FACULTY OF ENGINEERING

Scheme of Instruction & Examination

and

Syllabi

M.E. I to IV Semester

of

Two Year Post Graduate Degree Programme

In

Civil Engineering

Specialization in Transportation Engineering

(With effect from the academic year 2020– 2021)

(As approved in the faculty meeting held on …………. 2020)

Issued by

Dean, Faculty of Engineering

Osmania University, Hyderabad

2020

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

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	**PC 1401 TE**	Traffic Engineering	3	-	-	3	30	70	3	3
2	**PC 1402 TE**	Pavement Materials & Characterization	3	1	-	3	30	70	3	4
3		Professional Elective I	3	-	-	3	30	70	3	3
4		Professional Elective II	3	-	-	3	30	70	3	3
5		MC/Open Elective-I	3	-	-	3	30	70	3	3
6		Audit Course I	2	-	-	2	30	70	3	0
Practical/ Laboratory Courses										
7	**PC 1451 TE**	Traffic Design and Studio Lab	-	-	2	2	25	50	3	1
8	**PC 1452 TE**	Highway Materials & Pavement Engineering Lab	-	-	2	2	25	50	3	1
		Total	**16**	**2**	**4**	**20**	**300**	**450**		**18**

PC: Professional Core   PE: Professional Elective   OE: Open Elective
AD: Audit Courses   MC: Mandatory Courses

L: Lectures   T: Tutorials   P/D: Practical/Drawing

CIE: Continuous Internal Evaluation   **SEE:** Semester End Examination (Univ. Exam)

Note:
1. Each contact hour is a Clock Hour
2. The duration of the practical class is two clock hours, however it can be extended wherever necessary, to enable the student to complete the experiment

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

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1	**PC 1403 TE**	Urban Transportation Systems Planning	3	1	-	3	30	70	3	4
2	**PC 1404 TE**	Pavement Systems Engineering	3	1	-	4	30	70	3	4
3		Professional Elective III	3	-	-	3	30	70	3	3
4		MLC/Open Elective-II	3	-	-	3	30	70	3	3
5		Audit Course II	2	-	-	2	30	70	3	0
6	**PC 1461 TE**	Mini Project	-	-	4	2	100	-	3	2
Practical/ Laboratory Courses										
7	**PC 1453 TE**	Computational Lab	-	-	2	2	25	50	3	1
8	**PC 1454 TE**	Road Safety and Audit Lab	-	-	2	2	25	50	3	1
		Total	**14**	**2**	**8**	**21**	**300**	**450**		**18**

PC: Professional Core | PE: Professional Elective | OE: Open Elective
AD: Audit Courses | MC: Mandatory Courses

L: Lectures | T: Tutorials | P/D: Practical/Drawing

CIE: Continuous Internal Evaluation | **SEE:** Semester End Examination (Univ. Exam)

Note:
1. Each contact hour is a Clock Hour
2. The duration of the practical class is two clock hours, however it can be extended wherever necessary, to enable the student to complete the experiment

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

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Theory Courses										
1		Professional Elective IV	3	-	-	3	30	70	3	3
2		Professional Elective V	3	-	-	3	30	70	3	3
Practical/ Laboratory Courses										
3	**PC 1471 TE**	Dissertation Phase I	-	-	20	--	100	-	3	10
		Total	**9**	**-**	**20**	**20**	**190**	**140**		**16**

PC: Professional Core | PE: Professional Elective | OE: Open Elective

L: Lectures | T: Tutorials | P/D: Practical/Drawing

CIE: Continuous Internal Evaluation | **SEE:** Semester End Examination (Univ. Exam)

Note:
1. Comprehensive seminar presentation is required at the end of the semester.
2. Dissertation synopsis is required to be approved within four weeks of registration

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

S. No.	Course Code	Course Title	Scheme of Instruction				Scheme of Examination			Credits
			L	T	P/D	Contact Hrs/Wk	CIE	SEE	Duration in Hrs	
Practical/ Laboratory Courses										
1	**PC 1472 TE**	Dissertation Phase II	-	-	32	--	100	200	3	16
		Total	**-**	**-**	**32**	**-**	**100**	**200**		**16**

PC: Professional Core

L: Lectures T: Tutorials P/D: Practical/Drawing

CIE: Continuous Internal Evaluation **SEE:** Semester End Examination (Univ. Exam)

Note:

1. Minimum of two seminar presentation before final viva is required and a comprehensive viva at the end of the semester.

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

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 2019– 2020)
(As approved in the faculty meeting held on25-06-2019)

Issued by

Dean, Faculty of Engineering

Osmania University, Hyderabad – 500 007

2019

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
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Note:
1. Each contact hour is a Clock Hour.
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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. N o.	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
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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 subjects of Professional Core

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

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3	PC 1453 TE	Computational Lab

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>PC 1401 TE</td><td colspan="6">Pavement Materials and Characterization</td><td>Core</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>3</td><td>1</td><td>-</td><td>-</td><td>30</td><td>70</td><td>4</td></tr>
</table>

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

- To 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. Understand the concepts and applications of the elements involved in Highway InfrastructureDesign
2. Design intersections, 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.

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:

- To 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.
- To describe basic techniques for collecting and analysing traffic data, diagnosingproblems.

Course Outcomes

1. Use statistical concepts and applications in trafficengineering.
2. Identify traffic stream characteristics and Identify level ofservices
3. 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

- Learn the objectives, benefits and the telecommunications inITS.
- Learn about the functional areas, user needs and services inITS.
- Learn the concepts of ITS operations andapplications.

Course Outcomes

1. Able to appreciate the advantages of ITS and suggest the appropriate technologies for field conditions.
2. Able to suggest the appropriate system/s in various functional areas oftransportation.
3. Able to amalgamate the various systems, plan and implement the applications ofITS

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 Sadek A, “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

- Learn the rudiments of finite element analysis
- Study the fundamentals of domain discretization, interpolation, application of boundary conditions, assembly of global matrices, and solution of the resulting algebraicsystems.
- Explain the core concepts of variational and weighted residual methods inFEM
- Derive the element stiffness matrix for 1-D, 2-D and 3-Dproblems.
- Formulate the simple structural problems in to finiteelements

Course Outcomes

1. Build and analyse the FEA models for various engineeringproblems.
2. Identify the information requirements and sources for analysis, design andevaluation
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.

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>PE 1419 TE</td><td colspan="6">Analysis of Transportation Systems</td><td>Elective</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>3</td><td>-</td><td>-</td><td>-</td><td>30</td><td>70</td><td>3</td></tr>
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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

- Description about various spatial and non-spatial data types and data base managementmethods
- Development of the concepts and professional skills in utility of GIStechniques
- Enhancement of knowledge of GIS to transportation fieldproblems

Course Outcomes

1. GIS related data acquiring and processing that is associated with geographiclocations
2. Application of GIS techniques in the decision support systems useful for decision makers and community services in Transportationfield
3. Utility of GIS techniques in the fields of natural resource management, environment, transportation planning and development, etc.

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, Kulwer AcademicPublisher.
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

Course Outcomes

1. Application of basic principles in pavement design for ruralroads
2. Assimilation of mechanistic principles for the pavementdesign
3. 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 and economic evaluation highway infrastructureprojects
- To understand the principles and methods of economic analysis

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

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

- Introduction to various models ofsimulation
- Describe data processing techniques ofsimulation
- Explain exact sampling distributions andtesting

Course Outcomes

1. Understand various models ofsimulation
2. Build models for transportationsimulation
3. Evaluate and validate themodels

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

- To understand basic terminology and standards relate AirportEngineering
- To know the various components of airport and runwaycomponents
- To understand the various methods of air travel demandanalysis

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 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 basic working principles of various equipment used for pavementevaluation
- Describe design aspects of overlay thickness ofpavements
- Impart knowledge regarding the different types of distresses and LCCA ofpavements

Course Outcomes

1. Awareness about various NDT equipment used for pavementevaluation
2. Applications of pavement managementprinciples
3. Knowledge regarding the different levels 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

- To understand basic terminology related to RailwayEngineering
- To know the various components oftrack
- To understand the various methods of signalling interlocking methods

Course Outcomes

1. Develop and design of railway tracks with geometricstandards
2. Investigate and explore the failures of railway embankments and suggest remedialmeasures
3. Design points and crossings with modern signallingsystem

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.and Agarwal.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, explain the principles of design methods and list the steps involved in the design of various transportation structures.
- Identify the input parameters required for design of transportation structures and design and evaluate a transportation structures based on the datagiven.

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. Summarize the design methodology and arrive at design values for various transportation structures.

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. Heins and Richard A. Lawrie, `Design of Modern Concrete Highway Bridges, John Wiley and Sons,1999.
4. Baider Bakhtand 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

- To introduce fundamental knowledge of samplingtechnique
- To describe basic statistical techniques such as statistical distributions and correlationmethods
- To impart knowledge on 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. Applications of sampling 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.

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>PE 1430 TE</td><td colspan="6">Ground Improvement Techniques</td><td>Elective</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>3</td><td>-</td><td>-</td><td>-</td><td>30</td><td>70</td><td>3</td></tr>
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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

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 & Panaghiotis C.Kotzios - Soil Improvement by Preloading - John Wiley &Sons Inc. Canada.
5. R. Pumshothama Rao - Ground Improvement Techniques – Laxmi Publications (P) Limited.

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
4. Analyse problem by statistical techniques: ANOVA, F-test,Chi-square
5. 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 of writing 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. Ajit Parulekar and Sarita D'Souza, Indian Patents Law – Legal & Business Implications, Macmillan India Ltd,2006

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-Brobby and 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

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 Floods and 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 Dayal Goyandaka, Srimad Bhagavad Gita with Sanskrit Text, Word Meaning and Prose Meaning‖, Gita Press,Gorakhpur,2017.

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 Astanga Yoga 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, "Rajayoga or 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 Swarupananda Advaita 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/

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>PC 1451 TE</td><td colspan="6">Traffic Design and Studio Lab</td><td>Core</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
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Course Outcomes

1. To conduct traffic surveys, analyse and prepare summary/design reports related to intersection/road stretchimprovements
2. To designsignals
3. To investigate parking demand and to conduct accidentanalysis

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 Outcomes
1. Characterize the pavementmaterials.
2. 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 Outcomes

- Design the geometry ofhighways.
- Analyse and generate models for transportationplanning.
- 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

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>PC 1454 TE</td><td colspan="6">Seminar</td><td>Core</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
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Course Outcomes

1. Develop the habit of referring the journals for literaturereview.
2. Understand the gist of the researchpaper.
3. Identify the potential for furtherscope.
4. Present the work in an efficientmanner.
5. Write the documentation in standardformat.

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

FACULTY OF ENGINEERING

Scheme of Instruction & Examination

(AICTE Model Curriculum for the Academic Year 2020-2021)

and

Syllabus

M.E. III to IV Semester

of

Two Year Post Graduate Degree Programme

in

Civil Engineering
Specialization in Transportation Engineering

(With effect from the academic year 2020– 2021)

(As approved in the faculty meeting held on …………)

Issued by

Dean, Faculty of Engineering

Osmania University, Hyderabad – 500 007

2020

SCHEME OF INSTRUCTION & EXAMINATION
M.E. (Civil Engineering) – III 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	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 Transportation Engineering

S. N o.	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 subjects of Professional Electives 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 subjects of Professional Core

S. No.	Course Code	Course Title
1	PC 1456 TE	Major Project Phase – I
2	PC 1457 TE	Major Project Phase – II (Dissertation)

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:

- To introduce fundamental knowledge of traffic engineering so that students can understand and be able to deal with traffic issues including safety, planning, design, operation and control.
- To describe basic techniques for collecting and analysing traffic data, diagnosing problems.

Course Outcomes

1. Use statistical concepts and applications in traffic engineering.
2. Identify traffic stream characteristics and Identify level of services
3. Design a pre-timed signalized intersection, and determine the signal splits.

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 to improvements.

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 impact assessment.

Suggested Readings:

1. McShane, W.R., Roess, R.P. and Prassas, E.S., Traffic Engineering. Prentice Hall, Englewood Cliffs, 1997.
2. Highway Capacity Manual, Transportation Research Board, National Research Council, 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.

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>PE 1417TE</td><td colspan="6">Intelligent Transportation Systems</td><td>Elective</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
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Course Objectives

- Learn the objectives, benefits and the telecommunications in ITS.
- Learn about the functional areas, user needs and services in ITS.
- Learn the concepts of ITS operations and applications.

Course Outcomes

1. Able to appreciate the advantages of ITS and suggest the appropriate technologies for field conditions.
2. Able to suggest the appropriate system/s in various functional areas of transportation.
3. Able to amalgamate the various systems, plan and implement the applications of ITS

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 Guidance concepts.

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 Sadek A, "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 Hall Dept.

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>PE 1418 SE</td><td colspan="6">Finite Element Methods</td><td>Elective</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
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Course Objectives

- Learn the rudiments of finite element analysis
- Study the fundamentals of domain discretization, interpolation, application of boundary conditions, assembly of global matrices, and solution of the resulting algebraic systems.
- Explain the core concepts of variational and weighted residual methods in FEM
- Derive the element stiffness matrix for 1-D, 2-D and 3-D problems.
- Formulate the simple structural problems in to finite elements

Course Outcomes

1. Build and analyse the FEA models for various engineering problems.
2. Identify the information requirements and sources for analysis, design and evaluation
3. Use the standard finite element software to solve the structural engineering problems.
4. Interpret the results obtained from FEA software, not only in terms of conclusions but also awareness of limitations.

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.

<table>
<tr><td>Course Code</td><td colspan="4">Course Title</td><td colspan="2"></td><td>Core/Elective</td></tr>
<tr><td>PE 1419 TE</td><td colspan="6">Analysis of Transportation Systems</td><td>Elective</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
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<tr><td>-</td><td>3</td><td>-</td><td>-</td><td>-</td><td>30</td><td>70</td><td>3</td></tr>
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Course Objectives

- To discuss various components of urban transportation systems and its innovation
- To understand the concepts of linear programming formulation and various methods
- To review different transportation and assignment formulations and problems
- To examine various nonlinear programming and decision theories

Course Outcomes

1. To describe and evaluate various transportation systems impacts on society and economy
2. To identify the different solutions for linear programming problems including sensitivity analysis.
3. To demonstrate effective way of understanding transportation and assignment problems
4. To explain various issues related to uncertainty and decision theories

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 Human factors.

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 graphical solutions.

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 Edition 2000.
3. Render, B, Stair, R. M, Quantitative Analysis for Management, Prentice Hall of India Private Limited, Seventh Edition, 2000.

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>PE 1420 TE</td><td colspan="6">GIS and GPS Applications to Transportation Engineering</td><td>Elective</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
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Course Objectives

- Description about various spatial and non-spatial data types and data base management methods
- Development of the concepts and professional skills in utility of GIS techniques
- Enhancement of knowledge of GIS to transportation field problems

Course Outcomes

1. GIS related data acquiring and processing that is associated with geographic locations
2. Application of GIS techniques in the decision support systems useful for decision makers and community services in Transportation field
3. Utility of GIS techniques in the fields of natural resource management, environment, transportation planning and development, etc.

