FACULTY OF ENGINEERING

Scheme of Instruction & Examination

(AICTE Model Curriculum for the Academic Year 2019-2020)

and

Syllabus

M.E. I to IVSemester

of

Two Year Post Graduate DegreeProgramme

in

Civil Engineering

Specialization in Transportation Engineering

(With effect from the academic year 2020– 2021)

(As approved in the BOS (OU) meeting held on15–02–2020)

Issued by

Dean, Faculty of Engineering

Osmania University, Hyderabad – 500 007

2020

SCHEME OF INSTRUCTION & EXAMINATION
M.E. (Civil Engineering) – I Semester
Specialization in Transportation Engineering

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	Core	Program Core – I	3	1	-	4	30	70	3	4
2	Core	Program Core – II	3	-	-	3	30	70	3	3
3	Elective	Professional Elective – I	3	-	-	3	30	70	3	3
4	Elective	Professional Elective – II	3	-	-	3	30	70	3	3
5	MC or OE	Mandatory Course / Open Elective	3	-	-	3	30	70	3	3
6	Audit	Audit Course – I	2	-	-	2	30	70	3	0
Practical/ Laboratory Courses										
7	Lab	Laboratory – I	-	-	2	2	50	-	3	1
8	PC 1454 TE	Seminar	-	-	2	2	50	-	3	1
		Total	**17**	**01**	**04**	**21**	**280**	**420**		**18**

PC: Program Core **PE:** ProfessionalElective **OE**: Open Elective **AD**: Audit Course
MC: Mandatory Course **HS**: Humanities and social science

L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:

1. Each contact hour is a Clock Hour.
2. The practical class can be of two and half hour (clock hours) duration as per the requirementof a particular laboratory.
3. ** Open Elective Subject is not offered to the students of Civil Engineering Department.

SCHEME OF INSTRUCTION & EXAMINATION
M.E. (Civil Engineering) – II Semester
Specialization in Transportation Engineering

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	Core	Program Core – III	3	1	-	4	30	70	3	4
2	Core	Program Core – IV	3	1	-	3	30	70	3	4
3	Elective	Professional Elective – III	3	-	-	3	30	70	3	3
4	MC or OE	Mandatory Course / Open Elective	3	-	-	3	30	70	3	3
5	Audit	Audit Course – II	2	-	-	2	30	70	3	0
Practical/ Laboratory Courses										
6	Lab	Laboratory – III	-	-	2	2	50	-	3	1
7	Lab	Laboratory – IV	-	-	2	2	50	-	3	1
8	PC 1455 TE	Mini Project with Seminar	-	-	4	4	50	-	3	2
		Total	**14**	**02**	**08**	**24**	**300**	**350**		**18**

PC: Program Core **PE:** ProfessionalElective **OE**: Open Elective **AD**: Audit Course
MC: Mandatory Course **HS**: Humanities and social science

L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:

1. Each contact hour is a Clock Hour.
2. The practical class can be of two and half hour (clock hours) duration as per the requirementof a particular laboratory.
3. ** Open Elective Subject is not offered to the students of Civil Engineering Department.

SCHEME OF INSTRUCTION & EXAMINATION
M.E. (Civil Engineering) – III Semester
Specialization in TransportationEngineering

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	Elective	Professional Elective – IV	3	-	-	3	30	70	3	3
2	Elective	Professional Elective – V	3	-	-	3	30	70	3	3
3	PC 1456 TE	Major Project Phase – I	-	-	20	20	100	-	3	10
		Total	**06**	**-**	**20**	**26**	**160**	**140**		**16**

M.E. (Civil Engineering) – IV Semester
Specialization in TransportationEngineering

S. No.	Course Type/Code	Course Name	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	PC 1457 TE	Major Project Phase – II (Dissertation)	-	-	32	32	-	200	3	16
		Total	**-**	**-**	**32**	**32**	**-**	**200**		**16**

PC: Program Core **PE:** Professional Elective **OE**: Open Elective **AD**: Audit Course
MC: Mandatory Course **HS**: Humanities and social science

L: Lecture **T**: Tutorial **P**: Practical **D**: Drawing
CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:

1. Each contact hour is a Clock Hour
2. The practical class can be of two and half hour (clock hours) duration as per the requirement of a particular laboratory.
3. ** Open Elective Subject is not offered to the students of Civil Engineering Department.
4. The students who are willing to register for MOOCs in the M. Tech (TE) III – semester instead of Professional Electives – IV & V, should register for those of the courses, approved by the CBoS, OU and respective college MOOCs Coordinator. Those students are strictly not permitted to appear for either CIE or SEE of Professional Electives – IV & V if they abstain from attending the semester class work. Further, for students willing to appear for both MOOCS and Professional Electives, they should fulfil the minimum attendance criteria.

List of Professional Core Courses

S. No.	Course Code	Course Title
1	PC 1401 TE	Pavement Materials and Characterization
2	PC 1402 TE	Urban Transportation Systems Planning
3	PC 1403 TE	Pavement Systems Engineering
4	PC 1404 TE	Design of Highway Infrastructure

List of Professional Elective Courses I to V

S. No.	Course Code	Course Title
1	PE 1416 TE	Traffic Engineering
2	PE 1417 TE	Intelligent Transportation System
3	PE 1418 SE	Finite Element Methods
4	PE 1419 TE	Analysis of Transportation Systems
5	PE 1420 TE	GIS and GPS Application to Transportation Engineering
6	PE 1421 TE	Rural Roads
7	PE 1422 TE	Economic Evaluation and Analysis of Transportation Projects
8	PE 1423 TE	Transportation Modelling and Simulation
9	PE 1424 TE	Airport Planning and Design
10	PE 1425 TE	Pavement Evaluation Maintenance and Management
11	PE 1426 TE	Railway Engineering
12	PE 1427 TE	Transportation Structures
13	PE 1428 TE	Statistical Techniques
14	PE 1429 TE	Behavioural Modelling
15	PE 1430 TE	Ground Improvement Techniques

List of Mandatory Courses

S. No.	Course Code	Course Title
1	MC5121ME	Research Methodology & IPR

List of Open Elective Courses

S. No.	Course Code	Course Title
1	OE9101CE**	Cost Management of Engineering Projects
2	OE9102CS	Business Analytics
3	OE9103EC	Embedded System Design
4	OE9104EE	Waste to Energy
5	OE9105ME	Industrial Safety

Note: ** Open Elective Subject is not offered to the students of Civil Engineering Department.

List of Audit Course-I

S. No.	Course Code	Course Title
1	AD 9001 HS	English for Research Paper Writing
2	AD 9002 CE	Disaster Management
3	AD 9003 HS	Sanskrit for Technical Knowledge
4	AD 9004 HS	Value Education

List of Audit Course-II

S. No.	Course Code	Course Title
1	AD 9005 HS	Constitution of India and Fundamental Rights
2	AD 9006 HS	Pedagogy Studies
3	AD 9007 HS	Stress Management by Yoga
4	AD 9008 HS	Personality Development through life Enlightenment Skills

List of Laboratory Courses

S. No.	Course Code	Course Title
1	PC 1451 TE	Traffic Design and Studio Lab
2	PC 1452 TE	Highway Materials and Pavement Engineering Lab
3	PC 1453 TE	Computational Lab

Detailed Syllabus for Professional Core Courses

Course Code	Course Title						Core/Elective
PC 1401 TE	**Pavement Materials and Characterization**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives:

- Understand various tests on Sub grade soil, aggregates, bitumen andcement
- Learn bituminous mix and cement concrete mixdesigns
- Learn basic principles of super pave technology of bituminousmixes

Course Outcomes:

1. Enable characterization of soils based on index and engineeringproperties
2. Understand sub grade soil strength in terms of standard engineeringparameters
3. Application of basic principles of mix design of cement concrete and bituminousmixes

UNIT -I

Soil and Aggregate: Soil-Classification methods, Tests: Introduction to materials used for construction of sub grade, aggregate base course, bituminous base and surface courses of pavements, Understanding different tests: CBR, Durability, Resilient Modulus, soil-suction, Consistency, Engineering Properties and Modulus of sub-grade reaction of soil, selection of suitable filter for soils, Triaxial method. Aggregate Origin, Classification, requirements, properties and tests on road aggregates for flexible and rigid pavements. Blending of aggregates, Importance of aggregate shape factor in mixdesign

UNIT-II

Methods of Test for Stabilized Soils: Method of sampling and Preparation of Stabilized Soils for Testing, Relation for Moisture content and Dry Density of Stabilized mixes, wetting. Drying, Thawing & freezing tests for compacted soil cement mix, UCS of Stabilized soil, test for: soil bituminous, soil lime and soil fly ashmixes.

UNIT-III

Bitumen, Tar and Bituminous Mix Design; Origin, preparation, properties, requirements, criteria for selection of different binders, Temperature susceptibility, Bitumen test data chart, Stiffness modulus, VanderPoel Nomograph. Bituminous emulsion and Cutbacks, fillers, extenders, polymers, Crum rubber, and rubber modified bitumen and anti-Stripping agents on pavement performance. Bituminous mix design, binder content, gradation, Engineering properties: Dynamic conditions, Quasi static conditions, Fracture and Fatigue; Marshal stability, Hveem stability test; example problem, static creep test, repeated load test, Resilient & dynamic modulus test, empirical test, simulation test, flexural test, diametric repeated load test, splitting tension test, permanent deformation Parameters and other properties, Effects use of GeoSynthetics.

UNIT - IV

Introduction to Superpave Technology: Methods of selection of suitable ingredients for super pave method, Gyratory compaction, rolling thin film oven, pressure aging vessel, rotational viscometer, dynamic shear rheometer, bending beam rheometer, direct tension test. Use of superpave perform and grade binder specifications. Comparison between Marshal Mix method and Super pave method. Cement concrete Mixes: Requirements of paving concrete, mix design, Admixtures, Tests on cement Concrete. Recycling bituminous material, fundamental of recycling bituminous material, hot and cold recycling of bituminous material, methods of recycling, equipment use, sites specific material specifications, Design of mixes for recycling of

bituminous and concrete pavementsurface.

UNIT - V

Cement concrete mixes and recycling bituminous material; cement concrete Mixes: Requirements of paving concrete, mix design, admixtures, and tests on cement concrete. Introduction to advanced concretes like self-compacted concrete, light weight concrete, roller compacted concrete for pavement applications. Joint fillers for jointed plain cement concrete pavements and their characterization. Recycling bituminous material, fundamental of recycling of recycling bituminous material, methods of recycling, equipment use, sites specifications, Design of mixes for Recycling of bituminous and concrete pavement surface. Nano-technology applications in cement concrete.

Suggested Readings:

1. Highway Engineering, -Paul H. Wright, Karen K. Dixon, John Wiley & Sons, 7th edition,2004.
2. Principles and Practices of Highway Engineering, Sharma &Sharma.
3. SRC, DSIR, Bituminous Materials in Road Construction, HMSOpublication.
4. Principles of Pavement Design, Yoder E.J, and Witczak M. W. John Wiley & Sons,1975.
5. ISI and IRC relatedpublications.

Course Code	Course Title						Core/Elective
PC 1402 TE	**Urban Transportation Systems Planning**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To discuss various urban transportation systems planning process and itscomponents
- To understand a variety of travel surveys and data collectionprocedures
- To review different travel demand forecastingmodels
- To examine urban land use models and urban goods transportationmodels

Course Outcomes

1. To describe and evaluate various urban transportation issues and planningmethodologies
2. To identify the appropriate data collection methods and itsprocedures
3. To demonstrate effective way of understanding trip distribution and mode splitmodels
4. To explain various issues related to trip assignment and land use transportationmodels.

UNIT -I

Components of Transportation System and Challenges; Transportation system definition, urban issues, evolution of planning process, demand and supply, challenges, limitation, measure of effectiveness, measure of collectiveness, traffic problem elements, planning and management, models, planning methodologies. Emerging future trends in Transportation Systems.

UNIT - II

Data Collection and Travel Surveys; Collection of data, design of survey format, organization of surveys and analysis, study area definition, zoning system, types and sources of data, road side interview method, home interview survey, in-vehicle surveys, sampling, types, various techniques, expansion factors, logical checks, use of secondary sources of data, planning variables, vehicles ownership, projection of data and statistical techniques.

