report, 8
Tendering process - Preparation of tender documents for different types of road projects, tender evaluation.

EXPECTED OUTCOME:

Students who successfully complete this course will be able to:

- Plan and control construction related activities.
- Gain knowledge about different methods and techniques of pavement construction.
- To perform quality control checks on pavements.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5Marks
Class test II/Assignment	:	5Marks
Mid Semester Examination	:	30Marks
End Semester Examination	:	60 Marks

Text Books:

1. U.K.Srivastava, Construction Planning and Management, Galgotia Publication Pvt.Ltd.
2. K.G. Krishnamurthy and S.V. Ravindra, Construction and Project Management,

CBS Publishers and distributors Pvt. Ltd.

3. Shtub, Bard and Globerson, Project Management: Engineering, Technology, and Implementation, PH Inc.

Reference Books:

1. Fundamentals of Construction Management and Organisations by K.Waker A Teraih and Jose M.Grevarn;
2. Construction planning. Equipment and methods, Peurifoy R.C, and C.J.Shexnaydr, McGraw Hill.
3. Highway Engineering, Paul Wright, Karen K. Dixon, John Wiley& Sons,.7th edition.

PGCE2428 Hill Road Engineering

L-T-P: 3-0-0

Credits: 3

Prerequisite: Course of Highway Engineering, Geology and Geotechnical Engineering

Objectives: This course will enable students to understand planning, survey, design, construction and maintenance of hill roads.

DETAILED COURSE OUTLINE:

	Lectures
1 General Considerations: Design and Construction problems, Temperature, Rainfall, Atmospheric pressure and winds, Geological conditions.	6
2 Alignment of Hill roads: General considerations, resisting length, trace cut for hair pin bends, Geological considerations, Alignment survey – Reconnaissance, Trace cut and detailed survey	8
3 Geometrics of Hill roads: Width of pavement, Formation and land, Camber, super-elevation, Horizontal curve – widening of curve, setback distance, transition curves, gradients, hair pin bends	8
4 Design and Construction of Hill roads: Rock cutting, Precipice work, Retaining walls, Revetment walls, Pavement types	8
5 Drainage in Hill roads: Drainage of water from hill slope, Road side drains, Cross drainage, Sub-surface drainage	6
6 Maintenance Problems in Hill Roads: Maintenance of Drainage structures, Control of Avalanches, Prevention of land slides	6

EXPECTED OUTCOME: After studying this course student will be able to get the knowledge about the difficulties of hill road construction and maintenance and rehabilitation including safety measures.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	30 Marks
End Semester Examination	:	60 Marks

Text Books:

1. IRC: 52, “Recommendations about the Alignment, Survey and Geometric design of Hill roads”
2. Khanna, S. K. and Justo, C. E. G., Highway Engineering, Nemchand Bros., Roorkee
3. Kadiyali, L. R., Principle and Design of pavements, Khanna Publishers, New Delhi

Reference Books:

1. Marsani A. and Shrestha D.K., Transportation Engineering, Volume-I, Divine Print Support, Lagan Tole, Kathmandu.

PGCE2429 Pavement Mechanics

L-T-P: 3-0-0

Credits: 3

Prerequisite: Course of Pavement Materials and Pavement Analysis

Objectives:

- To introduce the concepts related to mechanics of continuous solids. Viscoelastic, Plasticity, Thermo-viscoelasticity for bituminous concrete.
- The students are expected to understand the principles and techniques of flexible pavement modelling.

DETAILED COURSE OUTLINE:

	Lectures
1 Mechanics of Continuous Solids: Introduction, mathematical preliminaries kinematics and strain, kinetics & stress conservation laws	6
2 One-dimensional constitutive theory: Introduction, elastic material model, viscous material model, viscoelastic material model, elasto-plastic material model, viscoplastic material model, thermo and hygro type material model	6
3 Elasticity and Thermo elasticity: Introduction, multi-dimensional linear elasticity, the linear elastic boundary value problems, thermodynamic constraints on elastic material behaviour, solution techniques for the linear elastic boundary value problems, micromechanics, multi-dimensional linear thermoelasticity, modeling the effects of moisture on roadway performance	6
4 Viscoelasticity and Thermo viscoelasticity: Introduction, multi-dimensional linear viscoelasticity, methods for solving viscoelastic IBVPs, material property characterization of viscoelastic media, mechanical analogs for creep compliances and relaxation moduli, procedure for curve fitting, multi-dimensional linear thermoviscoelasticity, non-linear viscoelasticity	6
5 Plasticity, Viscoplasticity and Fracture: Introduction, multi-dimensional plasticity, elastoplastic initial boundary value problem, multi-dimensional viscoplasticity, multi-dimensional thermoviscoplasticity, methods for modeling cracking, damage mechanics & fracture mechanics	6
6 Computational methods: Fundamentals of finite element method, implementation of constitutive and fracture models to a mechanics finite element code	6
7 Computational modeling applications: Computational micromechanics, simulating the resilient modulus test, multi-scaling	6

EXPECTED OUTCOME:

Students who successfully complete this course will be able to perform computational modelling of Bituminous Concrete mixes for their project work.

SCHEME OF EXAMINATION:

Class test I/Assignment	:	5 Marks
Class test II/Assignment	:	5 Marks
Mid Semester Examination	:	30 Marks
End Semester Examination	:	60 Marks

Text/Reference Book:

1. Dallas N. Little, David H. Allen, Amit Bhasin, Modelling and Design of Flexible pavements and materials, Springer publications.
2. Y.Richard Kim, Modelling of Asphalt Concrete, ASCE Press, Mc Graw Hill, New York.