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 accident investigation.

Suggested Readings:

1. GIS for Urban & Regional Planning, Scholten &Stillwen1990, Kulwer Academic Publisher.
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 and planning
- Introduction to inputs required for pavement design
- Concepts of mechanistic empirical methods of flexible and rigid pavements

Course Outcomes

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

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 subsurface systems.

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 code books
4. NRRDA -Guidelines and code books

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 and economic evaluation highway infrastructure projects
- To understand the principles and methods of economic analysis

Course Outcomes

1. Formulate and prepare Detailed Project Report for a highway project
2. Apply the methods of economic analysis for highway projects
3. Prepare Environmental Impact Assessment Report

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 in India.

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 Hill Publishers.
2. Economic Analysis for Highways - Winfrey. R; International Text Book Company.
3. Traffic Engineering and Transport Planning - L. R. Kadiyali, Khanna Publishers.
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, New Delhi.

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
- Introduction to various models of simulation
- Describe data processing techniques of simulation
- Explain exact sampling distributions and testing

Course Outcomes
1. Understand various models of simulation
2. Build models for transportation simulation
3. Evaluate and validate the 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 transportation engineering.

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. -Model Validation.

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 York 1983.
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

- To understand basic terminology and standards relate Airport Engineering
- To know the various components of airport and runway components
- To understand the various methods of air travel demand analysis

Course Outcomes

1. Conduct surveys, develop and design new airports with ICAO/FAA geometric standards
2. Investigate and explore the failures of runway pavements and suggest remedial design measures
3. Develop plans for installation of various types of devices pertaining to Air Traffic Controls

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 Turning Zones.

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, Turn Around.

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, New York.
4. Relevant IRC codes.
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 Book Co.
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 basic working principles of various equipment used for pavement evaluation
- Describe design aspects of overlay thickness of pavements
- Impart knowledge regarding the different types of distresses and LCCA of pavements

Course Outcomes

1. Awareness about various NDT equipment used for pavement evaluation
2. Applications of pavement management principles
3. Knowledge regarding the different levels maintenance treatment options

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, Rutting etc.

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 Hill publications.
2. Sargious, M.A. - Pavements and surfacing for highways and airports -Applied Science Publishers Ltd.
3. Bridge and Pavement maintenance - Transportation Research RecordNo.800, TRB.
4. Shahin M.Y. 1994 - Pavement Management for airports, roads and parking lots.
5. Bent Thagesan, 1996- Highway and Traffic engineering for developing countries.
6. Principles of Pavement Design, Yoder J. &Witzac Mathew W., John Wiley& Sons.
7. Pavement Analysis & Design, Yang H. Huang, Prentice Hall Inc.

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

- To understand basic terminology related to Railway Engineering
- To know the various components of track
- To understand the various methods of signalling interlocking methods

Course Outcomes

1. Develop and design of railway tracks with geometric standards
2. Investigate and explore the failures of railway embankments and suggest remedial measures
3. Design points and crossings with modern signalling system

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.and Agarwal.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, explain the principles of design methods and list the steps involved in the design of various transportation structures.
- Identify the input parameters required for design of transportation structures and design and evaluate a transportation structures based on the data given.

Course Outcomes

1. Decide the selection of transportation structures, list the factors affecting design of various transportation structures and generate the input parameters required for design.
2. Summarize the design methodology and arrive at design values for various transportation structures.

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 McGraw Hill,1999.
2. Krishna Raju ‘Bridge Engineering‘, UPD Publishers, New Delhi, 2000.
3. Conrad P. Heins and Richard A. Lawrie, `Design of Modern Concrete Highway Bridges, John Wiley and Sons, 1999.
4. Baider Bakhtand Leslie, G. Jaeger, `Bridge Analysis Simplified, McGraw-Hill Book Co,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

- To introduce fundamental knowledge of sampling technique
- To describe basic statistical techniques such as statistical distributions and correlation methods
- To impart knowledge on exact sampling distributions and the tests of significance

Course Outcomes

1. Use sampling techniques for conducting various surveys related to transportation Engineering
2. Decide best fit and develop the regression equations for the given variables
3. Applications of sampling 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 Biased Estimation.

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 IBH Calcutta,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 to transportation.
- To understand the frame work of choice theories and probabilistic theories
- To establish aggregate forecasting techniques and various sampling theories.
- To discuss multidimensional choice sets and estimation of the nested logit model.

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 utility theory
3. To identify various aggregate forecasting techniques and comparing with traditional methods
4. To describe derivation of nested logit model from generalised extreme value model

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.

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>PE 1430 TE</td><td colspan="6">Ground Improvement Techniques</td><td>Elective</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>3</td><td>-</td><td>-</td><td>-</td><td>30</td><td>70</td><td>3</td></tr>
</table>

Course Objectives

- To understand the objectives, necessity and scope of ground improvement techniques
- To learn different methods of in situ densification of cohesive, cohesion less soil
- To learn the classification, functions and applications of Geosynthetics in ground improvement
- To learn the process of identification of necessity for ground improvement, finding alternative methods and recommendation of the ideal technique through case studies

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 less soils
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

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., New York.
3. Winterkorn and Fang - Foundation Engineering Hand book -Van Nostrand Reinhold Co., New York.
4. Aris C.Stamatopoulos & Panaghiotis C.Kotzios - Soil Improvement by Preloading - John Wiley & Sons Inc. Canada .
5. R. Pumshothama Rao - Ground Improvement Techniques – Laxmi Publications (P) Limited.

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>PC 1456 TE</td><td colspan="6">Major Project Phase – I</td><td>Core</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td>20</td><td>100</td><td>-</td><td>10</td></tr>
</table>

Course Outcomes

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

1. Exposed to self-learning various topics.
2. Learn to survey the literature such as books, journals and contact resource persons for the selected topic of research.
3. Learn to write technical reports.
4. Develop oral and written communication skills to present.
5. Defend their work in front of technically qualified audience

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 individual contribution.
- Seminar should be based on the area in which the candidate has undertaken the dissertation work.
- The CIE shall include reviews and the preparation of report consisting of a detailed problem statement and a literature review.
- The preliminary results (if available) of the problem may also be discussed in the report.
- 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 the Institute.
- The candidate has to be in regular contact with his supervisor and the topic of dissertation must be mutually decided by the guide and student.

<table>
<tr><th colspan="3">Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100</th></tr>
<tr><th>Evaluation by</th><th>Max. Marks</th><th>Evaluation Criteria / Parameter</th></tr>
<tr><td rowspan="2">Supervisor</td><td>30</td><td>Project Status / Review(s)</td></tr>
<tr><td>20</td><td>Report</td></tr>
<tr><td rowspan="5">Departmental Committee (Chairperson BoS, O.U. and Head, Supervisor & Project coordinator from the respective department of the institution)</td><td>10</td><td>Relevance of the Topic</td></tr>
<tr><td>10</td><td>PPT Preparation</td></tr>
<tr><td>10</td><td>Presentation</td></tr>
<tr><td>10</td><td>Question and Answers</td></tr>
<tr><td>10</td><td>Report Preparation</td></tr>
</table>

Note: The Supervisor has to assess the progress of the student regularly.

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 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/equipments and draw logical conclusions from the results after analysing them.
4. Either work in a research environment or in an industrial environment.
5. Conversant with technical report writing and will be able to present and convince their topic of study to the engineering community.

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 present seminar.
- The dissertation should be presented in standard format as provided by the department.
- 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 and discussion.
- 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 the Institute.
- 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

DEPARTMENT OF
CIVIL ENGINEERING

Scheme of Instruction and Syllabi

(As per AICTE Model Curriculum)

M.E. (CIVIL)

(Full Time)

Specialization in

CONSTRUCTION MANAGEMENT

Issued by
Dean, Faculty of Engineering
Osmania University, Hyderabad – 500 007
2019-20

INSTITUTE

Vision

The Vision of the institute is to generate and disseminate knowledge through harmonious blending of science, engineering and technology. To serve the society by developing a modern technology in students' heightened intellectual, cultural, ethical and humane sensitivities, fostering a scientific temper and promoting professional and technological expertise.

Mission

- To achieve excellence in Teaching and Research
- To generate , disseminate and preserve knowledge
- To enable empowerment through knowledge and information
- Advancement of knowledge in Engineering, Science and Technology
- Promote learning in free thinking and innovative environment
- Cultivate skills, attitudes to promote knowledge creation
- Rendering socially relevant technical services to the community
- To impart new skills of technology development
- To inculcate entrepreneurial talents and technology appreciation programmes
- Technology transfer and incubation

DEPARTMENT

Vision

To be as a leading academic department on pace with global standards and contribute to the development of economic, technically viable and useful to societal problems and challenges of civil engineering profession and also contribute to the regional and country's developmental activities.

Mission

- To train the human resources with knowledge base in the field of Civil Engineering so that they can face the challenges of civil and infrastructural engineering problems to provide viable solutions.
- To integrate their understanding and attainable knowledge on the

specializations for effective functioning in their profession and useful to the welfare and safety of mankind.

- To enhance the technical knowledge and research aptitude in the domains of various Civil Engineering specializations to serve the society in highly professional manner.
- Produce highly competent and capable professionals and motivated young academicians to provide solutions to real life problems of Engineering and Technology and has apt for continuous learning and dedication towards societal issues.

Program Educational Objectives (PEO):

PEO-1: Impart and enrich knowledge of effective and quality construction management practices leading to savings in time and cost of construction projects.

PEO-2: Apply latest methods, procedures, modern tools and techniques to optimise resources for achieving project objectives in construction projects.

PEO-3: Communicate effectively, demonstrates leadership qualities, work in team environment and exhibit professional ethics.

PEO-4: Engage in lifelong learning for career enhancement as per the needs of practicing engineers and academician and adapt to changing societal.

Program Outcomes (PO):

PO-1: Apply knowledge of construction engineering to solve problems related to contemporary issues in construction Industry.

PO-2: Analyze, design, conduct numerical experiments, and interpret data of complex construction technology management problems.

PO-3: Use modern engineering tools, instrumentation and software in implementing construction projects.

PO-4: Communicate effectively, demonstrate leadership skills, work in inter-disciplinary engineering teams with social responsibility and ethical values.

PO-5: Engage in lifelong learning and demonstrate awareness of contemporary issues to meet the challenges and demand of the society.

PEO-6: Employ sustainable technologies to protect environment and ecosystems.

MAPPING OF PEO'S WITH PO'S

PROGRAMME EDUCATIONAL OBJECTIVES	**MAPPING WITH POs**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
PEO-1	Y	Y	-	-	Y	Y
PEO-2	Y	Y	Y	-	Y	Y
PEO-3	Y	-	-	Y	-	-
PEO-4	Y	Y	Y	Y	Y	Y

DEPARTMENT OF CIVIL ENGINEERING, U.C.E., O.U
M. E. CIVIL (CONSTRUCTION ENGINEERING MANAGEMENT)

w. e. f. 2019-2020

Type of course	Course Code	Course Name	Contact hours per week			Scheme of Examination		Credits
			L	T	P	CIE	SEE	
SEMESTER-I								
Core-I	CE601	**Construction Management**	3			30	70	3
Core-II	CE602	**Construction Planning and Administration**	3			30	70	3
Professional Elective-I	CE611	Economic Decision Analysis in Construction	3			30	70	3
	CE612	Legal Issues in Construction Management						
	CE411	Statistical Techniques						
Professional Elective-II	CE613	Construction Finance	3			30	70	3
	CE115	Structural Health Monitoring						
	CE117	Green Building Technology						
Audit-I	AC101	Disaster Mitigation & Management	2	1		30	70	0
	AC102	English for Research Paper Writing	2	1		30	70	0
Lab-I	CE651	Construction Engineering Lab - I			3	50	-	1.5
Lab-II	CE652	Computing Application Lab in Construction Management -I			3	50	-	1.5
MC	CE100	Research Methodology in Civil Engineering	3	-		30	70	3
TOTAL			16	2	8	280	420	18
SEMESTER-II								
Core-III	CE603	**Construction Planning and Scheduling**	3			30	70	3
Core-IV	CE604	**Quantitative methods in Construction Management**	3			30	70	3
Professional Elective-III	CE614	Neural Fuzzy and Expert Systems	3			30	70	3
	CE615	Value Engineering In Construction						
	CE616	TQM techniques in Construction						
Professional Elective-IV	CE617	Construction Safety Management	3			30	70	3
	CE618	Human Resources Development for Construction						
	CE121	Advanced Concrete Technology						
Audit-II	AC103	Personality Development	2	1		30	70	0
	AC104	Stress Management by Yoga						
	AC105	Constitution of India						
Core-V / MC	CE671	Mini Project			6	50		3

Lab-III	CE653	Construction Engineering Lab-II			3	50	-	1.5
Seminar	CE661	Seminar			3	50	-	1.5
TOTAL			14	1	12	300	350	18
SEMESTER-III								
Professional Elective-V	CE619	Construction Planning Equipments and Methods	3			30	70	3
	CE620	Management Information system						
	CE621	Functional Planning and Building Services						
	CE622	Timber and Formwork Design						
	CE623	Environmental Impact Assessment						
Open Elective	CE901	Cost Management of Engineering Projects	3			30	70	3
	CE902	Operation Research						
	CE903	Industrial Safety						
	CE904	Business Analytics						
	CE905	Waste to Energy						
	CE906	Intellectual Property Rights						
	CE907	Composite Materials						
	CE908	Geospatial Technology						
	CE681	Major Project Phase-I	6		20	100		10
TOTAL			12		20	160	**140**	16
SEMESTER-IV								
	CE682	Major Project Phase-II			32		200	16
GRAND TOTAL								68

CIE : Continuous Internal Evaluation **SEE : Semester End Examination**

.

SEMESTER-I

CONSTRUCTION MANAGEMENT

Instruction	:	**3 periods per week**
Duration of Semester End Examination	:	**3 hours**
Semester end Examination	:	**70marks**
Continuous Internal Evaluation	:	**30marks**

Course Objectives:

- Understand the broad principles and concepts of construction management
- To create awareness of MIS techniques in construction industry
- Represent various works measurement standards

Course Outcomes:

- Ability to take responsibilities as construction manager
- Awareness of principles of construction Management and decision making in construction Industry
- Applications of mobilization, cost time schedules and MIS technique in the real time construction operation
- Application of work study measurements
- Knowledge of work measurement application in construction industry

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.2	0.2	0.2	-	0.2	0.2
CO2	0.2	0.3	0.3	-	0.2	-
CO3	0.2	0.3	0.3	-	0.2	-
CO4	0.2	0.3	0.3	-	0.2	-
CO5	0.2	0.3	0.3	-	0.2	-

UNIT - I

Introduction to management, science or art ?, history of construction management, modern management, system approach and emergence of management thought, need, nature and purpose of construction management, major problems in construction industry, firm organization, chain of command, division of work, organization charts, functions and responsibilities of construction manager, case studies, future of construction management.