UNIT-III

Travel Demand Forecasting; Various trends, overall planning process, short and long term planning, travel attributes, traffic analysis zones, trip generation, category analysis, concept of gravity model, trip distribution, model split and trip assignment and land use transportationinteraction.

UNIT-IV

Trip Distribution and Model Split Analysis; Growth factor models, synthetic pattern models, gravity model, competing opportunity model, intervening opportunity model, linear programming model and abstract mode model, time series models, aggregate and disaggregate models, mode choice, competing modes, mode split models, trip interchange, Toronto transit model, service ratio model, probabilistic models, discriminate analysis, probit analysis and logit analysis, and probabilisticapproaches.

UNIT-V

Traffic Assignment and Plan Preparation; Nodes, links, transport. Network, coding, rout characteristics, network skims, various methods, judgment, towpath method, diversion curves, network, assignment, all or nothing assignment, capacity restraint techniques, multi-path assignment technique, graph theory, probabilistic assignment model, allocation of traffic, equilibrium assignment, dynamic assignment, land use transport @. models, Lowry models, Garin Lowry models, ISGLUTI models, mobility and accessibility,

five stage models, choice models, urban goods transport, strategies for the evaluation of alternate transportation plans and plan implementation, framework and case studies, preparation of master plans.

Suggested Readings:

1. Hutchinson, E.G., Principles of Urban Transport Systems Planning, McGraw Hill, New York,1974.
2. Ortuzar, J. and Williamson, E.G., Modelling Transport, Wiley, Chinchestor,1994.
3. Oppenheim, N., Urban Travel Demand Modeling: From Individual Choices to General Equilibrium, Wiley, New York,1995.
4. Thomas, R., Traffic Assignment Techniques, Avebury Technical, Aldershot,1991.
5. Taniguchi, E., Thompson, R.G, Yamada, T. and Van Duin, R., City Logistics - Network Modelling and Intelligent Transport Systems, Elsevier, Pergamon, Oxford,2001.
6. Bruton, M.I, Introduction to Transportation Planning, Hutchinson, London,1985.
7. Dickey, J.W, Metropolitan Transportation Planning, Tata McGraw Hill, New Delhi,1975.

Course Code	Course Title						Core/Elective
PC 1403 TE	**Pavement Systems Engineering**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives

- Introduction to various factors affecting pavementdesign
- Concepts of mechanistic empirical methods of flexible and rigidpavements
- Knowledge of pavement evaluation and the related maintenanceactivities

Course Outcomes

1. Application of basic principles in pavementdesign
2. Assimilation of mechanistic principles for the pavementdesign
3. Explain about appropriate evaluation and maintenance measures for better maintenance of pavements

UNIT - I

Introduction of Pavement Design: Various Factors, Types of Pavements, Functions of Individual Layers, Classification of Axle Types of Rigid Chassis and Articulated Commercial Vehicles, Legal Axle and Gross weights on single and multi-units, Tire Pressure, Contact pressure, EAL and ESWL concepts, Equivalent Axle Load Factor, Traffic Analysis: ADT.AADT, Truck factor, Growth factor, Lane, Directional distributions & Vehicle Damage factors, Effect of Transient & Movingloads.

UNIT - II

Stresses in Pavements: Vehicle-Pavement Interaction, Stress inducing factors in flexible and Rigid pavements. Stress in Flexible Pavements: Visco-Elastic Theory and Assumptions. Layered system concepts, Stress solutions for one, two and three layered systems. Fundamental Design concepts. Stresses in Rigid Pavements: Westergaard's theory and Assumptions, Stresses due loading, warping and Frictional Stresses, Friberg's Analysis of Dowel Bars and deflection of dowel-joints.

UNIT- III

Mechanistic Design Methodology for Pavements: General Methodology, Classification of design methods; Pavement Design Concepts; Flexible Pavements: Climatic Models, Structural models, Distress models: fatigue cracking, rutting and thermal cracking models; Rigid Pavements: Structural models, fatigue cracking: load and curling stress, Pumping and Erosion Models, Faulting Models, Joint Deterioration and Punch out models; Need and verification of Flexible and Rigid pavement Mechanistic design procedures.

UNIT - IV

Methods of Pavement Designs: Flexible Pavement Design Concepts, Asphalt Institute Methods with HMA and other Base Combinations, AASHTO, IRC Methods as per IRC37 and IRC: SP:72. Design of Rigid Pavements: Introduction to Calibrated Mechanistic Design Process, PCA, AASHTO, IRC specifications, Introduction to pre-stressed and continuously Reinforced Cement Concrete Pavement Design, Dowel bar design and design of tie bars as per IRC:58.

UNIT - V

Pavement Evaluation and Design of Overlays: Types of pavement evaluation: Serviceability concepts, IRI, Quarter Car Model, skid resistance; Pavement Deflection - Different Methods of NDT, Benkelman Beam, LaCroix Deflectometer, Dynaflect, Road Ratar, Rolling Dynamic Deflectometer, Load man, Different Types of Falling Weight Deflectometers(FWD) for evaluation of rigid and flexible pavements. Design of overlays: Types & Design of overlays: Asphalt Institute's Principal Component Analysis, IRC Methods of OverlayDesign.

Suggested Readings:

1. Design of Functional Pavements, Nai C. Yang, McGraw HillPublications.
2. Teng, Functional Design of Pavements - McGraw hill -1990.
3. Concrete Pavements, AF Stock, Elsevier, Applied SciencePublishers.
4. Principles of Pavement Design, Yoder J. &Witzac Mathew W. John Wiley &Sons.
5. Pavement Analysis & Design, Yang H. Huang, Prentice HallInc.
6. Pavement and surfacing for Highway & Airports, Micheal Sargious, and Applied science Publishers Limited.
7. Kadiyali and Lal, Principles of highway engineering, Khanna Publishers,Delhi-6.
8. IRC related Codes for Flexible and Rigid Pavementsdesign.

Course Code	Course Title						Core/Elective
PC 1404 TE	**Design of Highway Infrastructure**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives

- Provide an overview of concepts involved in geometric design of Highways, horizontal & vertical alignment of roads & pedestrianfacilities.
- Identify key design elements forintersections.
- Describe usage of traffic controldevices

Course Outcomes

1. Apply the concepts and applications of design elements involved in Highway InfrastructureDesign
2. Design intersections, traffic islands, bus bays, cycle tracks,subways

UNIT –I

Geometric Design of Highways: Functional classification of Highway system; Design controls - Topography, Driver characteristics, Vehicle characteristics. Traffic, Capacity and Level of Service, Design speed. Objectives of Geometric Design. Road Margins - design specifications; Pavement surface characteristics - Skid Resistance, measurement of skid resistance; Road roughness, measurement of Road roughness; Camber design and standards.

UNIT - II

Horizontal and Vertical Alignment: Sight Distance - SSD, OSD and ISD. Horizontal curves, Super elevation; computing of super elevation; attainment of super elevation; Extra widening on curves; Transition curves – Objectives and Design. Gradients - Types of Gradients, Design Standards; Summit Curves, Valley curves and Design criteria. Combination of Vertical and Horizontal curves - Grade Compensation. Importance of Sight Distances for Horizontal and Vertical curves.

UNIT- III

Design of Intersections: Types of Intersections; Design Principles for Intersections; Design At-grade Intersections – Channelisation, Objectives; Traffic Islands and Design Standards Rotary Intersection - Concept, Advantages and Disadvantages; Grade separated Interchanges - Types, warrants and Design standards as per IRC.

UNIT-IV

Traffic Signs and Road Markings: Types of Road Signs; Guidelines for the provision of Road Signs; Caution Signs, Regulatory signs. Information signs - Design standards. Road markings - Objectives of Road markings; Types of Road Marking, Role of Road markings in Road Safety and Traffic Regulation; Specification for Road Marking Highway Appurtenances-Delineators, Traffic Impact Attenuators, Safety Barriers.

UNIT – V

Pedestrian Elements: Requirements of Pedestrians; Pedestrian facilities on Urban Roads; Cycle Tracks - Guidelines and Design standards; Bus Bays-Types and Guide Lines-Design of On street and Off street parking facilities -Guidelines for lay out Design. Design of Subways and foot over bridges.

Suggested Readings:

1. Principles and Practice of Highway Engineering, L.R. Kadiyali andN.B.Lal, KhannaPublications.
2. Traffic Engineering and Transportation Planning, L.R. Kadiyai, KhannaPublications
3. Highway Engineering, C.E.G. Justo and S.K.Khanna, Nem Chand andBrothers
4. IRC Codes for signs, Markings and Mixed Traffic Control in UrbanAreas.

Detailed Syllabus for Professional Electives Courses I to V

Course Code	Course Title						Core/Elective
PE 1416 TE	**Traffic Engineering**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives:

- Introduce fundamental knowledge of traffic engineering so that students can understand and be able to deal with traffic issues including safety, planning, design, operation andcontrol.
- Describe basic techniques for collecting and analyzing traffic data, diagnosingproblems.
- Understand the highway capacity and performance characteristics
- Learn the concepts of traffic design and regulations

Course Outcomes

1. Undertake various types of road traffic studies and use of statistical concepts and applications in trafficengineering.
2. Suggest preventive measures to avoid accidents by analyzing the traffic conditions at site.
3. Identify traffic stream characteristics and level ofservice
4. Design a pre-timed signalized intersection, and determine the signalsplits.

UNIT-I

Basic Aspects of Traffic Engineering Aim of traffic engineering, traffic stream components and characteristics, road user characteristics, vehicle characteristics, acceleration characteristics, measure of quality, measures of separation, relationship among traffic parameters and empirical relationships, mechanics of traffic flow, macroscopic approach, microscopic approach and human factors approach, discrete distributions, binomial distribution, Poisson's distribution, exponential distribution, exponential distribution, normal distribution.

UNIT-II

Traffic Studies, Measurement and Analysis; Volume studies, speed studies, parking studies, Accident studies. Travel forecasting principles and techniques, design hourly volumes and speed, origin and destination studies, presentation of data and analysis, testing of hypothesis relating toimprovements.

UNIT-III

Travel Time amid Delay Studies; Various uses, travel time and delay studies, various methods, data collection and analysis, density studies and headways, gap acceptance studies, intersection delay studies, traffic flow theory, queuing theory and simulation models.

UNIT-IV

Capacity Analysis of Traffic Facilities; Uninterrupted facilities, interrupted facilities, Level of Service, quality of service as per HCM, factors affecting LOS, computation of capacity and LOS, Measure of effectiveness, highway capacity and performance characteristics, intersection design.

UNIT-V

Traffic Control, Design and Regulation; Traffic signals, types, principles of phasing, tune diagram, signalized intersection, saturation flow, saturation headway, capacity of lane group, concept of critical lane group, signal timing, phase plan, phase diagram, splitting of phase, clearance interval, pedestrian requirement, guidelines for protected movements, signal coordination, emerging themes, inter-modalism, access management, congestion management, environmental impactassessment.

Suggested Readings:

1. McShane, W.R., Roess, R.P. and Prassas, E.S., Traffic Engineering. Prentice Hall, EnglewoodCliffs, 1997.
2. HighwayCapacityManual,TransportationResearchBoard,NationalResearchCouncil, Washington, D.C.,2000.
3. Daganzo, C.R, Fundamentals of Transportation and Traffic Operations, Pergamon, Elsevier Science Inc., New York,1997.
4. Salter, R.J., Traffic Engineering: Worked Examples, Macmillan, London,1989.
5. Pignataro, L.J., Traffic Engineering: Theory and Practice, Prentice Hall, Englewood lifts,1973.
6. Wohl, M. and Martin, B.V, Traffic System Analysis for Engineers and Planners, McGraw Hill,New York,1983.
7. Drew, D.R., Traffic Flow Theory, McGraw Hill, New York,1964.

Course Code	Course Title						Core/Elective
PE 1417TE	**Intelligent Transportation Systems**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Introduce the objectives, benefits andthetelecommunications inITS.
- Understand about the functional areas, user needs and services in ITS.
- Learn the concepts of ITS operations and planning
- Learn ITS applications and its implementations in developing countries.