UNIT – II

Principles of construction management; planning, organizing, staffing, leading, controlling. Decision making in construction industry, nature of managerial decision making, the rational model of decision making, challenges to the rational model, improving the effectiveness of decision making tools and techniques, benefit-cost analysis, replacement analysis, break even analysis, risk management in construction industry.

UNIT – III

Site mobilization and demobilization aspects, various resource management based on funds availability, organization and monitoring of the construction work with respect to cost-time schedules, coordinating, communicating and reporting techniques, Application of MIS to construction, Training of Construction Managers.

UNIT – IV

Work Study: Definition, Objectives, basic procedure, method study and work measurement, work study applications in Civil Engineering.

Method study – Definition, Objective, Procedure for selecting the work, recording facts, symbols, flow process charts, multiple activity charts, string diagrams.

UNIT - V

Work measurement – Time and motion studies, Concept of standard time and various allowances, time study, equipment performance rating. Activity sampling, time - lapse photography technique, Analytical production studies.

Suggested reading:

1. Tenah, K.A. (1985). "The Construction Management Process" Reston Publishing Company, Inc. Virginia, USA.

2. Roy Pilcher (1985) "Project Cost Control in Construction," Collins Professional and technical books, London.
3. Raina, C.M. "Construction Management and Practice." Tata McGraw-Hill, New Delhi, 1980.
4. Construction Planning & management By P S Gahlot & B M Dhir , New Age International Limited Publishers
5. Construction Project planning & Scheduling By Charles Patrick, Pearson, 2012
6. Construction Project Management Theory & practice --- Kumar Neeraj Jha, Pearson,2012
7. Construction management Fundamantals by Knutson, Schexnayder, Fiori, Mayo, Tata McGraw Hill, 2nd Edition, 201
8. Modern construction management--.Harris, Wiley India.
9. Construction Management and Planning by Sengupta and Guha-Tata McGraw Hill publication.
10. Project Management – K Nagrajan – New age International Ltd.
11. Work study – Currie.
12. Professional Construction Management Barrie-Paulson-McGraw Hill Institute Edition.
13. Project Management – Ahuja H.N. – John Wiely, New York.
14. Construction Project Management Planning, Scheduling and Controlling-Chitakara- Tata McGraw Hill, New Delhi
15. Construction Management – Roy, Pilcher 13.Construction Management – O'Brien.
16. Project Management-Planning and Control---Rory Burkey 4th ed.— Wiley,India.

CE602 *With effect from the academic year 2019-20*

CONSTRUCTION PROJECT ADMINISTRATION

Instruction	:	**3 periods per week**
Duration of Semester End Examination	:	**3 hours**
Semester end Examination	:	**70marks**
Continuous Internal Evaluation	:	**30marks**

Course Objectives:

- To know the students about the construction administration and Quality aspects.
- To understand the lines of authority in construction projects
- To have the idea of different risks associated with construction industry and remedial measures
- To properly understand the IS specifications and drawings in construction projects.
- To visualize and understand pre-construction operations and its limitations.

Course outcomes:

- To be able to gain the knowledge of construction administration issues and quality related problems in construction projects.
- To be able to have an idea of hierarchy, work responsibility and work progress.
- To be able to understand risks and uncertainty related issues in constructions.
- To be able to understand the IS specifications and drawings for the Civil Engineering Construction projects.
- To be able to understand the pre-construction operations and techniques.

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.4	0.2	0.2	-	0.2	-
CO2	0.4	-	-	0.4	0.2	-
CO3	0.4	0.2	0.4	-	-	-
CO4	0.4	0.4	0.2	-	-	-
CO5	0.4	0.2	0.2	-	0.2	-

UNIT – I

Introduction to Construction Administration, Control of Quality in Construction, Organizational Structure, Design Build Contracts, Responsibility for Coordination of the trades Role of owner, Contractor, Engineer, and Construction Manager.

UNIT - II

Introduction to authority, Lines of Authority in Construction administration on Construction Projects, Responsibility, Familiarization with construction documents, Staffing responsibilities, Limitations of their duties/functions.

UNIT - III

Reasons for the risks, Certainty, Risk, and Uncertainty, Risk Management, Identification and Nature of Construction Risks, Contractual allocation of Risk, Types of Risks, Minimizing risks and mitigating losses, use of expected values, utility in investment decisions, decision trees, sensitivity analysis and their applications.

UNIT - IV

Specifications and drawings - Role of Engineers and Architects, Specifications, Conflicts due to drawings and specifications, unenforceable phrases; content of the specifications, CSI specifications format, allowances and tolerances in specifications, problems. Municipal regulations and construction drawings

UNIT - V

Preconstruction Operations-Need for the preconstruction operations, Equipments, material and manpower, Constructability Analysis, Issuance of

Bidding Documents, Prequalification of Bidders, Bonds, Opening Acceptance and Documentation of Bids, Limitations and advantages of preconstruction operations.

Suggested reading:

1. Fisk, E.R. (2000) "Construction Project Administration," Prentice Hall International, London.
2. Kwakye, A.A. (1997), "Construction Project Administration", Adisson Wesley Longman, London.

ECONOMIC DECISION ANALYSIS IN CONSTRUCTION

Instruction	:	**3 periods per week**
Duration of Semester End Examination	:	**3 hours**
Semester end Examination	:	**70marks**
Continuous Internal Evaluation	:	**30marks**

Course Objectives

- To cover the principles of engineering economy by following the basic methods for carrying out Economic studies.
- To demonstrate various interest formulas for comparing the alternative methods.
- To understand various methods of Depreciation for Replacement and Maintenance Analysis.
- To manage and control the Inventory and Cost of Production.
- To estimate the Economic life of an Asset with Inflation Effect.

Course Outcomes

- Highlight the basic principles of Economics and its concepts.
- Able to calculate various interest formulas for comparison of Alternatives.
- Ability to calculate various methods of Depreciation.
- Ability to control the Inventory and Cost of Production.
- Able to estimate the Economic life of an Asset with Inflation effect.

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.3	0.2	0.3	0.1	0.1	-
CO2	0.4	0.2	0.3	-	0.1	-
CO3	0.4	0.2	0.3	-	0.1	-
CO4	0.4	0.2	0.3	-	0.1	-
CO5	0.4	0.2	0.3	-	0.1	-

UNIT-I

Introduction to engineering economics, basic economic concepts related to construction industry- marginal cost, marginal revenue, opportunity cost contribution, time perspective, elementary economic analysis-material selection for a product, design selection, building material and process planning.

UNIT-II

Interest formulae's and their applications- time value of money, present worth method, future worth method, annual equivalent method, rate of return method.

UNIT-III

Replacement and maintenance analysis, determination of economic life of an asset, depreciation-straight line method of depreciation, declining balance method of depreciation, sum of the years digits methods depreciation, sinking funds method of depreciation etc.

UNIT-IV

Production and function, cost of production, inventory cost management , optimum rise of construction, input-output analysis in the construction industry.

UNIT-V

Inflation, procedure to adjust inflation, economic life determination without inflation effect, economic life determination with inflation effect, measurement of inflation, impact of inflation on economic evaluations, growth of multinational construction companies.

Suggested reading:

1. Shutt R.C. (1995), "Economics for the construction industry," Longman Scientific and Technical, England.
2. Panneerselvam, R. (2001), "Engineering Economics," Prentice Hall of India, India.

LEGAL ISSUES IN CONSTRUCTION MANAGEMENT

Instruction	**:**	**3 periods per week**
Duration of Semester End Examination	**:**	**3 hours**
Semester end Examination	**:**	**70marks**
Continuous Internal Evaluation	**:**	**30marks**

Course Objectives

- To study the various types of construction contracts and their legal aspects and provisions.
- To study the tenders, arbitration, legal requirements, labor and human rights regulations

Course Outcomes

- Student shall able to know basics on construction related contracts.
- Students shall be able to carry out the tendering process.
- Overview of construction management, administration and present status of construction industry.
- Students shall be aware of labor law related legislations.
- Students shall be able to know dispute resolution mechanism

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.5	0.15	0.15	0.1	0.1	-
CO2	0.5	0.1	0.2	0.1	0.1	-
CO3	0.5	0.1	0.1	0.1	0.1	-
CO4	0.5	0.1	0.1	0.1	0.2	-
CO5	0.5	0.1	0.1	0.1	0.2	-

UNIT-1

Introduction to Construction Law - Need for legal issues in Construction–The Indian Contract Act, 1872 - Definition of a Contract and its essentials, Formation of a valid Contract - Offer and Acceptance, Consideration, Capacity to Contract, Free consent, Legality of object, Discharge of a Contract by performance, Impossibility and Frustration, Breach, Damages for breach of a contract, Quasi contracts. Special Contracts Contract of Indemnity and Guarantee, Contract of Bailment and Pledge, Contract of Agency— I T Lawand its Influence on Construction Contracts

UNIT-2

Construction Tendering Process: Introduction to Construction Process,Need for tendering, process of Tendering in Construction, Importance ofSpecifications and Estimates in Construction, Concept of completion of the Contract, Sub-Contracts and requirements, Tendering Models andStrategies, Re Tendering , Prequalification of Bidders, Documents forming a BID and Contract, Agreements and Bonds in Tendering Process – E- Procurement

UNIT-3

Construction Administration: Duties and Responsibilities – ProjectManager, Owner, Engineers and Contractors, Important Site Documents,Process of Building Permissions, Provision for Scheduling delays andaccelerations, Environmental Provisions for Construction Contracts.

UNIT-4

Employment legislations - Industrial Dispute Act, Factories Act, Payment of Wages Act, Workmen's Compensation Act. Important Provisions of Employees' State Insurance Act, Payment of Gratuity Act, Employees Provident Fund Act, Worker Compensation and Insurance laws.

UNIT-5

Disputes and Liabilities in Construction: Major sources of disputes in construction, Reasons for Delays – Types, Claims and solutions Construction Liabilities and Litigations, Disputes in Land Development. Dispute Resolution in Construction and Judicial Process and ADRs, Arbitration and Conciliation Act 1996, Arbitration Agreement, Importance of ADR Methods in Construction, Arbitration Process, Arbitration Clause in Contracts

Suggested Readings:

1) Civil Engineering Contracts and Estimates - B. S. Patil – Universities Press- 2006 Edition, reprinted in 2009.
2) The Indian Contract Act (9 of 1872), 1872- Bare Act- 2018 edition, Asia Law Book Publishers Hyderabad..
3) The Arbitration and Conciliation Act,(1996), 1996 (26 of 1996)- 2006 Edition, Professional Book Publisher.
4) Law of contract Part I and Part II, Dr. R.K. Bangia- 2017 Edition, Allahabad Law Agency.
5) Arbitration, Conciliation and Alternative Dispute Resolution Systems- Dr. S.R. Myneni2004 Edition, reprinted in 2005- Asia Law House Publishers.
6) The Workmen‘s Compensation Act, 1923 (8 of 1923) Bare Act- 2005- Professional Book Publishers.
7) Standard General Conditions for Domestic Contracts- 2001 Edition- Published by Ministry Of Statistics and Program Implementation, Government of India.
8) FIDIC Document (1999). 9) Dispute Resolution Board foundation manual-www.drbf.org

CE411 *With effect from the academic year 2019-2020*

STATISTICAL TECHNIQUES

Instruction	**:**	**3 periods per week**
Duration of University Examination	**:**	**3 Hours**
University Examination	**:**	**70 Marks**
Sessionals	**:**	**30 Marks**

Course Objectives:

- To introduce fundamental knowledge of sampling techinue
- To describe basic statistical techniques such as statistical distributons and correlation methods
- To impart knowledge on exact sampling distributions and the tests of significance

Course Outcomes:

Students who successfully complete this course will be able to:

- Use sampling techniques for conducting various surveys related to construction industry.
- Apply the statistical distributions to various construction industry problems
- Decide best fit and develop the regression equations for the given variables
- Apply multi-variant data distributions.
- Applications of sampling distributions to construction Engineering problems.

CO-PO Articulation Matrix

Course Outcome	Program Outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.4	0.25	0.15	-	0.10	0.1
CO2	0.4	0.25	0.15	-	0.10	0.1
CO3	0.4	0.25	0.15	-	0.10	0.1
CO4	0.4	0.25	0.15	-	0.10	0.1
CO5	0.4	0.25	0.15	-	0.10	0.1

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 Biased Estimation.

UNIT - V

Exact Sampling Distributions and Tests of Significance; Chi-square distribution; students 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 Reading

1. Basic Statistics - Simpson and Kafks; Oxford and IBH Calcutta,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

CE613 ***With effect from the academic year 2019-20***

CONSTRUCTION FINANCE

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
Semester end Examination	**: 70marks**
Continuous Internal Evaluation	**: 30marks**

Course Objectives

- To train the students with the latest and the best in the rapidly changing field of Construction Engineering, Technology and Management.
- To arrive at the best Investment Options by employing the Capital Budgeting Methods.
- To apply various types of Budgets required for Civil Works.
- Effective Cost Control by employing Standards and Analysis of Variances.
- To manage the Working Capital requirements on Construction Projects.

Course Outcomes

- Understanding of the Pre-requisites before Investing Capital and Long Term Decisions.
- Enable to perform Capital Budgeting Techniques for Investment Analysis.
- Ability to prepare various types of Budgets required for Civil Works.
- Ability to measure the Variances between Standard and Actual performance.
- Ability to estimate the Working Capital requirements on a Construction Projects.

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.4	0.2	0.3	-	0.1	-
CO2	0.4	0.2	0.3	-	0.1	-
CO3	0.4	0.2	0.3	-	0.1	-
CO4	0.4	0.2	0.3	-	0.1	-
CO5	0.4	0.2	0.3	-	0.1	-

UNIT-I

Introduction to investments-types of investments problems, stages in an economic appraisal, risk and uncertainty in investments decisions, cost of capital, time values of money, cash flows, equivalence for comparison and selection, effect of rate of return, and capital ratio.

UNIT-II

Investment analysis- capital budgeting- methods of evaluation of capital budgeting- payback period methods, rate of return method, Net present value method, interval rate of return method, profitability index method.

UNIT-III

Cost concepts, break even analysis, Budgeting and budgeting control system, classification and types of budgets ,fixed and flexible budgets, sales budget, production budget, cost of production budget, materials budget, direct labor budget, overhead cost budget, selling and distribution overhead budget.

UNIT-IV

Standard costing and variance analysis in relation to construct , direct material variance , direct labor variance , overhead variances , job , batch and contract costing- procedures, determination of economic batch, Network analysis as a basis for cost control.

UNIT-V

Working capital, working capital at project level management of cash, Receivable management, Inventory management, price level accounting (Inflation Accounting), project management network techniques- program evaluation review techniques and critical path method.

Suggested reading:

1. Roy Pilcher (1985) “Project Cost Control in Construction,” Collins Professional and technical books, London.
2. Humphreys, K.K., and Wellman, P. (1996) “Basic Cost Engineering,” Marcel Dekker, Inc. New York.

CE115 *With effect from the academic year 2019-20*

STRUCTURAL HEALTH MONITORING

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
University Examinations	**: 70marks**
Continuous Internal Evaluation	**: 30 marks**

Course Objectives:

- Learn the fundamentals of structural health monitoring.
- Study the various vibration-based techniques for structural health monitoring.
- Learn the structural health monitoring using fiber-optic and Piezoelectric sensors.
- Study the structural health monitoring using electrical resistance and electromagnetic techniques.

Course Outcomes:

- Understand the fundamentals of maintenance and repair strategies.
- Diagnose for serviceability and durability aspects of concrete.
- Know the materials and techniques used for repair of structures.
- Decide the appropriate repair, strengthening, rehabilitation and retrofitting technique required for a case study building.
- Use an appropriate health monitoring technique and demolition technique.

CO-PO Articulation matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.6	-	-	-	0.2	0.2
CO2	0.6	-	0.1	-	0.2	0.1
CO3	0.6	-	0.1	-	0.2	0.1
CO4	0.5	-	0.2	-	0.2	0.1
CO5	0.5	-	0.2	-	0.2	0.1

UNIT-I

Introduction to SHM: An Overview of Structural Health Monitoring and Smart Materials

UNIT-II

Vibration Control for SHM: Vibration Control using SHM – Introduction to FE formulation, Constitutive Relationship, Element Stiffness Matrix for High Precision Finite Element, Element Mass Matrix for High Precision Finite Element, Developing Actuator and Sensor Influence Matrix, Estimating Sensor Voltage, Active Control of Damping, A Case study of Performance Estimation for Different Patches, SHM of Ribbon Reinforced Composite Laminate

UNIT-III

SHM using Piezo and Magnteostrictive Layers: Delamination Sensing using Piezo Sensory Layer, Voltage Response from Piezopatch, Electrical Impedance Method basic theory, A Case Study: Results and Discussions, SHM using Magnetostrictive Sensory Layer, Basics of Magnetization and Hysteresis, Delamination Sensing using Magnetostrictive Sensory Layer, Constitutive relationship with composite relationship, MS Layer in symmetric Laminate, MS Layer Away from the Midplane in Asymmetric Laminate, Case Studies related to MS Layer based SHM

UNIT-IV

SHM using LDV: Experimental Modal Analysis using LDV – Introduction, What is LDV?, Velocity and Displacement Measurement using LDV, Case Study for Symmetric Laminate, Case Study for Cross-ply

Suggested Reading:

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, Structural Health Monitoring, John Wiley and Sons, 2006.
2. Douglas E Adams, Health Monitoring of Structural Materials and Components-Methods with Applications, John Wiley and Sons, 2007.
3. J.P. Ou, H.Li and Z.D. Duan, Structural Health Monitoring and Intelligent Infrastructure, Vol-1, Taylor and Francis Group, London, U.K, 2006.
4. Victor Giurglutiu, Structural Health Monitoring with Wafer Active Sensors, Academic Press Inc, 2007.
5. Smart Materials and Structures, Gandhi and Thompson
6. Structural Health Monitoring: Current Status and Perspectives, Fu Ko Chang

CE117 *With effect from the academic year 2019-20*

GREEN BUILDING TECHNOLOGY

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
University Examinations	**: 70marks**
Continuous Internal Evaluation	**: 30 marks**

Course Objectives:

- Exposure to the green building technologies and their significance.
- Understand the judicial use of energy and its management.
- Educate about the Sun-earth relationship and its effect on climate.
- Enhance awareness of end-use energy requirements in the society.
- Develop suitable technologies for energy management.

Course Outcomes:

- Understand the fundamentals of energy use and energy processes in building.
- Identify the energy requirement and its management.
- Know the Sun-earth relationship vis-a-vis its effect on climate.
- Be acquainted with the end-use energy requirements.
- Be familiar with the audit procedures of energy.

CO-PO Articulation matrix

Course outcome	Program outcome					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	0.4	0.1	0.1	-	0.1	0.3
CO2	0.4	0.1	0.1	0.2	0.1	0.2
CO3	0.4	0.1	-	-	0.2	0.3
CO4	0.4	0.1	-	-	0.1	0.4
CO5	0.6	0.1	-	0.2	0.2	0.2

UNIT I

Overview of the significance of energy use and energy processes in building - Indoor activities and environmental control - Internal and external factors on energy use and the attributes of the factors - Characteristics of energy use and its management - Macro aspect of energy use in dwellings and its implications.

UNIT II

Indoor environmental requirement and management - Thermal comfort - Ventilation and air quality – Air-conditioning requirement - Visual perception - Illumination requirement - Auditory requirement.

UNIT III

Climate, solar radiation and their influences - Sun-earth relationship and the energy balance on the earth's surface - Climate, wind, solar radiation, and temperature - Sun shading and solar radiation on surfaces - Energy impact on the shape and orientation of buildings.

UNIT IV

End-use, energy utilization and requirements - Lighting and day lighting - End-use energy requirements - Status of energy use in buildings Estimation of energy use in a building. Heat gain and thermal performance of building envelope - Steady and non steady heat transfer through the glazed window and the wall - Standards for thermal performance of building envelope - Evaluation of the overall thermal transfer

UNIT V

Energy management options - Energy audit and energy targeting - Technological options for energy management

Suggested Reading:

1. Bryant Edwards (2005): Natural Hazards, Cambridge University Press, U.K.
2. Carter, W. Nick, 1991: Disaster Management, Asian Development Bank, Manila.
3. Sahni, Pardeep et.al. (eds.) 2002, Disaster Mitigation Experiences and Reflections,
   Prentice Hall of India, New Delhi.
4. Bryant Edwards (2005): Natural Hazards, Cambridge University Press,U.K.

AC101 *With effect from the academic year 2019-20*

DISASTER MITIGATION AND MANAGEMENT

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
University Examinations	**: 70marks**
Continuous Internal Evaluation	**: 30 marks**

Course Objectives:

- To know the various types of disasters and its effect on structures.
- Study the quality assurance and damage assessment of structures
- Educate different types of repair, strengthening, rehabilitation and retrofitting techniques.
- Awareness about flood characteristics and flood forecasting systems
- Description of Flood mitigation, adjustment, and regulation
- Knowledge of Hydrological time series analysis

Course Outcomes:

- Understand the fundamentals of disaster and seismic performance of buildings.
- Able to assess the various damages in structure and give assurance of quality of concrete.
- Decide the appropriate repair, strengthening, rehabilitation and technique required for a case study building.
- Ability to critically review and interpret scientific information on mathematics of flood forecasting and flood routing
- Advanced understanding of flood plain adjustment issues and the other technologies employed for flood management.

CO-PO Articulation matrix

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.6	-	-	-	0.2	0.2
CO2	0.5	-	0.1	-	0.2	0.2
CO3	0.5	-	0.1	-	0.2	0.2
CO4	0.5	0.1	0.1	-	0.1	0.2
CO5	0.5	0.1	0.1	-	0.1	0.2

UNIT – I

Disaster: Classifications - Causes - Impacts including social, economical, political, environmental, health, psychosocial, etc.
Seismic performance of buildings: case studies of major earthquakes in the country, damage to buildings, damage patterns, performance of non-engineered buildings.
Introduction to Repair and rehabilitation of structures.

UNIT – II

Quality assurance for concrete – Strength, Durability and Thermal properties of concrete.
Damage Assessment: - Condition assessment and distress, Purpose of assessment, Rapid assessment - diagnostic techniques, Investigation of damage, , Evaluation of surface and structural cracks, Damage assessment procedure, destructive, non-destructive and semi destructive testing systems, Procedure for evaluating damaged of structure.

UNIT III

Repair, Rehabilitation And Retrofitting Techniques : Repair materials, Common types of repairs – Repair in concrete structures – Repairs in under water structures – Guniting – Shot create –Underpinning, Strengthening of Structural elements, Repair of structures distressed due to corrosion, fire, Leakage, earthquake, Retrofitting techniques.

UNIT – IV

Introduction to Disasters: Hazard, Vulnerability, Resilience, Risks.-Disaster-Different types of cold wave-heat wave- droughts- floods-Effect of climate change on Processes.

Flood characteristics and forecasting: Measureable features of a flood (Elevation, discharge, volume, and duration), flood forecasting (unit hydrograph method, meteorological and snow data, and snow field air temperatures), operation of flood forecasting systems.

Space-time characteristics of rainfall: Policy criteria for design flood of a major and minor reservoir, spillways, diversion dams and barrages, design flood criteria for dams and other hydraulic structures (CWC recommendations).

UNIT - V

Flood Routing: Mathematics of flood routing, various methods of flood routing, Hydrologic and Hydraulic routing.

Flood mitigation: flood ways, channel improvement, evacuation and flood proofing, land management, flood plain management, estimating benefits of flood mitigation.

Flood plain adjustments and regulations: Results of controlling floods, alternatives to controlling floods, range of possible adjustments, practical range of choice, critical characteristics of flood hazards..

Suggested Reading:

1. Barry A. Richardson, “Defects and Deterioration in Buildings”, E &FN Spon Press, London, 1991.
2. J. H. Bungey, “Testing of Concrete in Structures”, Chapman and Hall,New York, 1989.
3. A.R. Santakumar, “Concrete Technology”, Oxford University Press,New Delhi, 2006.
4. Pankaj Agarwal and Manish Shrihkande (2006). “Earthquake Resistance Design of Structures.” Prentice Hall of India
5.Ravishankar.K., Krishnamoorthy.T.S, "Structural Health Monitoring, Repair and Rehabilitation of Concrete Structures", Allied Publishers, 2004.
6. CPWD and Indian Buildings Congress, Hand book on Seismic Retrofit of Buildings, Narosa Publishers, 2008.

7. Ven Te Chow (1964), ‘Hand Book of Applied Hydrology’, McGraw-Hill Publishers, New York.
8. Linsley, R. K. and Franzini A. W. (1992), ‘Water Resource Engineering’, McGraw-Hill Publishers, New York.
9. Varshney, R. S. (1979), ‘Engineering Hydrology’, Nem Chand Publishers, Roorkee.
10. Jaya Rami Reddy, P. (1987), ‘A. Text Book of Hydrology’, Lakshmi Publishers, New Delhi.
11. Daniel H. Hoggan (1989), ‘Computer Assisted Flood Plain Hydrology and Hydraulics’, McGraw-Hill Publishers, New York.

AC102 *With effect from the academic year 2019-20*

ENGLISH FOR RESEARCH PAPER WRITING

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
University Examinations	**: 70marks**
Continuous Internal Evaluation	**: 30 marks**

Course Objectives:

- To understand the nuances of language and vocabulary in writing a Research Paper.
- To develop the content, structure and format of writing a research paper.
- To enable the students to produce original research papers without plagiarism.

Course Outcomes: Upon completing this course, students will be able to:

- Interpret the nuances of research paper writing.
- Differentiate the research paper format and citation of sources.
- To review the research papers and articles in a scientific manner.
- Avoid plagiarism and be able to develop their writing skills in presenting the research work.
- Create a research paper and acquire the knowledge of how and where to publish their original research papers.

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

Text Book:

1. C. R Kothari, Gaurav, Garg, **Research Methodology Methods and Techniques,** New Age International Publishers. 4th Edition.

Suggested Reading:

1.Day R (2006) "How to Write and Publish a Scientific Paper**",** Cambridge University Press

2.MLA **"**Hand book for writers of Research Papers**"**, East West Press Pvt. Ltd, New Delhi, 7th Edition.

3.Lauri Rozakis, Schaum's, "Quick Guide to Writing Great Research Papers**"**, Tata McGraw Hills Pvt. Ltd, New Delhi.

Online Resource:

1. NPTEL: https://onlinecourses.nptel.ac.in/noc18_mg13/preview

CE651 *With effect from the academic year 2019-20*

Construction Engineering Laboratory-I

Instruction : **3 Periods per week**
Sessional : **50 Marks**

Course Objectives:

1. To evaluate the properties of constituents of concrete.
2. To evaluate the properties of various building materials.
3. To evaluate the properties of concrete with variable workability and variable parameters.

Course Outcomes:

1. Ability to evaluate the properties of various constituents of concrete.
2. Able to assess the properties of various building materials.
3. Understand the variation of workability with time for different grades of concrete.
4. Capable to correlate the properties of concrete with variable parameters.
5. Influence of various parameters on strength characteristics of concrete.

CO-PO Articulation matrix

Course outcome	Program outcome					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	0.5	0.3	-	-	0.1	0.1
CO2	0.5	0.3	-	-	0.1	0.1
CO3	0.6	-	-	-	0.2	0.2
CO4	0.5	0.3	-	-	0.1	0.1
CO5	0.5	0.3	-	-	0.1	0.1

1. Evaluation of properties of cement, fine aggregates and coarse aggregates.
2. Evaluation of properties of reinforcing steel, timber, building block and tile.
3. Variation of workability with time for different grades of concrete – experimental observations.
4. Experimental observation on influence of following parameters on strength characteristics of concrete (Some of these parameters may be considered depending up on time)
    i. Size, Shape and grade of coarse aggregate
    ii. Grading of fine aggregate
    iii. Hand Mixing / Machine Mixing
    iv. Aggregate – Cement Ratio
    v. Coarse Aggregate – Fine Aggregate Ratio
    vi. Size and Shape of Test Specimen
    vii. Admixtures

CE652 *With effect from the academic year 2019-20*

Computing Application Lab in Construction Management

Instruction **3 Periods per week**
Sessional **50 Marks**

Course objectives

- Understanding the concept of project planning and scheduling
- Application of PRIMAVERA to project planning and scheduling
- Preparation of project schedules

Course outcome

- Students are expected to have gained knowledge on PRIMAVERA software and its application to Construction Engineering and Management
- Students are expected to prepare construction project schedules using PRIMAVERA software

- Ability to extract required data from PRIMAVERA software

CO-PO Articulation matrix

Course Outcomes	Program Outcomes					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	0.2	0.3	0.2	0.2	-
CO2	-	0.3	0.3	0.2	0.2	-
CO3	-	0.2	0.3	0.3	0.1	-

Experiments:

1. Introduction to components of PRIMAVERA, and Setting up of project in PRIMAVERA (including creating and modifying calendar)
2. Creating Organizational Breakdown Structure (OBS)
3. Creating Enterprise Project Structure (EPS).
4. Creating New Project, Work Breakdown Structure (WBS),
5. Creating Activities and Assigning Duration
6. Assigning resources and their cost to the Activities
7. Scheduling project and identifying Float in PRIMAVERA
8. Identification of critical path in a project in primavera
9. Generating Project Baselines.
10. Importing and exporting files in PRIMAVERA

ENGINEERING RESEARCH METHODOLOGY IN CIVIL ENGINEEERING

No. of Credits	**: 3 Credits**
Instruction	**: 3 Periods per week**
Duration of University Examination	**: 3 Hours**
Semester End Evaluation	**: 70 Marks**
Continuous Internal Evaluation	**: 30 Marks**

Course Objectives:

- To introduce the conceptual and philosophical foundation of research methodology for Scientific and Engineering Research
- To provide an understanding of the importance of literature review and formulating of a good research problem.
- To offer procedural instruction on how to plan, design & conduct research projects and interpret the data
- To educate the importance of presentation skills and on publication ethics in research

Course Outcomes:

Upon completing this course, each student will be able to:

- Demonstrate the knowledge of research processes (reading, evaluating, and developing) and formulate a research problem
- Perform literature reviews, present research ideas, plan research projects, and to explain the rationale for research ethics
- Understand the importance of innovation & patenting and will be aware of rules and regulations about Intellectual Property Rights
- Choose relevant sampling methods for qualitative and quantitative data collection and processing
- Apply various statistical methods for proper characterization, stigmatization, presentation and interpretation of the

result of research, to test the Hypothesis by using SPSS software and similar software

CO-PO Articulation matrix

Course outcome	Program outcome					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	-	0.2	0.2	0.3	0.3	-
CO2	0.2	0.3	0.3	0.1	0.1	-
CO3	-	0.2	0.2	0.2	0.2	0.2
CO4	0.2	0.3	0.3	-	0.2	-
CO5	-	0.5	0.5	-	-	-

UNIT - I

Research methodology: Objectives and motivation of research - Types of research - Research approaches - Significance of research - Research methods verses methodology - Research and scientific method - Importance of research methodology - Research process - Criteria of good research - Problems encountered by researchers in India - Benefits to the society in general. Defining the research problem: Definition of research problem - Problem formulation - Necessity of defining the problem - Technique involved in defining a problem.