Course Outcomes

1. Appreciate the advantages of ITS and suggest the appropriate technologies for field conditions.
2. Suggest the appropriate system/s in various functional areas oftransportation.
3. Amalgamate the various systems, plan and implement the applications ofITS
4. Implement the ITS applications through case studies

UNIT I

Introduction to Intelligent Transportation Systems (ITS): Definition, Objectives, Historical Background, Benefits of ITS -ITS Data collection techniques – Detectors, Automatic Vehicle Location (AVL), Automatic Vehicle Identification (AVI), Geographic Information Systems (GIS), video data collection**.**

UNIT II

Telecommunications in ITS: Information Management, Traffic Management Centres (TMC). Application of sensors to Traffic management; Traffic flow sensor technologies; Transponders and Communication systems; Data fusion at traffic management centres; Sensor plan and specification requirements; Elements of Vehicle Location and Route Navigation and Guidanceconcepts.

UNIT III

Its Functional Areas: Advanced Traffic Management Systems (ATMS), Advanced Traveler Information Systems (ATIS), Commercial Vehicle Operations (CVO), Advanced Vehicle Control Systems (AVCS), Advanced Public Transportation Systems (APTS), Advanced Rural Transportation Systems (ARTS). 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.

UNIT IV

ITS Operations: Regional and Project ITS architecture; Concept of operations; ITS Models and Evaluation Methods; Planning and human factor issues for ITS, Case studies on deployment planning and system design and operation; ITS and safety, ITS and security, ITS as a technology deployment program, research, development and business models, ITS planning

UNIT V

ITS Applications: Traffic and incident management systems; ITS and sustainable mobility, travel demand management, electronic toll collection, ITS and road-pricing.; Transportation network operations; commercial vehicle operations; public transportation applications; Automated Highway Systems- Vehicles in Platoons –ITS in World – Overview of ITS implementations in developed countries, ITS in developing countries. [Case study]

Suggested Readings:

1. Choudury M A and SadekA, "Fundamentals of Intelligent Transportation Systems Planning" Artech House.
2. Kan Paul Chen, John Miles, "Recommendations for World Road Association (PIARC)" ITS Hand Book 2000.
3. Sussman, J. M., "Perspective on ITS", Artech House Publishers,2005.
4. US Department of Transportation, "National ITS Architecture Documentation", 2007(CDROM).
5. Turban. E and Aronson. J. E, "Decision Support Systems and Intelligent Systems", Prentice HallDept.

Course Code	Course Title						Core/Elective
PE 1418 SE	**Finite Element Methods**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Study the fundamentals of domain discretization, interpolation, application of boundary conditions, assembly of global matrices, and solution of the resulting algebraicsystems.
- Understand the core concepts of variation and weighted residual methods inFEM
- Identify the information requirements and sources for analysis, design andevaluation
- Derive the element stiffness matrix for 1-D, 2-D and 3-Dproblems.

Course Outcomes

1. Build and analyze the FEA models for various engineeringproblems.
2. Formulate the simple structural problems in to finiteelements
3. Use the standard finite element software to solve the structural engineeringproblems.
4. Interpret the results obtained from FEA software, not only in terms of conclusions but also awareness oflimitations.

UNIT – I

Introduction to FEM: Types of problems – Types of materials – Elastic, inelastic situations – Types of forces - Body forces, surface traction, point loads – Deformable bodies – Types of deformations – Homogeneous, non-homogeneous problems – Equations of equilibrium for elastic 2-D, 3-D continua - Equilibrium equations for 2-D, 3-D boundary elements – Boundary conditions – Strain-displacement relation for 2-D, 3-D problems – Stress-strain relation for 2-D, 3-D problems – Plane stress, plane strain problems. Virtual work formulation: Application to problems of plane trusses with static indeterminacy not exceeding three. Finite difference method with central differences: Solving ODE's and PDE's with central differences - Application to beam and plate bending problems of simple geometry.

UNIT – II

Variational formulation: Finite element formulation - Stationarity of functional - Given the functional or differential equation – Number of elements limited to two.

1-D Elements: Strain-displacement relation matrix - Stiffness matrix - Minimum potential energy approach - Rayleigh-Ritz Method - Introduction to natural coordinates - Stiffness matrix of second order bar element - Axial bar subjected to point loads, body forces and surface traction forces - Problems with kinematic indeterminacy not exceeding two.

2-D Triangular elements: Displacement models - Criterion for convergence - Geometric invariance - Conforming and non-conforming elements - 3-node triangular (CST) element - Strain-displacement matrix - Area coordinates, shape functions - Element stiffness and load matrices – Assembly of global stiffness and load matrices - Problems with kinematic indeterminacy not exceeding three. 2nd Order triangular elements: Shape functions – Degradation technique - Strain-displacement matrix - Expression for stiffness matrix - Load matrices due to body forces and surface traction.

UNIT – III

Iso-parametric elements: Quadrilateral elements: Shape functions using natural coordinates - Strain-displacement matrices - Load matrices for body force and surface traction - Stiffness matrix - Load matrices for 4-node quadrilateral elements - Gauss quadrature of numerical integration - Problems with rectangular elements, kinematic indeterminacy not exceeding three.

2nd Order Quadrilateral elements: - Shape functions for 2nd order quadrilateral elements and for elements of with serendipity – Strain displacement matrix - Load matrices for body force and surface traction.

UNIT – IV

Method of weighted residuals: Galerkin's method of weighted residuals: Application to problems of mathematics and structural engineering, number of trial functions not exceeding two.

Galerkin's finite element method: Weak form of trial function - Application to problems of mathematics and structural engineering, number of elements limited to two.

Axi-symmetric problems: Strain-displacement matrix - Stress-strain relationship - Stiffness matrix for 3-noded ring element - Load matrices for body force and surface traction - Problems with kinematic indeterminacy not exceeding three.

UNIT – V

Tetrahedron elements: Volume coordinates Strain-displacement matrix - Stiffness matrix - Load matrices due to body force and surface traction - Introduction to hexahedron (brick) elements. Non-linear Finite element analysis: Introduction – Problems with material non-linearity – Problems with geometric non-linearity – Problems with both material and geometric non- linearity. Introduction to MSC Nastran: Illustration on different modules of Nastran - Structural engineering applications of the package - Creation of a simple 1-D model, 2-D model and a 3-D model - Analysis and post processing of the results.

Suggested Readings:

1. R.D. Cook, "Concepts and Application of Finite Element Analysis", John Wiley and Sons,1981.
2. O.C. Zienkiewicz and R.L. Taylor, "The Finite Element Method, Volume 1: The Basis", McGraw-Hill, London,1989.
3. J.N. Reddy, "An Introduction to the Finite Element Method", McGraw-Hill, New York,1993.
4. David V. Hutton, "Fundamentals of Finite Element Analysis", Tata McGraw-Hill, New Delhi,2005.

Course Code	Course Title						Core/Elective
PE 1419 TE	**Analysis of Transportation Systems**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To discuss various components of urban transportation systems and itsinnovation
- To understand the concepts of linear programming formulation and variousmethods
- To review different transportation and assignment formulations andproblems
- To examine various nonlinear programming and decisiontheories

Course Outcomes

1. To describe and evaluate various transportation systems impacts on society andeconomy
2. To identify the different solutions for linear programming problems including sensitivityanalysis.
3. To demonstrate effective way of understanding transportation and assignmentproblems
4. To explain various issues related to uncertainty and decisiontheories

UNIT – I

Introduction to Transportation Systems: Goals and Scope of Transportation System Analysis, components of transportation system, Transportation innovations, Social and economic impacts of transportation, Decision makers and their options, Vehicle factors and Humanfactors.

UNIT- II

Linear Programming for Transportation: Formulation of Linear Programming, Graphical solutions, Simplex method, revised simplex method, Duality simplex problem, degeneracy, Big M method, sensitivity analysis and computer solutions for linear programming problems.

UNIT- III

Transportation and Assignment Problem: Introduction, mathematical model formulation, Types of Transportation problem - North West corner cell, least cost cell and Vogel's Approximation. Assignment Problem-Introduction, Zero- one programming model. Types of Assignment Problem-Hungerian Method, Branch and Bound Technique.

UNIT-IV

Analysis of Network Flows: Introduction, Types of network techniques -shortest path model, minimum spanning tree model and maximal flow model. Project management- CPM and PERT.

UNIT-V

Non Linear Programming and Decision Theory: Formulation, Characteristics of non-linear programming, convexity of a function, unconstrained single and multivariable problems, constrained optimization, quadratic programming, convex programming-gradient search, frank wolf algorithm and golden search code. Decision theory - introduction, game theory, terminologies of game theory, game with pure strategies, game with mixed strategies, dominance property and graphicalsolutions.

Suggested Readings:

1. Hillier, F.S and Lieberman, G. J, Introduction to Operations Research, McGraw-Hill, Seventh Edition, 2001.
2. Ravindran, A, Philips, D.T and Solberg, J. J, Operations Research: Principles and Practice, John Wiley and Sons, Second Edition2000.
3. Render, B, Stair, R. M, Quantitative Analysis for Management, Prentice Hall of India Private Limited, Seventh Edition, 2000.

Course Code	Course Title						Core/Elective
PE 1420 TE	**GIS and GPS Applications to Transportation Engineering**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Learn about various spatial and non-spatial data types and data base managementmethods
- Understand the concepts and professional skills in utility of GIStechniques
- Awareness of various techniques of GIS
- Study the application of GIS techniques in the decision support systems useful for decision makers and community services in Transportationfield

Course Outcomes

1. GIS related data acquiring and processing that is associated with geographiclocations
2. Utility of GIS techniques in the fields of natural resource management, environment, transportation planning and development, etc.
3. Implementation of alternative and operation of GIS
4. Enhancement of knowledge of GIS to transportation fieldproblems

UNIT -I

Introduction to GIS; Introduction, GIS over view, use of GIS in decision making. Data processing, components of GIS, The GIS and the organization, Data Input-Key board entry, Manual digitizing, scanning, Remotely and sensed data, existing digital data, census related data sets, Data output - Hard copy and soft copy devices.

UNIT-II

Data Acquisition and Data Management; Platforms, sensors used for the remote sensing data acquisition, data processing, radiometric, geometric corrections. Components of data quality - Micro level, Macro level components. Sources of error, a note about data accuracy. Management: The data base approach, 3 classic data models, Nature of geographic data, spatial data models. Databases for GIS.

UNIT- III

GIS Analysis and Functions; Organizing geographic data for analysis, Maintenance and analysis of the spatial data and non-spatial attribute data and its integration output formatting.

UNIT-IV

Implementation of GIS; Awareness, Developing system requirements, Evaluation of alternative systems, System justification and Development of an implementation plan, System acquisition and start-up, Operation of the system.

UNIT-V

Application of GIS for Transportation Engineering; Intelligent information system for road accessibility study, GIS database design for physical facility planning. Decision support systems for land use planning.GIS applications in environment impact assessment, GIS based Highway alignment, GIS based road network planning, GIS based traffic congestion analysis and accidentinvestigation.

Suggested Readings:

1. GIS for Urban & Regional Planning, Scholten &Stillwen1990, KulwerAcademicPublisher.
2. Lilles and Kiefer, Remote Sensing Principles and Interpretation, John Wiley & Sons, New York, 2000.

Course Code	Course Title						Core/Elective
PE 1421 TE	**Rural Roads**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Introduction to various factors affecting road alignment andplanning
- Introduction to inputs required for pavementdesign
- Concepts of mechanistic empirical methods of flexible and rigidpavements
- Understand various waste materials, maintenance and evaluation for pavement construction

Course Outcomes

1. Application of basic principles in pavement design for ruralroads
2. Assimilation of mechanistic principles for the pavementdesign
3. Application of waste materials and its specification for pavement construction
4. Explain about appropriate quality control measures during construction and evaluation and maintenancemeasures

UNIT - I

Planning and Alignment: Planning of Rural roads, concept of network planning, rural road plan, road alignment and surveys. Governing factors in route selection, factors considered for alignment.

UNIT - II

Materials and Pavement Design: Introduction, Soil material surveys, embankment and Sub grade materials, stabilized soils, road aggregates, aggregate for base courses, new materials as stabilizers, materials for desert areas, materials for bituminous constructions and surfacing; Materials for rigid pavements, special pavement, climatic suitability of concrete material. Introduction, Design procedure, pavement components, design of flexible and rigid pavements, Special pavements design. Types of drainage, General criteria for road drainage, system of drainage, surface and subsurfacesystems.