UNIT – II

Literature survey: Importance of literature survey - Sources of information - Assessment of quality of journals and articles - Information through internet.
Literature review: Need of review - Guidelines for review - Record of research review.

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 - Design of experimental set-up - Use of standards and codes.

UNIT – IV

Data collection: Collection of primary data - Secondary data - Data organization - Methods of data grouping - Diagrammatic representation of data - Graphic representation of data - Sample design - Need for sampling - Some important sampling definitions - Estimation of population - Role of statistics for data analysis - Parametric vs. non parametric methods - Descriptive statistics - Measures of central tendency and dispersion - Hypothesis testing - Use of statistical softwares.

Data Analysis: Deterministic and random data - Uncertainty analysis - Tests for significance - Chi-square - Student's t-test - Regression modeling - Direct and interaction effects – ANOVA - F-test - Time series analysis - Autocorrelation and autoregressive modeling.

UNIT - V

Research report writing: Format of the research report – Synopsis – Dissertation - Thesis - Its differentiation – References – Bibliography – Webliography - Technical paper writing - Journal report writing - Making presentation - Use of visual aids.

Research proposal preparation: Writing a research proposal and research report - Writing research grant proposal.

Suggested Reading:

1. C.R Kothari, "Research Methodology, Methods & Technique", New Age International Publishers, New Delhi, 2004.
2. R. Ganesan, "Research Methodology for Engineers", MJP Publishers, Chennai, 2011.
3. Ratan Khananabis and Suvasis Saha, "Research Methodology", Universities Press, Hyderabad, 2015.
4. Y.P. Agarwal, "Statistical Methods: Concepts, Application and Computation", Sterling Publishing Pvt. Ltd., New Delhi, 2004.
5. Vijay Upagade and Aravind Shende, "Research Methodology", S. Chand & Company Ltd., New Delhi, 2009.
6. G. Nageswara Rao, "Research Methodology and Quantitative methods", BS Publications, Hyderabad, 2012.

SEMESTER-II

CONSTRUCTION PLANNING AND SCHEDULING

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
Semester end Examination	**: 70marks**
Continuous Internal Evaluation	**: 30marks**

Course Objectives:

- Understand the concept of planning and scheduling techniques in the Construction Industry
- Discuss the various methods of time estimates and network techniques in the construction projects
- Evaluate the construction cost, duration and computer applications on network problems related to construction industry

Course outcomes:

- Able to gain the knowledge of project planning, scheduling and design related problems in construction projects.
- Ability to develop the planning and scheduling and control of the projects in the construction industry.
- Able to evaluate the construction cost, duration and quality of the construction projects.
- Apply the computer applications on network related problems to construction industry
- Ability to develop the working knowledge on various network techniques and softwares useful in the construction industry.

CO-PO Articulation matrix

Course outcome	Program outcome					
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	0.3	0.3	0.2	-	0.1	0.1
CO2	0.3	0.2	0.2	-	0.2	0.1
CO3	0.2	0.3	0.3	-	0.1	01
CO4	0.3	0.2	0.3	0.1	0.1	-
CO5	0.2	0.2	0.3	0.1	0.1	0.1

UNIT I

Construction Planning: Historical background and introduction to project planning, bar charts, limitations of bar charts, milestone charts, and work breakdown structure, events and activities numbering of networks, choice of technology and construction methods, PERT and CPM, Estimating Activity duration, Estimating resource requirements for work activities.

UNIT II

Scheduling Procedures and Techniques: Construction schedules, Critical Path Method- Scheduling calculations (time estimates), float, slack, probability of completion time, application of PERT/CPM to construction industry problems.

UNIT III

Cost analysis: Direct cost, indirect costs, and slope of the project activities, optimization of cost and schedule through network contraction – applications in construction industry, crashing and time/ cost tradeoffs, improving the scheduling process.

UNIT IV

Cost Control and Monitoring and Accounting: Cost control in construction projects, importance of cost control and its objectives, the project budget, forecasting for activity cost control, control of project cash flows, schedule control, schedule and budget updates, relating cost and schedule information. Resource analysis - smoothing and leveling of various construction projects.

UNIT V

Precedence Network: Precedence network, advantages of precedence network, logic of precedence network diagram, and computer applications on network problems related to construction industry.

Suggested reading

1. Moder, J.J., Phillips, C.R., and Davis, E.W., "Project Management with CPM and PERT and precedence diagramming." C.B.S. Publishers & Distributors, New Delhi, 1986.
2. Pilcher, R. "Project Cost Control in Construction." Collins, London, 1992
3. Brien. J.J. "CPM in Construction Management." McGraw Hill Book Company Inc.,NY,1971.
4. B.C. Punmia and K.K. Khandelwal., Project Planning and Control with PERT and CPM." Laxmi Publications (P), Ltd, 2008.

CE604 ***With effect from the academic year 2019-20***

QUANTITATIVE METHODS IN CONST. MANAGEMENT

Instruction	:	**3 periods per week**
Duration of Semester End Examination	:	**3 hours**
Semester end Examination	:	**70marks**
Continuous Internal Evaluation	:	**30marks**

Course Objectives:

1. To study the various quantitative methods applied to the elements of management.
2. To gain knowledge of formulation of optimization models using various methods.
3. To understand transportation model utility in construction industry
4. To modify and improve network flow problems to optimize the resourses.
5.To understand the concepts of simulation, decision theory, sequencing and queuing theory.

Course Outcomes:

1. Ability to learn various quantitative method and apply for various construction engineering problems.

2.Ability to form and solve application based Linear Programming problem to optimize the objectives .

3. Able to understand transportation model utility and its application in construction industry

4. Understand modification of network flow problems to optimize the usage of resources.

5. Understand the concept of simulation, decision theory, sequencing and queuing theory.

CO-PO Articulation matrix

Program outcomes	**Course outcomes**					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO1	0.4	0.2	0.3	-	0.1	-
CO2	0.4	0.2	0.3	-	0.1	-
CO3	0.4	0.2	0.3	-	0.1	-
CO4	0.4	0.2	0.3	-	0.1	-
CO5	0.4	0.2	0.3	-	0.1	-

UNIT – I

Introduction: Phases of operation research, models and scope of operation research in construction management

Linear Programming: Introduction, terminology, formulation of LPP, graphical and algebraic methods of solving LPP, standard form and canonical form of linear programming, illustrative examples.

UNIT – II

Linear Programming: Simplex methods, Artificial variable techniques, Dual formulations - illustrative examples, application to construction management.

UNIT – III

Transportation problem, introduction, terminology, formulation of mathematical models, minimization and maximization problems, methods of solution, illustrative examples.

Assignment problem: Introduction, terminology, formulation of mathematical models, solution of assignment problem, illustrative examples.

UNIT – IV

Decision theory - Introduction, types, decision trees, applications.

Simulation - Introduction, advantages, limitations, types, applications.

Network analysis - Modifications and improvements on CPM/PERT

UNIT – V

Sequencing problem - Introduction, concepts, definition, assumptions, types, applications.

Queuing Models- Introduction, structure of queuing system, characteristics, application.

Suggested reading:

1. Adrian, J. "Quantitative Methods in Construction Management." American Elsevier Publishing Co., Inc., Amsterdam, Netherlands, 1973.
2. Moder, J.J., Phillips, C.R., and Davis, E.W., "Project Management with CPM and PERT and precedence diagramming." C.B.S. Publishers & Distributors, New Delhi, 1986.
3. Stark, R.M., and Mayer, J.H. "Quantitative Construction Management." John Wiley and Sons, NY, 1983.

NEURAL FUZZY AND EXPERT SYSTEMS

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
University Examinations	**: 70marks**
Continuous Internal Evaluation	**: 30 marks**

Course Objectives:

- Explain the concepts of neural networks, fuzzy logic, and genetic algorithms.
- Solve problems that are appropriately solved by neural networks, fuzzy logic, and genetic algorithms.
- Understand the structure of expert systems.
- Understand the applications of the Neural Networks, Fuzzy Logic and Genetic Algorithms in construction management

Course Outcomes:

- Learn the applied mathematical concepts and problem-solving approaches to construction management problems
- Understanding the basic concepts and terminology and architecture of Neural networks models
- Ability to understand fuzzy logic concepts to apply for construction management problems
- Carry out intelligent and expert system approaches in solving engineering problems that are appropriate for construction management studies.
- Exposure to Matlab and tools pertaining to artificial neural networks, fuzzy logic using standard methods.

Program outcomes	Course outcomes					
	PO-1	**PO-2**	**PO-3**	**PO-4**	**PO-5**	**PO-6**
CO-1	0.2	0.2	0.2	0.2	-	0.2
CO-2	0.2	0.4	0.2	-	0.1	0.1
CO-3	0.2	0.4	0.2	-	0.1	0.1
CO-4	0.2	0.2	0.2	0.2	-	0.2
CO-5	0.2	0.3	0.2	-	0.2	0.1

UNIT-I

Introduction: Brief introduction to the study of artificial intelligence. An Insight to the concept of natural intelligence followed by the development of artificial neural networks, fuzzy logic systems and expert systems tools. Demonstration of the importance of artificial neural networks, fuzzy logic and expert systems with the help of at least two practical examples civil engineering for each study. Importance of nuero-fuzzy systems

UNIT-II

Neural Networks: Components of artificial neural networks - neurons, inputs, outputs, error, error propagation, hidden layers, threshold logic, weights, bias, noise, momentum, rate of learning, training and testing - Hebb's rule, Delta rule - Supervised learning - Generalized Delta rule - unsupervised learning.

Types of Neural Networks - Percptrons - feed forward back propagation networks - Hop field networks

UNIT-III

Fuzzy sets: Crispness, vagueness, uncertainty, and fuzzy sets. Basic. Definitions and operations of Fuzzy sets, approximate reasoning, and membership function. Fuzzy Relations: Fuzzy relation and fuzzy composition, fuzzy aggregation procedures, Dominance Matrix, Weightages, applications of Fuzzy sets to civil engineering problems, and pattern recognition.

UNIT-IV

Expert systems: Structure of expert systems, Knowledge acquisition, Knowledge organization, methods of representing .Knowledge, types of inference engines, reasoning under uncertainty, various types of expert system tools, heuristics, search mechanism, expert system developmen[1] and hybrid expert systems.

UNIT-V

Exposure to Software Packages: Neural networks (Matlab tool kit) — fuzzy logic — expert systems (L5 object).Applications of Artificial Neural Networks, Fuzzy logic and expert systems in civil engineering — Case studies with at least one problem on each aspect of ANN, FL and Expert systems.

Suggested Readings:

1. Fuzzy Sets, Decision Making, and Expert Systems-, Zimmerman, H. J., Kluwer Academic Publications, Boston, 1987.
2. "Artificial Intelligence and Expert System", Elaine Rich, Juda Pearl, Heuristics.
3. "Expert Systems in Construction and Structural Engineering" Adeli H., Chapman, 1988.
4. "Neural Networks Algorithms, Applications and Programming" Freeman, J.A., and Skapura, D.M. Addition-Wesley, Reading MA, 1991.

CE615 *With effect from the academic year 2019-20*

VALUE ENGINEERING IN CONSTRUCTION

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
Semester end Examination	**: 70marks**
Continuous Internal Evaluation	**: 30marks**

Course Objectives:

- Introduction to basic concepts of value engineering and construction project budgeting
- Analysis of various structures using LCC methodology
- Evaluation of projects based on various management tools

Course Outcomes:

- Acquaintance with the basic concepts of value engineering
- Ability to understand and apply the cost control methodology for various projects
- Knowledge of Life Cycle Cost methodology and its applications
- Comprehensive understanding about the various phases of Job and work plans
- Knack for the application of FAST and Delphi techniques for various projects

CO-PO Articulation Matrix

Course	**Program Outcomes**					
outcome	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
CO1	0.2	0.1	0.2	0.3	0.2	--
CO2	0.1	0.4	0.2	0.1	0.1	--
CO3	0.2	0.3	0.3	0.1	0.1	--
CO4	0.1	0.2	0.2	0.3	0.2	--
CO5	0.1	0.3	0.3	0.2	0.05	--

UNIT - I

Introduction to value engineering (VE), definition, objectives of value engineering, reasons for unnecessary costs, VE techniques and methodology, interface with the other programs.

UNIT - II

Elements of the project budget, need for cost control, meaning of capitalization, capitalization process, and capitalized income approach to construction project budgeting.

UNIT - III

Life cycle cost (LCC) and building costs, LCC technology and examples, LCC methodology, LCC formats and analysis and weighted evaluation – application of LCC to buildings.

UNIT - IV

Value engineering and total project management, level of effort, team selection, value engineering job plan, and work plan phases.

TQM TECHNIQUES IN CONSTRUCTION

Instruction	:	**3 periods per week**
Duration of Semester End Examination	:	**3 hours**
University Examinations	:	**70marks**
Continuous Internal Evaluation	:	**30 marks**

Course Objectives

1) To familiarize with quality management in construction industry.
2) To familiarize with clauses for quality management in construction industry.
3) To understand the leadership and teamwork for total quality management in construction organisation.
4) To understand the production and management and its application to construction industry.
5) To study the senior management and total quality management in construction industry.

Course Outcome

1) Able to adopt new approaches to maintain quality in construction industry.
2) Able to understand the clauses of ISO 9000.
3) Ability to apply tools in leadership and teamwork for total quality management.
4) Able to implement the techniques in construction industry.
5) Ability to handle the changes in construction industry by total quality management.