UNIT- III

Construction and Specifications: Introduction, Selection of materials and Methodology, Embankment and Sub grade, sub-base (granular), base(granular), shoulder, Bituminous concrete, Semi-rigid pavements construction, and Concrete pavements. Construction of special pavements, Equipment required for different procedures.

UNIT -IV

Waste Materials for Pavement Construction: Introduction, Fly ash for road construction, Design & Construction of Fly ash embankments, Lime flyash stabilized soil. Lime fly ash bound Macadam, Lime fly ash concrete, rolled compacted fly ash pavements. Control of compaction, concrete stabilized fly ash with admixtures.

UNIT - V

Quality Control in Construction and maintenance: Introduction, Prerequirements, organizational setup, specification and code of practice, Laboratory equipment. Earth and Granular layers, bituminous courses, Semi rigid and rigid pavements, special requirements, recovered of quality control data. Distresses/Defects in rigid and flexible pavements, Maintenance and Evaluation, Inventory of roads and inspections, Types of maintenance activities. Maintenance.

Suggested Readings:

1. IRC manual for rural roads. Special Publication -20(2002).
2. HMSO, Soil Mechanics for Road-Engineers,London
3. IRC related codebooks
4. NRRDA -Guidelines and codebooks

Course Code	Course Title						Core/Elective
PE 1422 TE	**Economic Evaluation and Analysis of Transportation Projects**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Provide knowledge in project formulation
- Learn the basic concept of economic evaluation highway infrastructureprojects
- Understand the principles and methods of economic analysis
- Introduce the scope of asset management and EIA inhighway projects

Course Outcomes

1. Formulate and prepare detailed project report for a highwayproject
2. Apply the methods of economic analysis for highwayprojects
3. Prepare Environmental Impact AssessmentReport
4. Ability to analyze and evaluate transportation project case studies

UNIT – I

Transportation Projects Formulation and Development: Requirements in project formulation. Components of project, Non- monetary and monetary Criteria in formulation of project. Decision making Criteria input in Project formulation. Preparation of DPR – Guidelines Transport Projects and development: preparation of Project, Highway Planning, Traffic infrastructure, Project formulation, Road Network project development.

UNIT- II

Economic evaluation of Transportation plans: Need for Economic Evaluation; Principles of economic evaluation; Welfare economics; Social costs, Vest change, Rate of return. Value of Travel Time Savings; Economic concept of evaluation of travel time savings, Issues connected with evaluation of travel time savings. Vehicle operating costs; Components of VOC, Road user Cost study in India; Accident costs; Methodologies for economic evaluation of an accident; Factors involved.

UNIT-III

Methods of Economic Analysis: Cash flow diagrams, Time value of money, Inflation, Interest, Depreciation, Cost and benefit components, discounting criteria. Equivalent Uniform Annual Cost Method; Present worth of cost method; Equivalent uniform annual net return method; Net-present value method; Benefit cost ratio method; Rate of Return Method; Application of these methods to numerical examples.

UNIT-IV

Analysis of variable costs and Transportation Asset Management: Types of Capital Financing; valuation; Project appraisal by shadow pricing with case studies. Economic Analysis of BOT and BOOT projects and allocations. Introduction and scope of asset management inIndia.

UNIT-V

Environmental Impact Assessment: Basic concepts, Objectives, Transportation related Environmental Impacts - Vehicular Impacts - Safety and Capacity Impacts - Roadway Impacts – Construction Impacts, Environmental Impact Assessment-Environmental Impact Statement, Environment Audit, Typical case studies.

Suggested Readings:

1. Transportation Engineering Economics - Heggie. I.G., McGraw HillPublishers.
2. Economic Analysis for Highways - Winfrey. R; International Text BookCompany.
3. Traffic Engineering and Transport Planning - L. R. Kadiyali, KhannaPublishers.
4. Road User Cost Study,CRRI.
5. Road Project Appraisal for Developing Countries, J. W. Dickey, John Wiley &Sons
6. Construction Management & Planning, B. Sengupta, H. Guha, Tata McGraw Hill, NewDelhi.

Course Code	Course Title						Core/Elective
PE1423 TE	**Transportation Modelling and Simulation**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Introduce various models ofsimulation
- Understand the role of optimization and its applications in simulation
- Learn the direct and indirect methods of solving inverse problems in simulation
- Identify various data processing and evaluation techniques insimulation

Course Outcomes

1. Formulate various models of transportation simulation
2. Build models for transportationsimulation
3. Build tools to view and control transportationsimulations and their results.
4. Evaluate and validate thetransportationsimulation models

UNIT-1

Introduction of Modelling: Fundamentals of systemic approach. System modelling, Model structure, Variables, controllable variables, uncontrollable variables, parameters, coefficients and other statistical methods for testing of models and data.

UNIT - II

Classification of Models: Classification of models - Linear models, Nonlinear models, Time-invariant models, Time-variant models, State-space models, Distributed. Parameter models. System Synthesis- - Direct and Inverse Problems, Role of optimization and examples from transportationengineering.

UNIT-III

Preliminary Data Processing: data collection, Regression Analysis-Linear multiple regression analysis; Analysis of residues, Tests of goodness of fit. Spatial Distribution- Polynomial surfaces, Spline functions, Cluster. Analysis sand Numerical production of contour maps. Time Series Analysis-Autocross. Correlation analysis, Identification of trend, spectral analysis, Identification of dominant cycles, smoothening techniques, Filters and forecasting.

UNIT-IV

Model Building: Choice of Model Structure- A priori considerations, Selection based upon preliminary data analysis, Comparing model structures. Model Calibration- Role of historical data, Direct and Indirect methods of solving inverse problem. -ModelValidation.

UNIT-V

Simulation: Random variables, Basic concepts. Probability density and distribution functions, Expectation and standard deviation of discrete and continuous random variables and their functions, Covariance and correlation, commonly used theoretical Probability distributions: Uniform, Normal, Binomial, Poisson, Negative exponential. Fitting distributions to raw data: Chi-square and Kolmogrov-Smirnov's tests of the goodness of fit. Central limit theorem, various algorithms for generation of Random numbers. Queuing theory: Elements, Deterministic queues. Applications of Monte, Carlo simulation:" Basic concepts. Generation-of synthetic observations, -Statistical interpretation of the output, Evaluation of definite integrals and examples.

Suggested Readings:

1. Bratley, P., Fox B. L., Schrage, L. E. B., Guide to Simulation, Springer-Verlag, New York1983.
2. Leigh, J. R., Modeling and Simulation, Peter Peregrinus, London,1983.
3. Bernard, Z., Theory of Modeling and Simulation, John- Wiley, New York,1976.
4. Ortuzar, J. and Willumsen, L.G, Modeling Transport, Wiley, Chinchestor, 1994.
5. Hansher, D. A., and Button. K. J., Handbook of Transport Modeling, Pergamon, Oxford, UK,2000

Course Code	Course Title						Core/Elective
PE 1424 TE	**Airport Planning and Design**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Understand basic terminology and standards related to AirportEngineering
- Learn the various components of airport and runwaycomponents
- Understand the strengthening of Airfield Pavements and maintenance operations.
- Identify various methods of air travel demandanalysis and ATC

Course Outcomes

1. Conduct surveys, develop and design new airports with ICAO/FAA geometricstandards
2. Investigate and explore the failures of runway pavements and suggest remedial designmeasures
3. Develop the micro and macro analysis of Air Travel Demand
4. Develop plans for installation of various types of devices pertaining to Air TrafficControls

UNIT-I

Airport Planning: Growth of Air Transport, Technological Developments, Institutional Development for Planning, Regulatory Practices; Aircraft characteristics related to airport planning and design, Future trends in Aircraft design and Airport Planning; Airport master plan, site selection, planning surveys etc. Airport Obstructions: Zoning Laws, Classification, Approach and TurningZones.

UNIT-II

Runway Design and Airport Capacity: Runway Orientation, Basic Runway Length and Factors affecting, Correction for elevation, temperature and gradient as per ICAO and FAA, Run way Geometric Design. Airport

Capacity: Classification and Standards; Capacity of Airport, Runway, Taxiway and Gate; Delays; Configuration of Airport and Configuration; Runway Intersection Design; Terminal Facilities and Standards: Planning Concepts. Taxiway Design: Factors affecting Taxiway Design, Geometric Design as per ICAO, Exit taxiways, Fillets, Separation clearance, Holding Apron, TurnAround.

UNIT-III

Design of Airport Pavements: Design factors, Calculation of ESWL with different wheel load configurations and methods, Repetition of loads, failure criteria; Flexible Pavements Design: US corps of Engineers Method, FAA method; Rigid Pavement Design methods: US corps of Engineers method, PCA Method, FAA method, LCN Method and CAN-PCN System.; Overlays; Drainage: Surface and subsurface methods, filter materials, Special characteristics and requirements of Airport Drainage. Airfield Pavement Maintenance and Rehabilitation: Need, Failures, Evaluation of flexible and Rigid Pavements, Strengthening of Airfield Pavements and maintenance operations.

UNIT-IV

Air Travel Demand Analysis: The Demand Analysis, Microanalysis of Air Travel Demand, Calibration of Macro analysis of Air Travel Demand, Disaggregate Models Route Frequency planning. Air travel choice Models, Simultaneous Models of Demand and supply. Optimal Route Frequency Planning.

UNIT-V

Air Traffic Controls (ATC): Visual Aids: marking and lighting; Need, Network and Aids for ATC, Radio equipment; Design of Heliports and STOLPORTS: Design Factors, Planning, Site selection. Geometric

Designs, Visual Aids.

Suggested Readings:

1. Principles of Pavement Design, Yoder E.J. and Witczak M. W. John Wiley &-Sons,1975.
2. Elementary Hand Book of Aircraft Engines, A. W. Judge, Chapman and Hall ltd,London.
3. Airplanes Structures, A.S. Nil.es and J.S. Newell, M. W. John Wiley &Sons, NewYork.
4. Relevant IRCcodes.
5. Air Port Engineering, Norman Ashford and Paul H Wright, M. W. John Wiley&Sons.
6. The Planning and Design of Airports, Robert Horojeff, McGraw Hill BookCo.
7. Airport Planning and Design, S.K. Khanna, Arora and S.S. Jain, Nem Chand & Bros.Roorkee.

Course Code	Course Title						Core/Elective
PE 1425 TE	**Pavement Evaluation Maintenance and Management**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Understand the functional and structural evaluation methods for pavement performance
- Identify various pavement performance prediction models, techniques and tools for implementation of PMS
- Know the different types of distresses and LCCA ofpavements
- Learn the need of highway maintenance

Course Outcomes

1. Apply Pavement Performance Prediction Models for Pavements
2. Investigate various NDT equipment used for pavementevaluation
3. Applypavement maintenance and managementprinciples
4. Build the different levels of pavement maintenance treatmentoptions

UNIT-I

Pavement Inventories and Evaluation: Purposes, functional Evaluation: Serviceability concepts, Distress types: Bituminous and Concrete pavements; Visual Rating; PSI; Methods of Measuring Roughness: Response type &Profile type; IRI: Quarter Car Model, Riding Number; Pavement Safety Evaluation: Skid Resistance, measurement of skid, skid resistance, Change of Skid resistance with time, traffic and climate; Control of Skid Resistance; Distress Modes - Cracking, Ruttingetc.

UNIT-II

Structural Evaluation: Pavement Deflection: Different Methods of NDT(Working Principles): Benkelman Beam, LaCroix Deflectometer, Dynaflect, Road Ratar, Rolling Dynamic Deflectometer, Loadman, Different Types of Falling Weight Deflectometers (FWD) for evaluation of rigid and flexible pavements; Factors influencing deflections, Back-calculation of Pavement Layer Moduli and detection of loss of bonding of cement concrete pavements using FWD data; Destructive Structural Evaluation; Pavement Performance Prediction Models for Flexible and Rigid Pavements.

UNIT-III

Pavement Management System (PMS): Components of PMS and their activities; Major steps in implementing PMS; Inputs; Design construction and maintenance; Rehabilitation and Feedback systems; Examples of HDM and RTIM packages; Evaluating alternate strategies and Decision criteria based on Structural section, Material type, Construction policy, maintenance policy, Overlay and seal coat; Pavement performance prediction models; Techniques and Tools, Expert Systems and Pavement Management.

UNIT - IV

Pavement Maintenance Management: Components of maintenance management and related activities-Network and project level analysis-Budgeting; Prioritization Techniques and Formulation of Maintenance Strategies, Pavement Preservation. Pavement Life Cycle Cost Analysis (LCCA): Cost Components, Methods of LCCA-Components involved, Brief Description - Items considered - Case studies.

UNIT - V

Highway Maintenance: Need of Highway maintenance, methods of maintenance for flexible and rigid pavement layers; WBM, Bituminous and Cement Concrete pavements.

Suggested Readings:

1. Haas and Hudson W.R. Pavement management systems - McGraw Hillpublications.
2. Sargious, M.A. - Pavements and surfacing for highways and airports -Applied Science PublishersLtd.
3. Bridge and Pavement maintenance - Transportation Research RecordNo.800,TRB.
4. Shahin M.Y. 1994 - Pavement Management for airports, roads and parkinglots.
5. Bent Thagesan, 1996- Highway and Traffic engineering for developingcountries.
6. Principles of Pavement Design, Yoder J. &Witzac Mathew W., John Wiley&Sons.
7. Pavement Analysis & Design, Yang H. Huang, Prentice HallInc.

Course Code	Course Title						Core/Elective
PE 1426 TE	**Railway Engineering**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Understand basic terminology related to RailwayEngineering
- Know about railway track components, their materials, size, function and importance
- Understand the various guidelines for provision of subgrade formation and ballast
- Understand the various methods of signaling interlocking methods

Course Outcomes

1. Carry out geometric design of railway track
2. Develop and design of railway tracks with geometricstandards
3. Investigate and explore the failures of railway embankments and suggest remedialmeasures
4. Design points and crossings with modern signalingsystem

UNIT-I

General Features of Railways: development in Indian railways, modes of transport, organization of Indian railways, finances and their control commission of railway safety, long term planning process, classification of railway lines, general features of Indian railways, impartment statistics.,. Alignment of railway lines, railway track gauge, engineering surveys.

UNIT-II

Rails, Sleepers, Track and Track Stresses: requirements of good track, maintenance of permanent way, track as an elastic structure, coning of wheels, tilting of rails. Functions of creep, creep adjuster, measures to reduce creep. Sleepers, requirements, sleeper density, types; wooden, steel channel, steel of rails, types, requirements for an ideal rail section, rail manufacture, rail wear, defects in rails, rail failure, and rail flaw detection. Creep: causes, effects of creep, measurement trough, cast iron, concrete etc.

UNIT-III

Geometric Design of Railway Track; Necessity of Geometric design details of geometric design of track, circular curves, super elevation, transition curve, reverse curve, extra clearance of curves, widening of gauge on curves, vertical curves, cutting rails on curves, check rails on curves.

UNIT-IV

Sub grade Formation and Ballast; Slope of formation, execution of earthwork in embankments and cuttings, blanketing Material, Failure of railway embankment, site investigations. Ballast: functions, types, sizes of ballast, requirement, design of ballast section, collection and transportation of ballast, methods of measurement, laboratory tests for physical properties of ballast. Guidelines for provision of sub-ballast.

UNIT – V

Points and Crossings, Level Crossings, Signalling and Interlocking; Crossings, switches, number and angle of crossing, reconditioning of worn out crossings, turnouts, turnout with curved switches, layout of turnout, trends in turnout design on Indian Railways, inspection and maintenance of points and crossings. Level crossing: types, dimensions, accidents and remedial measures, maintenance of LC, inspection-LC by PWI. Signalling and interlocking: types, signalling systems, systems for controlling train movement, interlocking, modern signalling installations.

Suggested Readings:

1. Chandra, S.andAgarwal.M.M. "Railway Engineering". Oxford University Press, New Delhi,2007.
2. Rangwala, K. S. "Principles of Railway Engineering". Charotar Publishing House, India(1991)

Course Code	Course Title						Core/Elective
PE 1427 TE	**Transportation Structures**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Classify the various transportation structures
- Understand the principles of design methods and list the steps involved in the design ofvarious transportation structures.
- Identify the input parameters required for design of transportation structures
- Learn sub-structure design of bridges

Course Outcomes

1. Decide the selection of transportation structures, list the factors affecting design of various transportation structures and generate the input parameters required fordesign.
2. Calculate various types of design loads for the design of various transportation structures.
3. Summarize the design methodology and arrive at design values for various transportation structures.
4. Design and evaluate a transportation structures based on the datagiven.

UNIT-I

Introduction: Principles of Planning of Elevated Rail Transit System, grade separation structures, pedestrian crossing and sub- ways.

UNIT-II

Loads on Bridges: Dead loads, live loads, dynamic effects of vehicles, longitudinal forces, centrifugal forces, wind loads, earth quake forces, stream flow pressure, load combinations, design examples.

UNIT-III

Design of Bridge Slabs: Longitudinally reinforced deck slabs, transversely reinforced bridge slabs.

UNIT-IV

Design of Reinforced Concrete Bridges: Design procedures for T- beam, box girder bridges design examples.

Design of Prestressed Concrete Bridges: Design code, design examples

UNIT-V

Segmental Box bridges - precast sections, criteria, design examples

Sub-Structure Design: Foundation investigation, bearings, bridge pier design, and abutment design, Examples.

Suggested Readings:

1. Raina, R.K, 'Principles of Design of RCC Bridges, Tata McGrawHill,1999.
2. Krishna Raju ‘Bridge Engineering‘, UPD Publishers, New Delhi,2000.
3. Conrad P. Heinsand Richard A. Lawrie, `Design of Modern Concrete Highway Bridges, John Wiley and Sons,1999.
4. BaiderBakhtand Leslie, G. Jaeger, `Bridge Analysis Simplified, McGraw-Hill BookCo,1998.
5. Johnson Victor, `Bridge Engineering', Oxford IBH, New Delhi,2000.

Course Code	Course Title						Core/Elective
PE 1428 TE	**Statistical Techniques**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Introduce fundamental knowledge of samplingtechnique
- Describe basic statistical techniques such as statistical distributions and correlationmethods
- Understand various multi variate data distribution techniques
- Know about exact sampling distributions and the tests ofsignificance

Course Outcomes

1. Use sampling techniques for conducting various surveys related to transportationEngineering
2. Decide best fit and develop the regression equations for the givenvariables
3. Build multi variate data distribution techniques to solve traffic engineering problems
4. Applysampling distributions in highway and traffic engineering problems

UNIT-I

Introduction: Frequency distribution; Measures of central tendency; Measures of dispersion; Standard error, Moments (about mean, arbitrary numbers and origin); Skewness; Kurtosis; Sampling-Definitions and Applications; Simple random sampling; Stratified sampling; Systematic sampling; Sample size determination; Applications in Highway and Traffic Engineering.

UNIT-II

Statistical Distribution; Probability, Bayes' Theorem; Binomial, Poisson, Exponential and Normal distributions; Fitting of distributions; Mean and variance; Chi-square test of goodness-of-fit; Applications in Highway and traffic Engineering. Mathematical expectation.

UNIT-III

Regression and Correlation: Linear regression and correlation; Multiple correlation; Multiple correlation coefficient; Standard error of estimate; Analysis of variance; Curvilinear regression; Applications in Transportation Engineering.

UNIT-IV

Multi Variate Data Distributions: Types of data; Basic vectors and matrices; Simple estimate of centroid, Standard deviation Variance and covariance; Correlation matrices; Principal component analysis; Time series analysis. Estimation-Point Estimation Interval Estimation, Box Plot, Maximum likelihood estimation, Biased &Non BiasedEstimation.

UNIT -V

Exact Sampling Distributions and Tests of Significance; Chi-square distribution; student's t-distribution; Snedectors F-distribution. Large sample and small sample tests; Tests for single mean. Means of two samples, Proportions, two variances, two observed correlation coefficients, paired T-tests, Applications. Intervals for mean, variance and regression Coefficients; Applications in Highway and Traffic Engineering Problems.

Suggested Readings:

1. Basic Statistics - Simpson and Kafks; Oxford and IBHCalcutta,1969.
2. Fundamentals of Mathematical Statistics - Gupta, S.C. and Kapoor, K.V.Sultanchand
3. Multivariate Data Analysis – Cootey W.W &Cochens P.R; John Wiley &Sons.

Course Code	Course Title						Core/Elective
PE 1429TE	**Behavioural Modelling**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To review the background of discrete choice analysis and its applications totransportation.
- To understand the frame work of choice theories and probabilistictheories
- To establish aggregate forecasting techniques and various samplingtheories.
- To discuss multidimensional choice sets and estimation of the nested logitmodel.

Course Outcomes

1. To demonstrate the methods of estimation of discrete choice theory and statistics for model estimation
2. To explain binary logit model and multinomial logit models including random utilitytheory
3. To identify various aggregate forecasting techniques and comparing with traditionalmethods
4. To describe derivation of nested logit model from generalised extreme valuemodel

UNIT -I

Introduction & Review of the statistics of Model Estimation: Background of Discrete Choice-analysis, Transportation applications of Discrete Choice Analysis. The estimation problem, small sample properties, asymptotic properties, methods of estimation, key statistical tests.

UNIT-II

Theories of Individual Choice Behaviour: Introduction, A frame work for choice theories, rational behaviour, economic consumer theory, discrete choice theory, probabilistic theory.

UNIT-III

Binary and Multinomial Choice Models: Random utility theory, binary choice models, examples, maximum likelihood estimation, examples. Theory of multinomial choice, multinomial logit models, properties logit, specification of multinomial logit model, estimation of multinomial logit, examples of estimation results.

UNIT-IV

Aggregate Forecasting Techniques & Theory of sampling: Problem of aggregation across individuals, typology of aggregation methods, a comparison of methods for aggregate forecasting. Basic sampling concepts, sampling strategies, overview, choosing a sample design for discrete choice analysis.

UNIT-V

Nested Logit and Models of Travel Demand: Multidimensional choice sets, estimating the nested logit model, multinomial probit model, measure of accessibility, derivation of the nested logit model from the generalized extreme value model. Components of travel demand modelling process, behavioural theory, measurement, statistical model structure and estimation.

Suggested Readings:

1. Ben-Akiva, M and Lerman, S. R. "Discrete Choice Analysis: Theory and Application to Travel Demand"'. The MIT press, Cambridge, Massachusetts,London.
2. Train, K. E. "Discrete Choice Methods with Simulation". Cambridge University Press,London.

Course Code	Course Title						Core/Elective
PE 1430 TE	**Ground Improvement Techniques**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand the objectives, necessity and scope of ground improvementtechniques
- To learn different methods of in situ densification of cohesive, cohesion lesssoil
- To learn the classification, functions and applications of Geosynthetics in groundimprovement
- To learn the process of identification of necessity for ground improvement, finding alternative methods and recommendation of the ideal technique through casestudies

Course Outcomes

1. Ability to understand the necessity of ground improvement and potential of a ground for improvement
2. To gain comprehensive understanding about the improvement of in-situ cohesive soils as well as Cohesion lesssoils
3. Competence to analyse an in-situ ground, identification of ground improvement techniques feasible, selection of the ideal method, its planning , design, implementation and evaluation of improvement level
4. Apply Geo-textiles in Highway construction.

UNIT - I

Ground Modification: Need and objectives of Ground Improvement, Classification of Ground Modification Techniques - suitability and Feasibility, Emerging Trends in ground improvement.

UNIT - II

Mechanical and Hydraulic Modification: Methods of compaction, Shallow compaction, Deep compaction techniques - Vibro floatation, Blasting, Dynamic consolidation, pre-compression and compaction piles, Field compaction control. Hydraulic Modification: Methods of dewatering- open sumps and ditches, Well-point system, Electro-osmosis, Vacuum dewatering wells; pre-loading without and with sand drains, strip drains and rope drains.

UNIT-III

Physical and Chemical modification: Stabilisation with admixtures like cement, lime, calcium chloride, fly ash and bitumen, Grouting: categories of grouting, Art of grouting, Grout materials, Grouting techniques and control.