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.3	-	0.3	0.2	0.2	-
CO2	0.4	-	0.3	-	0.3	-
CO3	0.3	0.2	0.4	-	0.1	-
CO4	0.4	-	0.4	-	0.2	-
CO5	0.3	-	0.1	0.3	0.3	-

UNIT-1

Quality management in construction industry, new approach to quality management, and road to quality management.

UNIT-II

Formal QA, quality assurance, ISO 9000, clauses of ISO 9000, third party assessment for construction works.

UNIT-III

Leadership and total quality management, tools for total quality management, teamwork for total quality management, stages in team development and role within a team.

UNIT-IV

Learning organization, lean production and management applied to construction industry.

UNIT-V

Quality management in the construction industry, research objectives, senior management and total quality management, cultural change in construction.

Suggested reading:

1. Steven McCabe. (1998). “Quality Improvement Techniques in Construction.” LONGMAN.
2. Kwakye, A.A. (1997), “Construction Project Administration”, Adisson Wesley Longman, London.

CE617 *With effect from the academic year 2019-20*

CONSTRUCTION SAFETY MANAGEMENT

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
University Examinations	**: 70marks**
Continuous Internal Evaluation	**: 30 marks**

Course Objectives:

- To study and understand the various safety concepts and requirements applied to construction industry.
- To study the various construction safety problems and safety programs.
- To study the various laws related to safety in construction industry
- To study the importance of workers compensation insurance.

Course outcomes

- Able to know the importance of safety and create safety organization in the conduction projects.
- Able to create and manage an effective safety program and identify hazards using various techniques in a construction company.
- Able to handle equipments and materials with safety precautions
- Will be aware of various laws related to construction safety and able to evaluate workers insurance.
- Understand experience modification rates (EMR) and perform safety analysis in the construction industry.

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.5	0.1	0.1	0.1	0.1	0.1
CO2	0.6	0.1	0.1	0.1	0.1	0.1
CO3	0.5	0.1	0.1	0.1	0.1	0.1
CO4	0.5	0.1	0.1	0.1	0.1	0.1
CO5	0.5	0.1	0.1	0.1	0.1	0.1

UNIT-1

Safety management function, Importance of safety in construction industry, Line versus staff authority, Safety responsibility and accountability in construction industry, Safety organizations, Safety administration.

UNIT-II

Construction safety problems, Hazards in construction projects, Accident: definition, causes, cost, measurement, investigation and prevention of accidents, Legal and financial aspects of accident, Safety Program: Need, Elements of an Effective and safety program, general safety program in construction industry.
Hazard Identifications and Control Techniques – HAZOP, FMEA, FMECA.

UNIT-III

Safety in use of construction equipment - vehicles, cranes, hoists and lifts etc., Safety of scaffolding, ladders, working platforms etc, safety while using electrical appliances, explosives, blasting etc, Fire safety
Causes and safety of accidents on various construction sites, safety measures for storage and handling of building materials.
Safety equipment and gear used on construction site, First aid on site.

UNIT-IV

Laws related to construction industry, Laws related to the Industrial Safety,
Safety Provisions in the Factory Act, Labour laws.
Measurement of Safety Performance, Safety Audit.
Experience modification rating, workers insurance,

UNIT-V

Case based reasoning, case indexing, retrieval, accident prevention and forecasting using CBR method
Systems safety analysis, faulty tree analysis, failure modes and effects analysis in construction industry.

Suggested reading:

1. John V. Grimaldi. (1996). “Safety Management.” AITBS Publishers & Distributors, New Delhi, India.
2. Kwakye, A.A. (1997), “Construction Project Administration”, Adisson Wesley Longman, London.
3. Jimmy W.Hinze, “Construction Safety ", Prentice Hall Inc., 1997.
4. Richard J. Coble, Jimmie Hinze and Theo C. Haupt, “Construction Safety and Health Management ", Prentice Hall Inc., 2001. Internal continuous assessment: 100 marks Internal continuous assessment is in the form of periodical tests, assignm
5. James, J.O Brien, “Construction Inspection Handbook - Quality Assurance and Quality Control ", Van Nostrand, New York, 1989. 14
6. Kwaku A., Tenah and Jose M.Guevera, “Fundamental of Construction Management and Organization ", Prentice Hall of India, 1995.
7. Juran Frank, J.M. and Gryna, F.M. " Quality planning and Analysis ", Tata McGraw Hill, 1982.
8. Hutchins. G., “ISO 9000 ", Viva Books, New Delhi, 1993.
9. Hand book on Construction Safety Practices, SP:70, BIS,2001.
10. Safety Management in Construction Industry- A manual for project managers, NICMAR, Mumbai

HUMAN RESOURSES DEVELOPMENT FOR CONSTRUCTION

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
University Examinations	**: 70marks**
Continuous Internal Evaluation	**: 30 marks**

Course Objections

- To study the human resource management in relation to job analysis, selection, recruitment in construction industry.
- To understand the various concepts of organisation and management theories.
- To study the strategic human resource management approaches and operational human resources management approaches.
- To study the employee relations and the evolution of empowerment within human resource management.
- Educate the students to know about trade unions and management relationships to solve the employee problems in the industry.

Course Outcome

- Able to understand the job analysis, selection, recruitment in construction industry
- Ability to understand and apply the management theories and human behaviour theories.
- Able to understand the human resource approaches and apply in the construction management.
- Able to understand the changing role of trade unions and collective bargaining.
- Ability to solve employee problems and promote industrial counselling.

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.3	-	0.3	0.2	0.2	-
CO2	0.4	-	-	0.4	0.2	-
CO3	0.3	-	0.3	0.2	0.2	-
CO4	0.4	-	-	0.4	0.2	-
CO5	0.4	-	-	0.4	0.2	-

UNIT-I

The Human resource Management an Introduction:- Human resource, Nature and scope of HRM, The human resource in the environment, Human resource activities, Diversity of work and Strategies- Human resource hiring:- Job analysis, selection, recruitment, orientation, placement, socialization- Maintenance and development of the Human Resource: Work motivation and performance, Employee welfare, Compensation, Welfare schemes, Career enlargement and enrichment, Leadership and Effective communication.

UNIT-II

Organization and management theory: Challenges of managing people in construction, Contemporary management Theory, Production efficiency: the Classical Approach, Human Behavior theory, Manager's attitude towards people in construction, Expectations of the employment relationship.

UNIT-III

Strategic HRM approaches and operational HRM approaches: Models of HRM, Employee resourcing, Recruitment & Selection, Case Study Discussion, Training & Development, Appraisal Systems, Reward management, Case Study Discussion, Mentoring, Career in Construction Management.

UNIT-IV

Employee relations and empowerment: Employees relations, The changing role of trade unions, The effect of unions, Collective bargaining, Case Study Discussion, The evolution of empowerment within HRM.

UNIT-V

Work for Analysis:-Trade Unions and Management relationships, Ethical Issues, Employee problems, Industrial Counseling.

Employee empowerment- salient features- diversity and worklife balance.

Employee welfare - strategic Human resource development - employment legislation -legal aspects.

Suggested reading:

1. Langfor D.A. Human Resource management in construction, Longman, 1995.
2. Martin Loosemore, Andrew Dainty, Helen Lingard, Human Resource Management in construction projects: strategic and operational approaches, Taylor and Francis, 2010.

ADVANCED CONCRETE TECHNOLOGY

Instruction : 3 periods per week
Duration of Semester End Examination : 3 hours
University Examinations : 70marks
Continuous Internal Evaluation : 30 marks

Course Objectives:

- Learn the characterization of constituents of concrete.
- Design concrete mix by various methods as per different codes.
- Study the different types of admixtures, mix design, properties and applications of special concretes.

Course Outcomes:

- Learn hydration of cement and tests on properties of cement and aggregates.
- Comprehend the properties and testing of concrete in fresh and hardened state.
- Understand the shrinkage and creep mechanisms, curing and durability of concrete.
- Design concrete mixes by various methods.
- Familiarize with the types of admixtures, and applications of special concretes.

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.6	-	-	-	0.2	0.2
CO2	0.6	-	-	-	0.2	0.2
CO3	0.6	-	-	-	0.2	0.2
CO4	0.6	-	-	-	0.2	0.2
CO5	0.6	-	-	-	0.2	0.2

UNIT - I

Concrete as a composite material; advantages-limitations; Materials science aspects of the properties and behavior of Cement Concrete: physical and chemical aspects of cement hydration, type and morphology of hydrates; Structure of concrete-Transition zone-Micro structural engineering. Modern trends in concrete manufacture and placement techniques-methods of transportation-placing and curing-extreme whether concreting-special concreting methods-vaccum dewatering of concrete-under water concreting.

UNIT – II

Strength of Hardened concrete-NDT; Stress-strain relations; Dimensional stability-shrinkage and creep; Durability of concrete -Durability concept- pore structure and transport processes- reinforcement corrosion-chloride attack-carbonation- fire resistance- frost damage- sulphate attack- alkali aggregate reaction- delayed ettringite formation- methods of providing durable concrete-short-term tests to assess long-term behavior.

UNIT - III

Mix design of concrete –Quality control – Principles of concrete mix design-Various methods of mix design - IS code method - British and ACI methods-Mix design of special concrete- Design of high strength and high performance concrete-Design of pumpable concrete

UNIT – IV

Mineral Admixtures – Hydration of Admixtures - Slags – Pozzolanas and Fillers – Dispersing admixtures-Retarding admixtures-Accelerating admixtures-Air entraining admixtures-Water resisting admixtures-Corrosion inhibiting admixtures-Shrinkage reducing admixtures-Under water admixtures-Sprayed concrete admixtures- Compatibility issues with Chemical Admixtures.

UNIT - V

Special concrete- Fly ash concrete -Silica fume concrete -Fiber reinforced concrete- Sprayed concrete - Geopolymer concrete-Self compacting concrete-Roller compacted concrete- Ferro cement-Recycled aggregate concrete-Slurry Infiltrated Concrete-Mix design-properties and their applications; Engineered cementitious composites

Suggested Reading:

1. A.M. Neville, “Properties of Concrete”, English Language Book Society-Longman Publications, 1988.
2. A.M. Neville & J.J.Brooks, “Concrete Technology”, Pearson Education Limited, 2010.
3. P.K. Mehta and J.M.M. Paulo, “Concrete – Microstructure – Properties and Material”, McGraw-Hill, New York, 1997.
4. Zongji Li “Advanced Concrete Technology”, John Wiley & sons, inc, 2011.
5. John Newman, Ban Seng Choo, “Advanced Concrete Technology”, Elsevier publisher, 2003.
6. Thomas Dyer, “ Concrete Durability”, CRC Press, Taylor & Francis group,2014
7. N. Krishna Raju, “Design of Concrete Mix”, CBS Publications, New Delhi, 1985.

PERSONALITY DEVELOPMENT

Instruction	**: 2 periods per week**
Duration of Semester End Examination	**: 3 hours**
University Examinations	**: 70marks**
Continuous Internal Evaluation	**: 30 marks**

Course Objectives:

- To learn to achieve the highest goal happily.
- To become a person with stable mind, pleasing personality and determination.
- To awaken wisdom among themselves.

Course Outcomes: Upon completing this course, students will be able to:

- Develop their personality and achieve their highest goal of life.
- Lead the nation and mankind to peace and prosperity.
- To practice emotional self regulation.
- Develop a positive approach to work and duties.
- Develop a versatile personality.

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 (dont's) - Verses 71,73,75 & 78 (do's) - Approach to day to day works and duties.

UNIT-III

Introduction to Bhagavadgeetha for Personality Development - Shrimad Bhagawad Geeta: 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 BhagawadGeeta: 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 Bahgavadgeeta 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 Reading:

1.“Srimad Bhagavad Gita” by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata

2. Bhartrihari’s Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi

Web Resource

1. NTPEL:http://nptel.ac.in/downloads/109104115

STRESS MANAGEMENT BY YOGA

Instruction : **2 periods per week**

Course Objectives:

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

Course Outcomes: Upon completing this course, students will be able to:

- To understand yoga and its benefits.
- Enhance Physical strength and flexibility.
- Learn to relax and focus.
- Relieve physical and mental tension through asanas
- Improve work performance and efficiency.

UNIT-I

Meaning and definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga 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 Reading:

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

Online Resources:

1. https://onlinecourses.nptel.ac.in/noc16_ge04/preview
2. https://freevideolectures.com/course/3539/indian-philosophy/11

CONSTITUTION OF INDIA

Course Objectives:

- The history of Indian Constitution and its role in the Indian democracy.
- 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 Indian nationalism.
- Have knowledge of the various Organs of Governance and Local Administration.

Course Outcomes: Upon completing this course, students will be able to:

- Understand the making of the Indian Constitution and its features.
- Understand the Rights of equality, the Right of freedom and the Right to constitutional remedies.
- Have an insight into various Organs of Governance - composition and functions.
- Understand powers and functions of Municipalities, Panchayats and Co-operative Societies.
- Understand Electoral Process, special provisions.

UNIT-I

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

UNIT-II

Contours of Constitutional Rights and 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, Powers and Functions, Union executives : 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, ayor and role of Elected Representative, CEO of Municipal Corporation. Panchayati Raj: Introduction, PRI: Zilla Panchayat, Elected Officials and their roles, CEO Zilla Panchayat: positions 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 Reading:

1. "The Constitution of India", 1950 (Bare Act), Government Publication.
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.

Web Resource:

1. http://www.nptel.ac.in/courses/103107084/Script.pdf

MINI PROJECT

Instruction : 2 periods per week
Duration of Semester End Examination 6 hours
Continuous Internal Evaluation 50 marks

Course Objectives

- To review available literature and formulate construction industry related problems
- To learn the technique of writing reports and prepare presentation

Course Outcomes

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

- Solve complex problems in the field of construction industry by applying appropriate techniques and tools.
- Prepare technical reports and presentations
- Exhibit good communication skill to engineering community and society.
- To publish paper on research work

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.6	0.2	0.2	-	0.1	-
CO2	0.6	-	-	0.4	-	-
CO3	-	-	-	0.6	0.2	0.2
CO4	0.45	0.1	0.1	0.15	0.1	0.1

Each student will be attached to a faculty member who will monitor the progress of the student.

Mini Project will have mid semester presentation and end semester presentation. Mid semester Presentation will include identification of the problem based on the literature review on the topic referring to latest literature available. End semester presentation should be done along with the report on identification of topic for the work and the methodology adopted involving scientific research, collection and analysis of data, determining solutions highlighting individuals' contribution. The student is required to submit a technical writeup, presentation of their study (about 20 minutes) followed by a discussion. The dissertation shall be internally scrutinized by a Viva-Voce committee consisting of the Head of the Department, Chairman Board of Studies, Supervisor and Examiner.

CE653 *With effect from the academic year 2019-20*

Construction Engineering Laboratory-II

Instruction : **3 Periods per week**
Sessional : **50 Marks**

Course Objectives:

- To study the concrete mix design using various codes and evaluate the properties of concrete.
- To evaluate the properties of concrete and correlate them with the non-destructive testing results.
- To evaluate the effect of different parameters on non-destructive testing results.
- Evaluate the crack propagation in a beam under single-point - two-point loading.

Course Outcomes:

- Able to design the concrete mixes using various codes and assess the properties of concrete.
- Competent to correlate the properties of concrete with the non-destructive testing results.
- Able to assess the effect of different parameters on non-destructive testing results.
- Able to estimate the crack propagation and crack patterns in a beam.

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.5	0.3	-	-	0.1	0.1
CO2	0.5	0.3	-	-	0.1	0.1
CO3	0.5	0.3	-	-	0.1	0.1
CO4	0.5	0.3	-	-	0.1	0.1

1. Concrete mix design by BIS, ACI and BS method – proportioning, batching, mixing, moulding of specimens for compression, modulus of elasticity and modulus of rupture – testing of specimens as per relevant codes of practice (comparative study).

2. Development of correlation between Non-Destructive and Destructive tests using Rebound Hammer & UPV instruments.

3.Influence of following parameters on NDT readings – experimental observations.

- Aggregate Cement Ratio
- Cement Ratio
- Excess / Deficient Cement
- Excess / Deficient Water
- Aggregate type.

(Some of the above parameters may be considered depending upon time)

4. Strain and deflection measurement for a structural member under single point / two point loading – crack propagation observation. Measurement and plotting.

CE661 ***With effect from the academic year 2019-20***

Seminar

Instruction **: 3 Periods per week**
Sessional **: 50 Marks**

Course Objectives

- To work on a specific technical topic in Construction Engineering and Management in order to acquire the skills of oral presentation.
- To acquire technical writing abilities for seminars and conferences.

Course Outcomes:

- Detailed literature review and collection of relevant material
- Narrowing the suitable seminar topic
- Framing the objectives
- Prepare technical reports and presentations

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.4	0.15	0.15	0.15	0.1	.05
CO2	0.4	0.15	0.15	0.15	0.1	.05
CO3	0.6	0.15	0.15	-	0.1	-
CO4	0.6	-	-	0.4	-	-

The objective of the seminar is to prepare the student for a systematic and independent study of the state of art topics in his/her specialization. Seminar topics may be chosen by the students with the advice of the faculty members. Each student is required to submit a technical write-up, presentation of their study (about 20 minutes) followed by a discussion. At least two faculty members will be associated with the seminar presentation to evaluate and award marks.

SEMESTER-III

CONSTRUCTION PLANNING EQUIPMENTS AND METHODS

Instruction	:	**3 periods per week**
Duration of Semester End Examination	:	**3 hours**
University Examinations	:	**70marks**
Continuous Internal Evaluation	:	**30marks**

Course Objectives:

- Importance of prefabrication in construction
- Advantages of modular coordination in prefabrication
- Application of different equipments in construction industry

Course Outcomes:

- Evaluate advantages and disadvantages of prefabrication in construction industry
- comprehend different I.S. recommendations for modular planning
- Able to understand the role of hoisting equipments in construction industry
- Able to apply the knowledge of equipment in the manufacturing of concrete.
- Acquire the knowledge of conveying equipments used in construction industry.

Course outcome	Program outcome					
	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.6	-	-	-	0.2	0.2
CO2	0.6	-	-	-	0.2	0.2
CO3	0.6	-	-	-	0.2	0.2
CO4	0.6	-	-	-	0.2	0.2
CO5	0.6	-	-	-	0.2	0.2

UNIT-I

Precast and Prefabricated construction - need for prefabrication, classification and scope. Advantages and disadvantages of prefabrication and design principles of prefabrication system.

UNIT-II

Modular coordination and its importance, I.S. Recommendations for modular planning, standardization, mass production and methods of Transportation.

UNIT-III

Construction equipment- hoisting equipment such as hoist winch, hoisting chains and hooks, slings. Various types of cranes - tower crane, mobile crane, and derrick crane, safety in crane operations, their characteristics performance and applications to building process.

UNIT-IV

Concrete mixers, truck mixers, pneumatic concrete placer and vibrators for concrete, and Scaffolding. Their characteristics performance and applications to building process

UNIT-V

Conveying equipment - package conveyor, screw conveyor, bucket conveyor and different types of belts, their Characteristics, performance and applications.

Suggested Reading:

1. Peurify, R.L.(1996). “Construction, Planning, Equipment and Methods." McGraw-Hill Book Company, Inc, NY
2 Mahesh Varma (1997) “Construction Equipment and its planning & applications." Metropolitan Book Co (P) Ltd, New Delhi, India.
5. U.K. Srivastava (1999). "Construction Planning and Management." Galgotia Publications Pvt., ltd, New Delhi, India

MANAGEMENT INFORMATION SYSTEMS

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
University Examinations	**: 70marks**
Continuous Internal Evaluation	**: 30 marks**

COURSE OBJECTIVES

- To study the importance of management information system in construction industry.
- To study the concepts of information system management and decision making in construction industry.
- Understand the strategic information systems related to construction industry.
- To study the role of information technology in construction industry.
  To study the data base management systems in construction organisations.

COURSE OUTCOME

- The student will be able to know the logical foundation of MIS and managers view of information system.
- Ability to understand the concepts of information system and apply in decision making process in construction industry.
- Ability to apply the strategic uses of information technology in construction industry.
- Able to understand the impact of information technology on individuals and construction organisation.
- Ability to implement file structures and processing methods in construction organisation.

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.3	0.2	0.3	-	0.2	-
CO2	0.3	0.3	0.2	-	0.2	-
CO3	0.3	0.2	0.3	-	0.2	-
CO4	0.3	0.3	-	-	0.4	-
CO5	0.3	-	0.4	-	0.3	-

UNIT-1

Importance of management information systems (MIS), logical foundation of MIS, manger's view of information systems, functions of management, managerial role, activities of a construction organization.

UNIT-II

Management and decision making in construction industry, classification of information systems, and impact of construction work on management information systems.

UNIT-III

Strategic uses of information technology, inter organizational systems, strategic information systems related to construction industry.

UNIT-IV

Information technology, role of information technology in construction industry, impact of information technology on the individuals, impact on the construction organization, and process of reengineering work.

UNIT-V

File structures and processing methods in construction organizations, data base concepts, an data base management systems.

Suggested reading:

1. Robert Schultheis, Mary Sumner. (1999). "Management Information Systems-The Manager's View." Tata McGraw Hill Edition, New Delhi.
2. Kwakye, A.A. (1997), "Construction Project Administration", Adisson Wesley Longman, London.

CE621 *With effect from the academic year 2019-20*

FUNCTIONAL PLANNING AND BUILDING SERVICES

Instruction	:	**3 periods per week**
Duration of Semester End Examination	:	**3 hours**
Semester end Examination	:	**70marks**
Continuous Internal Evaluation	:	**30marks**

Course Objectives:

- Understand functional planning aspects in buildings.
- Understanding of water requirement and distribution aspects in buildings
- Conceptualization of solid waste disposal, fire fighting and codal practices of electrical fixtures in building.

Course Outcomes: The students will be able to

- Able to understand the space requirements of typical buildings like Residential, Office and Hospitals.
- Preparation of layout plan for water distributions and drainages.
- Apply the guidelines for municipal solid waste management
- Prepare schedule for maintenance of various service equipments like Lifts and Electrical devices in buildings.
- Know the concepts of building maintenance

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.5	0.10	-	-	0.2	0.2
CO2	0.6	0.10	0.1	-	0.1	0.1
CO3	0.6	0.10	0.1	-	0.1	0.1
CO4	0.5	0.10	-	-	0.2	0.2
CO5	0.5	0.1	-	0.2	0.1	0.1

UNIT-I

Components of urban forms and their planning, Concepts of neighborhood unit, Functional planning of buildings, Importance of building services, type of services required, planning of services, organization structures of services management, role and administrative functions of supervisors.

Space requirements and relationship for typical buildings like residential, offices hospitals etc.

UNIT-II

Plumbing & Water supply system: Basics of plumbing systems, requirement of plumbing works, activity flowchart for plumbing work, Quality, checking of materials, water requirements for different types of buildings, simple method of removal of impurities, water saving practices and their potential, rainwater harvesting , type of spouts, sizes of rainwater pipes, typical detail of a water harvesting pit.

Water supply and distribution system is high-rise building, pumps and pumping mechanisms, Operation & maintenance of fittings & fixtures of water supply & sanitary. Do’s & Don’ts for water pipe.

UNIT-III

Solid Waste disposal : Approaches for solid waste management, Solid wastes collection and removal from buildings, On-site processing and disposal methods, guidelines for municipal solid waste management, e-waste management

Disposal of Wastes : Sanitary land filling, composting, Vermi-compost, Incineration, Pyrolysis Treatment system, Root zone treatment system, Decentralized Wastewater Treatment Systems (DEWATS), Soil Bio technology, packaged Bio-Reactor

UNIT-IV

Fire fighting : Basic requirement and various components of the fire fighting system. maintenance, fire fighting in high-rise buildings, commercial/industrial complexes, public buildings, checklist for fire safety.

Lifts/Elevators, Escalators: Legal formalities for elevators, various types of lifts, working mechanisms of lift and escalators. Indian standard codes for planning & installations of elevator, inspection & maintenance of lifts.

UNIT V

Telecommunication network, computer network LAN, electrical network, basics of single phase & three phase electrification, precautions and safety measures, IS codes for electrical appliances & wiring operations & maintenance of network & appliances.

Air-Conditioning and Heating: Flowcharts, Centralized systems, monitoring and working of the equipments, checklist of inspection, performance tests.

Building maintenance: Scheduled and contingency maintenance planning, M.T.S. for building maintenance, maintenance standards, Economic maintenance decisions, applications of computer in service management

Suggested Readings:

1. Building Technology IVOR H. Seeley, Mac Millian.
2. Building Finishes, fittings and domestic service Chudley, longman, Scientific and Technical.
3. Fred Hall,Building Services & Equipment ,Longman Scientific and Technical.
4. Lee Smith, Harry Slecter, Plumbing Technology, Design and installation, Delmar Publisher INC.
5. Fred Hall, Plumbing Cold water supplies, Drainage and Sanitation, Longman Scientific & Technical.
6. Roger Greeno, Building Services, Technology and Design, Longman.
7. Norbert Lechner, Heating Cooling, Lighting John Wiley & Sons.
8. Maintenance of Buildings A.C. Panchadari, New age international (P) limited Publishers.

CE622 *With effect from the academic year 2019-20*

TIMBER AND FORMWORK DESIGN

Instruction	:	**3 periods per week**
Duration of Semester End Examination	:	**3 hours**
Semester end Examination	:	**70marks**
Continuous Internal Evaluation	:	**30marks**

Course objectives

- To study and understand the overall and detailed planning of formwork.
- To understand the Design and erection of forms for various elements such as slabs, beams, columns, walls.
- To know the latest methods of form construction.

Course outcomes

- Able to understand the material used in form work and false work system
- Acquire the knowledge to design decking, form work and false work.
- Understand the sequence of construction of civil engineering structures.
- Understand the safety steps involved in the design of form work and false work.
- Know the detailed planning of framework, design of forms and erection of form work.

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.6	-	-	-	0.2	0.2
CO2	0.45	0.2	0.15	-	0.1	0.1
CO3	0.6	-	-	-	0.2	0.2
CO4	0.6	-	-	-	0.2	0.2
CO5	0.45	0.2	0.15	-	0.1	0.1

UNIT-I

Introduction: Formwork and false work - Temporary work systems, construction planning and site constraints, Materials and construction of the common formwork and false work systems, Special and proprietary forms.

UNIT-II

Formwork – Design: Concrete pressure on forms, Design of timber and steel forms, Loading and moment of formwork.

UNIT-III

Design of Decks and False works: Types of beam, decking and column formwork, Design of decking, Design of formwork for walls, False work design, Effects of wind load

UNIT-IV

Foundation and soil on false work design; Design of formwork for shear wall

UNIT-V

Special forms: The use and applications of special forms; Sequence of construction; Safety use of formwork and false work. Timber Fasteners – nails, screws, bolts

Suggested Readings:

1. Austin, C.K., Formwork for Concrete, Cleaver, Hume Press Ltd., London, 1996.
2. Michael P. Hurst, Construction Press, London and NewYork, 2003.

ENVIRONMENTAL IMPACT ASSESSMENT

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3hours**
CIE	**: 30 marks**
SEE	**: 70 marks**
Credits	**: 3**

Course Objectives:

- Introduction of EIA concepts and methodologies.
- Importance of data collection of EIA assessment.
- Preparation of EIA reports and discussion about various environmental impact Laws pertaining to India.

Course Outcomes

- Knowledge to assess environmental Inventory and principles.
- Understanding legislative acts to contribute towards clean environment
- Applying the legislation acts of EIA in designs.
- Understanding various characteristics of municipal solid waste.
- Design of an efficient municipal solid waste management system

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.4	-	-	-	0.2	0.4
CO2	0.4	-	-	0.1	0.1	0.4
CO3	0.4	-	-	0.1	0.1	0.4
CO4	0.4	-	-	0.1	0.15	0.35
CO5	0.4	-	-	0.1	0.15	0.35

UNIT I

Enviornmental Impact Assessment: Definition, basic concepts and principles of EIA. Regulatory frame work in India. Enviornmental inventory, base line studies, over view of EIA studies.

UNIT II

Assessment and Methodologies: Physical, biological assessment, Socio economic and cultural enviornmental assessment, EIA methodologies–Adhoc, matrix, checklist approaches. Economic evaluation of impacts-cot benefits of EIA, Public participation in enviornmental decision making. Procedures for reviewing EIA analysis and statement.

UNIT III

Enviornmental Assessment: Introduction, process, Basic steps involved, Description of enviornmental setting – Base line data collection, possible impacts due to water resources projects. Impact prediction and assessment – methods of impact assessment, Matrix and check list method, Selection of proposed action. Preparation of enviornmental impact statement.

UNIT IV

Environmental Legislation and Regulations: Rationale, concerns, legislative data systems, safe drinking water act, clean water act, clean air act, noise control act, resource conservation and recovery act, comprehensive environmental response, compensation and liability act.

UNIT V

Municipal Solid Wastes: Characteristics, generation, collection and transportation of solid wastes, engineered systems for solid waste management (reuse/recycle, energy recovery, treatment and disposal).

References:

1. Canter, L.W. (1996), 'Environmental Impact Assessment', McGraw-Hill Book Company, New York.
2. Corbitt Robert A. (1999), Standard Hand Book of Environmental Engineering' McGraw-Hill Book Company, New York.