UNIT-IV

Reinforced Earth Technology: Concept of soil reinforcement, Reinforcing materials, and Backfill criteria, Art of reinforced earth technology, Design and construction of reinforced earth structures.

UNIT -V

Soil Confinement Systems and Miscellaneous techniques: Concept of confinement, Gabbion walls, CRB walls, Sand bags, Evergreen systems and fabric formwork. Miscellaneous Techniques: Design, Construction and applications of stone columns lime columns and cofferdams, Applications of Geo-textiles in Highway construction.

Suggested Readings:

1. Manfred R. Hansmann - Engineering principles of ground modification - Me Graw-Hill pub. Co., New York.
2. Robert M. Koerner - Construction and Geotechnical methods in Foundation Engineering- McGraw-Hill Pub. Co., NewYork.
3. Winterkorn and Fang - Foundation Engineering Hand book -Van Nostrand Reinhold Co., NewYork.
4. Aris C.Stamatopoulos&PanaghiotisC.Kotzios - Soil Improvement by Preloading - John Wiley &Sons Inc. Canada.
5. R. Pumshothama Rao - Ground Improvement Techniques – Laxmi Publications (P) Limited.

Detailed Syllabus for Mandatory Course

Course Code	Course Title						Core/Elective
MC 5121 ME	**Research Methodology and IPR**						**Mandatory Course**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

To make students to

- Motivate to choose research ascareer
- Formulate the research problem, prepare the researchdesign
- Identify various sources for literature review and data collection report writing
- Equip with good methods to analyse the collecteddata
- Know about IPRcopyrights

Course Outcomes

1. Define research problem, review and asses the quality of literature from varioussources
2. Improve the style and format of writing a report for technical paper/ Journal report, understand and develop various researchdesigns
3. Collect the data by various methods: observation, interview,questionnaires and analyze problem by statistical techniques: ANOVA, F-test,Chi-square
4. Understand apply for patent andcopyrights

UNIT - I

Research Methodology: Objectives and Motivation of Research, Types of Research, research approaches, Significance of Research, Research Methods Verses Methodology, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Benefits to the society in general. Defining the Research Problem: Selection of Research Problem, Necessity of Defining the Problem

UNIT - II

Literature Survey and Report writing: Importance and purpose of Literature Survey, Sources of Information, Assessment of Quality of Journals and Articles, Need of Review, Guidelines for Review, Record of ResearchReview.

Report writing: Meaning of interpretation, layout of research report, Types of reports, Mechanism ofwriting a report. **Research Proposal Preparation**: Writing a Research Proposal and Research Report, Writing Research GrantProposal.

UNIT - III

Research Design: Meaning of Research Design, Need of Research Design, Feature of a Good Design, Important Concepts Related to Research Design, Different Research Designs, Basic Principles of Experimental Design, Developing a Research Plan, Steps in sample design, types of sample designs.

UNIT - IV

Data Collection and Analysis: Methods of data collection, Data organization, Methods of data grouping, Diagrammatic representation of data, Graphic representation of data. Importance of Parametric, non-parametric test, testing of variance of two normal populations, use of Chi-square, ANOVA, F-test, z-test**UNIT - V**

Intellectual Property Rights: Meaning, Nature, Classification and protection of Intellectual Property, The main forms of Intellectual Property, Concept of Patent, Patent document, Invention protection, Granting of patent, Rights of a patent, Licensing, Transfer of technology.

Suggested Readings:

1. C.R Kothari, Research Methodology, Methods & Technique‖; New Age International Publishers, 2004
2. R. Ganesan, Research Methodology for Engineers‖, MJP Publishers,2011
3. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computation‖, Sterling Publications Pvt. Ltd., New Delhi,2004
4. G.B. Reddy, Intellectual Property Rights and the Law 5th Ed. 2005 GogiaLawAgency
5. AjitParulekar and Sarita D'Souza, Indian Patents Law – Legal & Business Implications, Macmillan India Ltd,2006

Detailed Syllabus for Open Elective Courses

Course Code	Course Title						Core/Elective
OE 9101 CE	**Cost Management of Engineering Projects**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To apply modern software packages to conduct analysis of real worlddata.
- To understand the technical underpinning of engineering economicanalysis.
- The ability to apply the appropriate analytical techniques to a wide variety of real world problems and datasets.
- To summarize and present the analysis results in a clear and coherentmanner.

Course Outcomes

1. Students should be able to learn the cost concepts in decisionmaking
2. Student should be able to do cost planning and MarginalCosting
3. Students should be able to create a database for operational control and decisionmaking.

UNIT-I

Introduction and Overview of the Strategic Cost Management Process: Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT-II

Project: meaning, Different types, why to manage, cost overruns centers, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and non-technical activities. Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts. Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical andprocess.

UNIT-III

Cost Behavior and Profit Planning Marginal Costing: Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis.

Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.

UNIT-IV

Activity-Based Cost Management: Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT-V

Quantitative techniques for cost management: Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

Suggested Readings:

1. Cost Accounting – A Managerial Emphasis, Prentice Hall of India, NewDelhi
2. Charles T. Horngren and George Foster, Advanced ManagementAccounting
3. Robert S Kaplan Anthony A. Alkinson, Management & CostAccounting

Course Code	Course Title						Core/Elective
OE 9102 CS	**Business Analytics**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Understand the role of business analytics within anorganization
- Analyse data using statistical and data mining techniques and understand relationships between the underlying business processes of anorganization
- To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decisionmaking
- To become familiar with processes needed to develop, report, and analyse businessdata
- Use decision-making tools/Operations researchtechniques
- Mange business process using analytical and managementtools
- Analyse and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.
- Student will able to understand the basic rules of research formulation and procedure for obtaining patentrights

Course Outcomes

1. Students will demonstrate knowledge of dataanalytics
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modelling to support businessdecision-making
4. Students will demonstrate the ability to translate data into clear, actionableinsights

UNIT-I

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organization, competitive advantages of Business Analytics.

Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methodsoverview.

UNIT-II

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT-III

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process, Prescriptive Modelling, nonlinear Optimization.

UNIT-IV

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models.

Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT-V

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without 8 Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

Recent Trends in Embedded and collaborative business intelligence, Visual data 4 recovery, Data Storytelling and Data journalism.

Suggested Readings:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FTPress.
2. Business Analytics by James Evans, personsEducation.

Course Code	Course Title						Core/Elective
OE 9103 EC	**Embedded System Design**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Detailed overview of important concepts of Embeddedsystem
- Analyse PIC microcontroller, its features and programming
- Describe ARM Microcontroller architectural details and instructionset
- Understand ARM Memorymanagement
- Learn the techniques to develop an embedded system and casestudies

Course Outcomes

After completing this course, the student will be able to:

1. Understand the fundamentals of the embedded systemdesign
2. Enumerate the instruction set of ARM Processor by studying the architecture of ARM core
3. Acquire knowledge on the serial, parallel and network communicationprotocols.
4. Learn the embedded system design life cycle and co-designissues.
5. List the various embedded software development tools used in the design of embedded system for variousapplications.

UNITI

Introduction to Embedded Systems: Overview of Embedded System Architecture, Challenges & Trends of Embedded Systems, Hardware Architecture, Software Architecture. Application areas of Embedded Systems and Categories of Embedded Systems. Embedded System Design and Co-Design issues and Design Cycle Process

UNIT II

PIC 18: Family Overview, Architecture, Instruction Set, Addressing modes. Timers, interrupts of PIC 18, Capture/Compare and PWM modules of PIC 18

UNIT III

ARM Architecture: ARM Design Philosophy, Registers, Program Status Register, Instruction Pipeline, Interrupts and Vector Table, Architecture Revision, ARM Processor Families. Instruction Set: Data Processing Instructions, Addressing Modes, Branch, Load, Store Instructions, PSR Instructions, Conditional Instructions.

UNIT IV

ARM Thumb Instruction Set: Register Usage, Other Branch Instructions, Data Processing Instruction Single-Register and Multi Register Load-Store Instructions, Stack, Software Interrupt Instructions. Exception and interrupt handling.

ARM Memory Management: Cache Architecture, Polices, Flushing and Caches, MMU, Page Tables, Translation Access Permissions, Context Switch.

UNIT V

Embedded Software Development Tools, Host and Target Machines, Linkers/Locators for Embedded Software, Getting Embedded Software into the Target System. Debugging Techniques.

Case Studies: Design of Embedded Systems using Microcontrollers–for applications in the area of communications and automotives. (GSM/GPRS, CAN, Zigbee)

Suggested Readings:

1. Raj Kamal, Embedded Systems – Architecture, Programming and Design, 2nd Edition, TMH,2008.
2. Andrew N. Sloss, Dominic Symes, Chris Wright, ARM Systems Developer's Guides – Designing & Optimizing System Software, Elsevier,2008.
3. Mazidi, MCKinlay and Danny Causey, PIC Microcontrollers and Embedded Systems, Pearson Education,2007
4. David. E. Simon, An Embedded Software Primer, 1st Edition, Pearson Education,1999
5. Jonathan W. Valvano, Embedded Microcomputer Systems, Real Time Interfacing, Thomas Learning,1999.

Course Code	Course Title						Core/Elective
OE 9104 EE	**Waste to Energy**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To enable students to aware about the generation of energy from thewaste.

Course Outcomes

1. Students should able to learn the Classification of waste as afuel.
2. Students should able to learn the Manufacture ofcharcoal.
3. Students should able to carry out the designing of gasifiers and biomassstoves.
4. Student should able to learn the Biogas planttechnology.

UNIT-I

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors. Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields andapplications.

UNIT-II

Biomass Gasification: Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT-III

Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs, fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomasscombustors.

UNIT-IV

Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction

UNIT-V

Biochemical conversion: Anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production - Urban waste to energy conversion - Biomass energy programme inIndia.

Suggested Readings:

1. Non-Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd.,1990.
2. Biogas Technology - A Practical Hand Book, Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd.,1983.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd.,1991.
4. Biomass Conversion and Technology, C. Y. Were Ko-Brobbyand E. B. Hagan, John Wiley& Sons,1996.

Course Code	Course Title						Core/Elective
OE 9105 ME	**Industrial Safety**						**Open Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Causes for industrial accidents and preventive steps to be taken.
- Fundamental concepts of MaintenanceEngineering.
- About wear and corrosion along with preventive steps tobetaken
- The basic concepts and importance of faulttracing.
- The steps involved in carrying out periodic and preventive maintenance of various equipments used inindustry

Course Outcomes

After completing this course, the student will be equipped with:

1. concepts of engineering systemssafety
2. Identify the causes for industrial accidents and suggest preventivemeasures.
3. Identify the basic tools and requirements of different maintenanceprocedures.
4. Apply different techniques to reduce and prevent Wear and corrosion inIndustry.
5. Identify different types of faults present in various equipments like machine tools, IC Engines, boilersetc.
6. Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machinetoolset.

UNIT-I

Industrial safety: Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc., Safety colour codes. Fire prevention and fire fighting, equipment and methods.

UNIT-II

Fundamentals of maintenance engineering: Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT-III

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT-IV

Fault tracing: Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT-V

Periodic and preventive maintenance: Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept andimportance.

Suggested Readings:

1. Maintenance Engineering Handbook, Higgins &Morrow, Da InformationServices.
2. Maintenance Engineering, H. P. Garg, S. Chand andCompany.
3. Pump-hydraulic Compressors, Audels, McGraw HillPublication
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & HallLondon

Detailed Syllabus for Audit Courses-I

Course Code	Course Title						Core/Elective
AD 9001 HS	**English for Research Paper Writing**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- Understand that how to improve your writing skills and level ofreadability
- Understand the nuances of language and vocabulary in writing a ResearchPaper.
- Develop the content, structure and format of writing a researchpaper.
- Produce original research papers withoutplagiarism

Course Outcomes

After completing this course, the student will be able to:

1. Interpret the nuances of research paperwriting.
2. Differentiate the research paper format and citation ofsources.
3. To review the research papers and articles in a scientificmanner.
4. Avoid plagiarism and be able to develop their writing skills in presenting the researchwork.
5. Create a research paper and acquire the knowledge of how and where to publish their original researchpapers.

UNIT - I

Academic Writing: Meaning & Definition of a research paper– Purpose of a research paper – Scope – Benefits, Limitations – outcomes.

UNIT - II

Research Paper Format: Title – Abstract – Introduction – Discussion – Findings, Conclusion – Style of Indentation – Font size/Font types – Indexing – Citation of sources.

UNIT - III

Research Methodology: Methods (Qualitative – Quantitative) Review of Literature. Criticizing, Paraphrasing & Plagiarism.

UNIT - IV

Process of Writing a research paper: Choosing a topic - Thesis Statement – Outline – Organizing notes - Language of Research – Word order, Paragraphs – Writing first draft –Revising/Editing - The final draft and proof reading.

UNIT - V

Research Paper Publication: Reputed Journals – National/International – ISSN No, No. of volumes, Scopus Index/UGC Journals – Free publications - Paid Journal publications – Advantages/Benefits

Presentation Skills: Developing Persuasive Presentations, Structure of Presentation, Presentation Slides, Presentation Delivery, role of the audience, what to search and cite, how to establishcredibility.

Suggested Readings:

1. C. R Kothari, Gaurav, Garg, ―Research Methodology Methods and Techniques‖, 4/e, New Age InternationalPublishers.
2. Day R, ―How to Write and Publish a Scientific Paper**",** Cambridge University Press,2006
3. MLA Hand book for writers of ResearchPapers‖, 7/e, East West Press Pvt. Ltd, New Delhi
4. Lauri Rozakis, Schaum's, Quick Guide to Writing Great Research Papers‖, Tata McGraw Hills Pvt. Ltd, NewDelhi.

Course Code	Course Title						Core/Elective
AD 9002 CE	**Disaster Management**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- To impart knowledge in students about the nature, causes, consequences and mitigation measures of the various naturaldisasters
- To enable the students to understand risks, vulnerabilities and human errors associated with human induceddisasters
- To enable the students to understand and assimilate the impacts of any disaster on the affected area depending on its position/ location, environmental conditions, demographicetc.

Course Outcomes

1. Learn to demonstrate a critical understanding of key concepts in disaster riskreduction
2. and humanitarianresponse.
3. Critically evaluate disaster risk reduction and humanitarian response policy and Practice from multipleperspectives.
4. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflictsituations.
5. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in**.**

UNIT-I

Introduction: Disaster: Definition, Factors and Significance; Difference between Hazard and Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT-II

Repercussions of Disasters and Hazards: Economic Damage, Loss of Human and Animal Life, Destruction of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts and Famines, Landslides and Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks and Spills, Outbreaks of Disease and Epidemics, War andConflicts.

UNIT-III

Disasters Prone Areas in India: Study of Seismic Zones; Areas Prone to Floodsand Droughts, Landslides and Avalanches; Areas Prone to Cyclonic and Coastal Hazards with Special Reference to Tsunami; Post-Disaster Diseases andEpidemics

UNIT-IV

Disaster Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological and Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT-V

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival. Meaning, Concept and Strategies of Disaster Mitigation, Emerging Trends in Mitigation. Structural Mitigation and Non-Structural Mitigation, Programs of Disaster Mitigation inIndia.

Suggested Readings:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal BookCompany.
2. Sahni, Pardeep (Eds.),"Disaster Mitigation Experiences and Reflections", PHI, NewDelhi.
3. Goel S. L., "Disaster Administration and Management Text and Case Studies", Deep & Deep Publication Pvt. Ltd., NewDelhi.

Course Code	Course Title						Core/Elective
AD 9003 HS	**Sanskrit for Technical Knowledge**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- To get a working knowledge in illustrious Sanskrit, the scientific language in theworld
- To make the novice Learn the Sanskrit to develop the logic in mathematics, science & othersubjects
- To explore the huge knowledge from ancient Indianliterature

Course Outcomes

1. Develop passion towards Sanskritlanguage
2. Decipher the latent engineering principles from Sanskritliterature
3. Correlates the technological concepts with the ancient Sanskrithistory.
4. Develop knowledge for the technologicalprogress
5. Explore the avenue for research in engineering with aid ofSanskrit

UNIT-I

Introduction to Sanskrit Language: Sanskrit Alphabets-vowels-consonants- significance of Amarakosa-parts of Speech-Morphology-creation of new words-significance of synonyms-sandhi-samasa-sutras-active and passive Voice-Past/Present/Future Tense-Syntax-Simple Sentences (elementary treatment only)

UNIT-II

Role of Sanskrit in Basic Sciences: Brahmagupthas lemmas (second degree indeterminate equations), sum of squares of n-terms of AP- sulba, sutram or baudhayana theorem (origination of Pythagoras theorem)-value of pie-Madhava's sine and cosine theory (origination of Taylor's series).

The measurement system-time-mass-length-temp, Matter elasticity-optics-speed of light (origination of Michaelson and Morley theory).

UNIT-III

Role of Sanskrit in Engineering-I (Civil, Mechanical, Electrical and Electronics Engineering):

Building construction-soil testing-mortar-town planning-Machine definition-crucible-furnace-air blower-Generation of electricity in a cell-magnetism-Solar system-Sun: The source of energy, the earth-Pingala chandasutram (origination of digital logic system)

UNIT-IV

Role of Sanskrit in Engineering-II (Computer Science Engineering & Information Technology): Computer languages and the Sanskrit languages-computer command words and the vedic command words-analogy of pramana in memamsa with operators in computer language-sanskrit analogy of physical sequence and logical sequence, programming.

UNIT-V

Role of Sanskrit in Engineering-III (Bio-technology and Chemical Engineering): Classification of plants- plants, the living-plants have senses-classification of living creatures, Chemical laboratory location and layout- equipment-distillation vessel-kosthiyanthram

Suggested Readings:

1. M Krishnamachariar, History of Classical Sanskrit Literature, TTD Press,1937.
2. M.R. Kale, A Higher Sanskrit Grammar: For the Use of School and College Students, MotilalBanarsidass Publishers,2015.
3. Kapail Kapoor, Language, Linguistics and Literature: The Indian Perspective, ISBN- 10: 8171880649,1994.
4. Pride of India, Samskrita Bharati Publisher, ISBN: 81-87276 27-4,2007.
5. Shri RamaVerma, Vedas the source of ultimate science, Nag publishers,2005.

Course Code	Course Title						Core/Elective
AD 9004 HS	**Value Education**						**Audit I**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- Understand the need and importance of Values for self-development and forNationaldevelopment.
- Imbibe good human values andMorals
- Cultivate individual and Nationalcharacter.

Course Outcomes

After completion of the course, students will be able to:

1. Gain necessary Knowledge forself-development
2. Learn the importance of Human values and their application in day to day professionallife.
3. Appreciate the need and importance of interpersonal skills for successful career and sociallife
4. Emphasize the role of personal and social responsibility of an individual for all-roundgrowth.
5. Develop a perspective based on spiritual outlook and respect women, other religious practices, equality, non-violence and universalbrotherhood.

UNIT-I

Human Values, Ethics and Morals: Concept of Values, Indian concept of humanism, human values; Values for self-development, Social values, individual attitudes; Work ethics, moral and non- moral behaviour, standards and principles based on religion, culture andtradition.

UNIT-II

Value Cultivation, and Self-management: Need and Importance of cultivation of values such as Sense-of Duty, Devotion to work, Self-reliance, Confidence, Concentration, Integrity & discipline, and Truthfulness.

UNIT-III

Spiritual outlook and social values: Personality and Behavior, Scientific attitude and Spiritual (soul) outlook; Cultivation of Social Values Such as Positive Thinking, Punctuality, Love & Kindness, avoiding fault finding in others, Reduction of anger, forgiveness, Dignity of labour, True friendship, Universal brotherhood and religious tolerance.

UNIT-IV

Values in Holy Books: Self-management and Good health; internal & external cleanliness, Holy books versus Blind faith, Character and Competence, Equality, Nonviolence, Humility, Role of Women.

UNIT-V

Dharma, Karma and Guna: Concept of soul; Science of Reincarnation, Character and Conduct, Concept of Dharma; Cause and Effect based Karma Theory; The qualities of Devine and Devilish; Satwic, Rajasic and Tamasic gunas.

Suggested Readings:

1. Chakroborty,S.K., Values & Ethics for Organizations Theory and Practical‖, Oxford University Press, New Delhi,1998.
2. Jaya DayalGoyandaka, Srimad Bhagavad Gita with Sanskrit Text, Word Meaning and Prose Meaning‖, Gita Press,Gorakhpur,2017.

Detailed Syllabus for Audit Courses-II

Course Code	Course Title						Core/Elective
AD 9011 HS	**Constitution of India and Fundamental Rights**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective and to address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indiannationalism.

Course Outcomes

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indianpolitics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution inIndia.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the IndianConstitution.
4. Discuss the passage of the Hindu Code Bill of1956.

UNIT-I

History of Making of the Indian Constitution: History, Drafting Committee, (Composition & Working) Philosophy of the Indian Constitution: Preamble, Salient Features.

UNIT-II

Contours of Constitutional Rights & Duties: Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT-III

Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications. Powers and Functions.

UNIT-IV

Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative CEO of Municipal Corporation, Panchayat raj: Introduction, PRI: Zilla Panchayat, Elected officials and their roles, CEO Zilla Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT-V

Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

Suggested Readings:

1. The Constitution of India, 1950 (Bare Act), GovernmentPublication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition,2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis,2015.

Course Code	Course Title						Core/Elective
AD 9012 HS	**Pedagogy Studies**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- To present the basic concepts of design and policies of pedagogystudies.
- To provide understanding of the abilities and dispositions with regard to teaching techniques, curriculum design and assessmentpractices.
- To familiarize various theories of learning and their connection to teachingpractice.
- To create awareness about the practices followed by DFID, other agencies and otherresearchers.
- To provide understanding of critical evidence gaps that guides the professionaldevelopment

Course Outcomes

1. Illustrate the pedagogical practices followed by teachers in developing countries both in formal and informalclassrooms.
2. Examine the effectiveness of pedagogicalpractices.
3. Understand the concept, characteristics and types of educational research and perspectives of research.
4. Describe the role of classroom practices, curriculum and barriers tolearning.
5. Understand Research gaps and learn the futuredirections.

UNIT-I

Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions, Overview of methodology and Searching.

UNIT-II

Thematic Overview: Pedagogical practices followed by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education

UNIT-III

Evidence on the Effectiveness of Pedagogical Practices: Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and Practicum) and the school curriculum and guidance material best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches – Teachers attitudes and beliefs and pedagogic strategies.

UNIT-IV

Professional Development: alignment with classroom practices and follow up support - Support from the head teacher and the community – Curriculum and assessment - Barriers to learning: Limited resources and large class sizes.

UNIT-V

Research Gaps and Future Directions: Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment – Dissemination and research impact.

Suggested Readings:

1. Ackers J, Hardman F, Classroom Interaction in Kenyan Primary Schools, Compare‖, 31 (2): 245 – 261,2001.
2. Agarwal M, Curricular Reform in Schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361 – 379,2004.
3. Akyeampong K, Teacher Training in Ghana – does it count? Multisite teacher education research project (MUSTER), Country Report 1. London: DFID,2003.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J, Improving teaching and learning of Basic Maths and Reading in Africa: Does teacher Preparation count? International Journal Educational Development, 33 (3): 272- 282,2013.
5. Alexander R J, Culture and Pedagogy: International Comparisons in Primary Education, Oxford and Boston: Blackwell,2001.
6. Chavan M, Read India: A mass scale, rapid, learning to read campaign,2003.

Course Code	Course Title						Core/Elective
AD 9013 HS	**Stress Management by Yoga**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

The Course will introduce the students to

- Creating awareness about different types of stress and the role of yoga in the management ofstress.
- Promotion of positive health and overall wellbeing (Physical, mental, emotional, social and spiritual).
- Prevention of stress related health problems by yogapractice.

Course Outcomes

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

1. Understand yoga and itsbenefits.
2. Enhance Physical strength andflexibility.
3. Learn to relax andfocus.
4. Relieve physical and mental tensionthroughasanas.
5. Improve work performanceandefficiency.

UNIT -I

Meaning and Definition of Yoga - Historical perspective of Yoga - Principles of AstangaYoga by Patanjali.

UNIT - II

Meaning and Definition of Stress - Types of stress - Eustress and Distress. Anticipatory Anxiety and Intense Anxiety and depression. Meaning of Management- Stress Management.

UNIT - III

Concept of Stress According to Yoga - Stress assessment methods - Role of Asana, Pranayama and Meditation in the management of stress

UNIT - IV

Asanas- (5 Asanas in each posture) - Warm up - Standing Asanas - Sitting Asanas - Prone Asanas - Supine asanas - Surya Namaskar.

UNIT - V

Pranayama- Anulom and Vilom Pranayama - Nadishudhi Pranayama - Kapalabhati Pranayama - Bhramari Pranayama - Nadanusandhana Pranayama.

Meditation Techniques: Om Meditation - Cyclic meditation: Instant Relaxation technique (QRT), Quick Relaxation Technique (QRT), Deep Relaxation Technique (DRT)

Suggested Readings:

1. "Yogic Asanas for Group Training - Part-I", Janardhan Swami Yogabhyasi Mandal,Nagpur.
2. Swami Vivekananda, "Rajayogaor Conquering the Internal Nature", Advaita Ashrama (Publication Department),Kolkata.
3. Nagendra H.R and Nagaratna R, "Yoga Perspective in Stress Management", Swami Vivekananda Yoga Prakashan,Bangalore.

Course Code	Course Title						Core/Elective
AD 9014 HS	**Personality Development Through Life Enlightenment Skills**						**Audit II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**2**	**-**	**-**	**-**	**30**	**70**	**-**

Course Objectives

- To learn to achieve the highest goalhappily
- To become a person with stable mind, pleasing personality anddetermination
- To awaken wisdom instudents

Course Outcomes

1. Develop their personality and achieve their highest goal oflife.
2. Lead the nation and mankind to peace andprosperity.
3. Practice emotionalself-regulation.
4. Develop a positive approach to work andduties.
5. Develop a versatilepersonality.

UNIT - I

Neetisatakam – Holistic Development of Personality - Verses 19, 20, 21, 22 (Wisdom) - Verses 29, 31, 32 (Pride and Heroism) - Verses 26,28,63,65 (Virtue)

UNIT - II

Neetisatakam – Holistic Development of Personality (cont'd) - Verses 52, 53, 59 (don'ts) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.

UNIT - III

Introduction to Bhagavadgeetha for Personality Development - Shrimad Bhagavadgeetha: Chapter 2 – Verses 41, 47, 48 - Chapter 3 – Verses 13,21,27,35 - Chapter 6 – Verses 5,13,17,23,35 - Chapter 18 –Verses 45, 46, 48 Chapter – 6: Verses 5, 13, 17, 23, 35; Chapter – 18: Verses 45, 46, 48

UNIT - IV

Statements of Basic Knowledge - Shrimad Bhagavadgeetha: Chapter 2- Verses 56, 62,68 - Chapter 12 – Verses 13, 14, 15, 16, 17, 18 - Personality of Role model from Shrimad Bhagawat Geeta.

UNIT - V

Role of Bhagavadgeetha in the Present Scenario - Chapter 2 – Verses 17 - Chapter 3 – Verses 36, 37, 42 - Chapter 4 – Verses 18, 38, 39 - Chapter 18 – Verses 37, 38, 63.

Suggested Readings:

1. Srimad Bhagavad Gita, Swami SwarupanandaAdvaita Ashram (Publication Department),Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya), P.Gopinath, Rashtriya SanskritSansthanam, NewDelhi

Online Resources: NTPEL: http://nptel.ac.in/downloads/109104115/

Detailed Syllabus for Laboratory Courses

Course Code	Course Title						Core/Elective
PC 1451 TE	**Traffic Design and Studio Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**50**	**-**	**1**

Course Objectives

- Conduct traffic surveys, analyse and prepare summary/design reports related to intersection/road stretchimprovements
- Investigate parking demand and to conduct accidentanalysis
- Understand the design procedure of traffic signals

Course Outcomes

1. Find out peak hour traffic & peak time for a given location on the road.
2. Calculate design speed, maximum speed & minimum speed limits of a location through spot speed.
3. Draw parking accumulation curve and design traffic signal

List of Experiments:

1. Driver testingExperiments
2. Classified volume countsurvey
3. Moving carmethod
4. Highway capacityEstimation
5. Origin and DestinationStudies
6. Speed and DelayStudies
7. PedestrianSurvey
8. Travel BehaviorStudies
9. Headway and Gap-acceptancestudies
10. ParkingStudies
11. AccidentStudies
12. Intersectiondesigns
13. SignalDesign
14. Environmental impact – Noise studies and vehicular emissionmeasurement

Note: All the Data Collection procedures as per HCM 2010

Course Code	Course Title						Core/Elective
PC 1452 TE	**Highway Materials and Pavement Engineering Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**50**	**-**	**1**

Course Objectives

- Bitumen and & its engineering behavior.
- Aggregate & its engineering behavior.
- Concept of traffic behavior

Course Outcomes

1. Identify engineering properties of aggregate.
2. Identify the grade & properties of bitumen.
3. Characterize the pavementmaterials.
4. Perform quality control tests on pavement material and pavements.

List of Experiments:

1. AggregateTests
2. Bitumen and Tar Tests as per IS codeprovisions
3. Benkelman Beam DeflectionStudies
4. Stone Polishing Valuetest
5. International Roughness Indextest
6. Mix design for Bituminousmixes
7. California Bearing RatioTest
8. Soil Classification & Grain sizeanalysis
9. Skid ResistanceStudies
10. Road RoughnessMeasurement
11. Rolling DynamicDeflectometer
12. Falling WeightDeflectometer
13. Pavement ConditionStudies
14. Roadinventory

Note: All tests as per IS, ASTM, AASHTO, TRL, IRC procedures/specifications and guidelines.

Course Code	Course Title						Core/Elective
PC 1453 TE	**Computational Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**50**	**-**	**1**

Course Objectives

- Learn the highway geometric elements
- Identify the transportation planning models
- Understand the various software packages related to transportation engineering

Course Outcomes

1. Design geometric elements for highway alignment.
2. Analyse and generate models for transportationplanning.
3. Identify the adequacy of the pavement performance- functional andstructural.

List of Experiments:

Part-A: Demonstration and Assignment

Module-1: Highway Geometry

1. Design of horizontalalignment
2. Verticalalignment
3. Generating cross section and design ofintersections.

Module-2: Transportation Planning:

(Data will be provided to compute the following)

4. Trip generationmodelling
5. Mode choice/modal splitproblems
6. Trip assignmentproblems

Part-B: Introduction to Use of Software Related to TransportationEngineering

Module-3: Pavement Evaluation & Economic AnalysisPackages:

7. Ken layer &Kenslab
8. Economic AnalysisPackage
9. Highway Development and Maintenance Management System (HDM) –4

Moducle-4: Traffic Engineering Packages:

10. SignalDesign
11. TRANSIT
12. SYNCRO
13. ACCIDENT ANALYSISPACKAGE
14. TIME SERIESPACKAGE

Course Code	Course Title						Core/Elective
PC 1454 TE	**Seminar**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**50**	**-**	**1**

Course Objectives

- Develop the habit of referring the journals for literaturereview.
- Understand the gist of the researchpaper.
- Identify the potential for furtherscope.

Course Outcomes

1. Write the documentation in standardformat.
2. Prepare PPT presentation
3. Present the work in an efficientmanner.

Guidelines:

- Each student shall present a seminar, generally comprising about three to four weeks of prior literature review and finally a presentation of their work forassessment.
- The seminar report shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions andreference.
- At least two faculty members will be associated with the seminar presentation to evaluate and award marks.

Course Code	Course Title						Core/Elective
PC 1455 TE	**Mini Project with Seminar**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**4**	**50**	**-**	**2**

Course Outcomes

1. Formulate a specific problem and givesolution
2. Develop model/models either theoretical/practical/numericalform
3. Solve, interpret/correlate the results anddiscussions
4. Conclude the resultsobtained
5. Write the documentation in standardformat

Guidelines:

- As part of the curriculum in the II- semester of the programme each student shall do a mini project, generally comprising about three to four weeks of prior reading, twelve weeks of active research, and finally a presentation of their work forassessment.
- Each student will be allotted to a faculty supervisor formentoring.
- Mini projects should present students with an accessible challenge on which to demonstrate competence in research techniques, plus the opportunity to contribute something moreoriginal.
- Mini projects shall have inter-disciplinary/ industryrelevance.
- The students can select a mathematical modeling based/Experimental investigations or Numerical modeling
- All the investigations should be clearly stated and documented with thereasons/explanations.
- The mini-project shall contain a clear statement of the research objectives, background of work, literature review, techniques used, prospective deliverables, and detailed discussion on results, conclusions andreference

Departmental committee: Supervisor and a minimum of two faculty members

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 50		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	20	Progress and Review
	05	Report
Departmental Committee	05	Relevance of the Topic
	05	PPT Preparation
	05	Presentation
	05	Question and Answers
	05	Report Preparation

Course Code	Course Title						Core/Elective
PC 1456 TE	**Major Project Phase – I**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**20**	**100**	**-**	**10**

Course Objectives

1. Learn to survey the literature such as books, journals and contact resource persons for the selected topic of research.
2. Learn to write technicalreports.
3. Learn to prepare PPT presentation

Course Outcomes

At the end of this course, students will be able to

1. Exposed to self-learning varioustopics.
2. Develop oral and written communication skills topresent.
3. Defend their work in front of technically qualifiedaudience

Guidelines:

- The Project work will preferably be a problem with research potential and should involve scientific research, design, generation/collection and analysis of data, determining solution and must preferably bring out the individualcontribution.
- Seminar should be based on the area in which the candidate has undertaken the dissertationwork.
- The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literaturereview.
- The preliminary results (if available) of the problem may also be discussed in thereport.
- The work has to be presented in front of the committee consists of Chairperson-BoS, O.U and Head, Supervisor & Project coordinator from the respective Department of theInstitute.
- The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide andstudent.

Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	30	Project Status / Review(s)
	20	Report
Departmental Committee (Chairperson BoS, O.U. and Head, Supervisor & Project coordinator from therespective department of theinstitution)	10	Relevance of the Topic
	10	PPT Preparation
	10	Presentation
	10	Question and Answers
	10	Report Preparation

Note: The Supervisor has to assess the progress of the studentregularly.

Course Code	Course Title						Core/Elective
PC 1457 TE	**Major Project Phase – II (Dissertation)**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**32**	**-**	**200**	**16**

Course Objectives

- Understand the emerging research areas
- Enhance their programming ability
- Acquire knowledge to develop any application or research projects
- Able to present and convince their topic of study to the engineering community thorough a technical report writing.

Course Outcomes

At the end of this course, students will be able to

1. Use different experimental techniques and will be able to use different software/ computational /analytical tools.
2. Design and develop an experimental set up/ equipment/test rig.
3. Conduct tests on existing set ups/equipment and draw logical conclusions from the results after analyzing them
4. Apply on a case study either in a research environment or in an industrial environment.

Guidelines:

- It is a continuation of Major Project Phase – I started in semester-III.
- The student has to submit the report in prescribed format and also presentseminar.
- The dissertation should be presented in standard format as provided by thedepartment.
- The candidate has to prepare a detailed project report consisting of introduction of the problem, problem statement, literature review, objectives of the work, methodology (experimental set up or numerical details as the case may be) of solution and results anddiscussion.
- The report must bring out the conclusions of the work and future scope for the study. The work has to be presented in front of the examiners panel consisting of an approved external examiner and Chairperson BoS, &Head, O.U.and Supervisor from theInstitute.
- The candidate has to be in regular contact with his/her Supervisor / Co-Supervisor

Guidelines for awarding marks in SEE (Semester End Examination): Max. Marks: 200		
Evaluation by	**Max. Marks**	**Evaluation Criteria / Parameter**
Supervisor	10	Regularity and Punctuality
	10	Work Progress
	30	Quality of the work which may lead to publications
	10	Analytical / Programming / Experimental Skills Preparation
	10	Report preparation in a standard format
External Examiner and Chairperson, BoS&Head, O.U. and together	20	Power Point Presentation
	60	Quality of thesis and evaluation
	30	Innovations, application to society and Scope for future study
	20	Viva-Voce