3. Marriott ( ), 'Environmental Impact Assessment: A Practical Guide', McGraw-Hill Book Company, New York.
4. Sabins F.F. Jr.(1978), 'Remote Sensing Principles and Interpretations' W.H. Freeman and Company, San Francisco
5. Jensen John R. (1986), 'Introductory Digital Image Processing', Prentice-Hall of India New York

COST MANAGEMENT OF ENGINEERING PROJECTS

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
Semester end Examination	**: 70marks**
Continuous Internal Evaluation	**: 30marks**

Objectives

- Introduce the concepts of cost management, inventory valuation , decision making
- Fundamentals of cost overruns, project execution and technical activities
- Introduce the concepts of Quantitative techniques for cost management, Linear Programming, PERT/CPM

Outcomes

- Understanding of strategic cost management process, control of cost and decision making based on the cost of the project.
- Ability to appreciative detailed engineering activities of the project and execution of projects
- Preparation of project report and network diagram
- Able to plan Cost Behavior , Profit Planning , Enterprise Resource Planning, Total Quality Management.
- Applications of various quantitative techniques for cost management.

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 centres, various stages of project execution: conception to commissioning- Project execution as conglomeration of technical and non- technical activities- Detailed Engineering activities.

UNIT III

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 and process

UNIT IV

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- 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 Reading::

1.Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi

2.Charles T. Horngren and George Foster, Advanced Management Accounting

3.Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting

4.Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher

5.N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

CE902 *With effect from the academic year 2019-20*

OPERATION RESEARCH

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
Semester end Examination	**: 70marks**
Continuous Internal Evaluation	**: 30marks**

Objectives

- Introduce the concepts of optimization techniques
- Formulation of LPP models
- Basic concepts of Non-linear programming, Dynamic programming, Game theory are introduced.

Course Outcomes

- Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.
- Students should able to apply the concept of non-linear programming
- Students should able to carry out sensitivity analysis
- Student should able to model the real world problem and simulate it.
- Student should able to apply graph theory, competitive models, and game theory simulations

Unit 1:

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

Unit 2

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

Unit 3:

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT

Unit 4

Scheduling and sequencing - single server and multiple server models deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

Unit 5

Competitive Models, Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

Suggested Reading::

1.H.A. Taha, Operations Research, An Introduction, PHI, 2008

2.H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.

3.J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008

4.Hitler Libermann Operations Research: McGraw Hill Pub. 2009

5.Pannerselvam, Operations Research: Prentice Hall of India 2010

6.Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

INDUSTRIAL SAFETY

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
Semester end Examination	**: 70marks**
Continuous Internal Evaluation	**: 30marks**

Course Objectives:

- Causes for industrial accidents and preventive steps to be taken.
- Fundamental concepts of Maintenance Engineering.
- About wear and corrosion along with preventive steps to be taken
- The basic concepts and importance of fault tracing.
- The steps involved in carrying out periodic and preventive maintenance of various equipments used in industry

Course Outcomes: Upon completing this course, students will be able to:

- Identify the causes for industrial accidents and suggest preventive measures.
- Identify the basic tools and requirements of different maintenance procedures.
- Apply different techniques to reduce and prevent Wear and corrosion in Industry.
- Identify different types of faults present in various equipments like machine tools, IC Engines, boilers etc.
- Apply periodic and preventive maintenance techniques as required for industrial equipments like motors, pumps and air compressors and machine tools etc

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 color codes, Fire prevention and firefighting, 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 of Screw down grease cup, Pressure grease gun, Splash lubrication, Gravity lubrication, Wick feed lubrication, Side feed lubrication, Ring lubrication, Definition of corrosion, 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, any one machine tool, Pump, Air compressor, Internal combustion engine, Boiler, 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 Machine tools, Pumps, Air compressors, Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

Text Books:

1. H. P. Garg, "Maintenance Engineering", S. Chand and Company
2. Audels, "Pump-hydraulic Compressors", Mcgraw Hill Publication

Suggested Reading:

1. Higgins & Morrow, "Maintenance Engineering Handbook", Da Information Services.
2. Winterkorn, Hans, "Foundation Engineering Handbook", Chapman & Hall London

BUSINESS ANALYTICS

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
Semester end Examination	**: 70marks**
Continuous Internal Evaluation	**: 30marks**

Course Objectives:

- Understanding the basic concepts of business analytics and applications
- Study various business analytics methods including predictive, prescriptive and prescriptive analytics
- Prepare the students to model business data using various data mining, decision making methods

Course Outcomes: Upon completing this course, students will be able to:

- To understand the basic concepts of business analytics
- Identify the application of business analytics and use tools to analyze business data
- Become familiar with various metrics, measures used in business analytics
- Illustrate various descriptive, predictive and prescriptive methods and techniques
- Model the business data using various business analytical methods and techniques

UNIT-I

Introduction to Business Analytics: Introduction to Business Analytics, need and science of data driven (DD) decision making, Descriptive, predictive, prescriptive analytics and techniques, Big data analytics, Web and Social media analytics, Machine Learning algorithms, framework for decision making, challenges in DD decision making and future.

UNIT-II

Descriptive Analytics: Introduction, data types and scales, types of measurement scales, population and samples, measures of central tendency, percentile, decile and quadrille, measures of variation, measures of shape-skewness, data visualization

UNIT-III

Forecasting Techniques: Introduction, time-series data and components, forecasting accuracy, moving average method, single exponential smoothing, Holt's method, Holt-Winter model, Croston's forecasting method, regression model for forecasting, Auto regression models, auto-regressive moving process, ARIMA, Theil's coefficient

UNIT-IV

Decision Trees: CHAID, Classification and Regression tree, splitting criteria, Ensemble and method and random forest. **Clustering**: Distance and similarity measures used in clustering, Clustering algorithms, K-Means and Hierarchical algorithms, **Prescriptive Analytics-** Linear Programming(LP) and LP model building,

UNIT-V

Six Sigma: Introduction, introduction, origin, 3-Sigma Vs Six-Sigma process, cost of poor quality, sigma score, industry applications, six sigma measures, DPMO, yield, sigma score, DMAIC methodology, Six Sigma toolbox

Text Books:

1. U Dinesh Kumar, "Data Analytics", Wiley Publications, 1st Edition, 2017
2. Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, "Business analytics Principles, Concepts, and Applications with SAS", Associate Publishers, 2015

Suggested Reading:

1. S. Christian Albright, Wayne L. Winston, "Business Analytics - Data Analysis and Decision Making", 5th Edition, Cengage, 2015

Web Resources:

1. https://onlinecourses.nptel.ac.in/noc18-mg11/preview
2. https://nptel.ac.in/courses/110105089/

CE905 *With effect from the academic year 2019-20*

WASTE TO ENERGY

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
Semester end Examination	**: 70marks**
Continuous Internal Evaluation	**: 30marks**

Course objectives:

- To know the various forms of waste
- To understand the processes of Biomass Pyrolysis.
- To learn the technique of Biomass Combustion.

Course outcomes: Upon completing this course, students will be able to:

- Understand the concept of conservation of waste
- Identify the different forms of wastage
- Chose the best way for conservation to produce energy from waste
- Explore the ways and means of combustion of biomass
- Develop a healthy environment for the mankind

UNIT-I:

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT-II:

Biomass Pyrolysis: Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT-III:

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-IV:

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 biomass combustors.

UNIT-V:

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 - biochemical conversion anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass Bio diesel production - Urban waste to energy conversion - Biomass energy programme in India.

Suggested Reading::

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. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.

OE906 *With effect from the academic year 2019-20*

INTELLECTUAL PROPERTY RIGHTS

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
Semester end Examination	**: 70marks**
Continuous Internal Evaluation	**: 30marks**

Objectives

- Acquaint the students with basics of intellectual property rights with special reference to Indian Laws and its practices.
- Compare and contrast the different forms of intellectual property protection in terms of their key differences and similarities.
- Provide an overview of the statutory, procedural, and case law underlining these processes and their interplay with litigation.

Outcomes

- Skill to understand the concept of intellectual property rights.
- Develop proficiency in trademarks and acquisition of trade mark rights
- Skill of acquiring the copy rights , ownership rights and transfer
- Able to protect trade secrets, liability for misappropriations of trade secrets
- Ability to apply the patents and demonstration of case studies

UNIT I:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT – II

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

UNIT – III

Law of copy rights : Fundamental of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law. Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer

UNIT – IV

Trade Secrets: Trade secrete law, determination of trade secrete status, liability for misappropriations of trade secrets, protection for submission, trade secrete litigation. Unfair competition: Misappropriation right of publicity, false advertising.

UNIT V

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Suggested Reading

- Halbert, "*Resisting Intellectual Property*", Taylor & Francis Ltd, 2007.
- Mayall, "*Industrial Design*", McGraw Hill, 1992.
- Niebel, "*Product Design*", McGraw Hill, 1974.
- Asimov, "*Introduction to Design*", Prentice Hall, 1962.
- Robert P. Merges, Peter S. Menell, Mark A. Lemley, " *Intellectual Property in New Technological Age*", 2016.
- T. Ramappa, *"Intellectual Property Rights Under WTO*", S. Chand, 2008.

COMPOSITE MATERIALS

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3 hours**
Semester end Examination	**: 70marks**
Continuous Internal Evaluation	**: 30marks**

Course Objectives

- Study the concepts of composite construction.
- Learn analysis and designs of composite beams, floors, columns and trusses as per the recommendations of IS codes of practice.
- Apply the concepts for design of multi-storey composite buildings.
- Scope of analysis is restricted to skeletal structures subjected to prescribed dynamic loads.

Course Outcomes

- Understand the fundamentals of composite construction, and analysis and designs of composite beams.
- Analyse and design the composite floors
- Select suitable materials for composite columns,
- Analyse composite trusses and understand connection details.
- Analyse and design the multi-storey composite buildings

UNIT-I

Introduction of composite constructions: Benefits of composite construction - Introduction to IS - BS and Euro codal provisions.

Composite beams: Elastic behaviour of composite beams - No and full interaction cases - Shear connectors - Ultimate load behaviour - Serviceability limits - Effective breadth of flange - Interaction between shear and moment - Basic design consideration and design of composite beams.

UNIT-II

Composite floors: Structural elements - Profiled sheet decking - Bending resistance - Shear resistance - Serviceability criterion - Analysis for internal forces and moments - Design of composite floors.

UNIT-III

Composite columns: Materials - Concrete filled circular tubular sections - Non-dimensional slenderness - Local buckling of steel sections - Effective elastic flexural stiffness - Resistance of members to axial compressions - Composite column design - Fire resistance.

UNIT-IV

Composite trusses: Design of truss - Configuration - Truss members - Analysis and design of composite trusses and connection details.

UNIT-V

Design of multi-storey composite buildings: Design basis - Load calculations - Design of composite slabs with profile decks - Composite beam design - Design for compression members - Vertical cross bracings - Design of foundation.

Suggested Reading:

1. R.P. Johnson, “Composite Structures of Steel and Concrete - Beams, Slabs, Columns and Frames in Buildings”, Blackwell Publishing, Malden, USA, 2004.
2. “INSDAG Teaching Resources for Structural Steel Design”, Vol-2, Institute for Steel Development and Growth Publishers, Calcutta, India.
3. “INSDAG Handbook on Composite Construction – Multi-Storey Buildings”, Institute for Steel Development and Growth Publishers, Calcutta, India.
4. “INSDAG Design of Composite Truss for Building”, Institute for Steel Development and Growth Publishers, Calcutta, India.
5. “INSDAG Handbook on Composite Construction – Bridges and Flyovers”, Institute for Steel Development and Growth Publishers,

Calcutta, India.
6. IS: 11384-1985, “Code of Practice for Composite Construction in Structural Steel and Concrete”, Bureau of Indian Standards, New Delhi, 1985.

CE908 **With effect from the academic year 2019-20**

GEOSPATIAL TECHNOLOGY

Instruction	**: 3 periods per week**
Duration of Semester End Examination	**: 3hours**
CIE	**: 30 marks**
SEE	**: 70 marks**

Course Objectives:

- Understand the various spatial and non-spatial data types, and data base management techniques
- Develop the concepts and professional skills in utility of geospatial techniques
- Improve the working knowledge of geospatial techniques in field problems

Course Outcomes:

At the end of the course the student will be able to:

- Understand the geospatial technology relating to the data acquiring and processing that is associated with geographic locations
- Apply Geospatial techniques in the decision support systems useful for decision makers and community services.
- Ability to solve the problems related to the natural resource management, environment, urban planning and Infrastructure development, etc.
- Able to generate the thematic maps using Geospatial techniques
- Apply the concept of Geospatial Techniques to the Civil Engineering problems

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	-	0.2	0.4	0.2	0.1	0.1
CO2	0.2	0.3	0.3	0.1	0.1	-
CO3	0.3	0.2	0.2	0.1	0.1	0.1
CO4	0.2	0.2	0.2	0.2	0.1	0.1
CO5	0.1	0.2	0.3	0.2	0.1	0.1

UNIT –I

Introduction **-** Basic concepts, socioeconomic challenges, fundamentals of geographical information systems (GIS), history of geographical information system, components of geographical information systems.

Projections and Coordinate Systems - Map definitions, representations of point, line, polygon, common coordinate system, geographic coordinate system, map projections, transformations, map analysis.

UNIT –II

Data Acquisition and Data Management **-** data types, spatial, non spatial (attribute) data, data structure and database management, data format, vector and raster data representation, object structural model filters and files data in computer, key board entry, manual digitizing, scanner, aerial photographic data, remotely sensed data, digital data, cartographic database, digital elevation data, data compression, data storage and maintenance, data quality and standards, precision, accuracy, error and data uncertainty.

Data Processing **-** Geometric errors and corrections, types of systematic and non systematic errors, radiometric errors and corrections, internal and external errors.

UNIT –III

Data Modeling - Spatial data analysis, data retrieval query, simple analysis, recode overlay, vector data model, raster data model, digital elevation model, cost and path analysis, knowledge based system.

GIS Analysis and Functions - Organizing data for analysis, analysis function, maintenance and analysis of spatial data, buffer analysis, overlay analysis, transformations, conflation, edge matching and editing, maintenance and analysis of spatial and non spatial data.

UNIT –IV

Applications of GIS - Environmental and natural resource management, soil and water resources, agriculture, land use planning, geology and municipal applications, urban planning and project management, GIS for decision making under uncertainty, software scenario functions, standard GIS packages, introduction to Global Positioning Systems (GPS) and its applications.

UNIT – V

Introduction to Remote Sensing - General background of remote sensing technology, objectives and limitations of remote sensing, electro-magnetic radiation, characteristics, interaction with earth surface and atmosphere, remote sensing platforms and sensors, satellite characteristics, digital image processing, IRS series and high resolution satellites, software scenario functions, remote sensing applications to watershed modeling, environmental modeling, urban planning and management.

References:

1. Burrough, P. A., and McDonnell R. A. (1998). *Principles of Geographical Information Systems.* Oxford University Press, New York, Pp.333.
2. Choudhury S., Chakrabarti, D., and Choudhury S. (2009). *An Introduction to Geographic Information Technology.* I.K. International Publishing House (P) Ltd, New Delhi, Pp.276.
3. Kang-tsung Chang. (2006). *Introduction to Geographical information Systems.* Tata McGraw-Hill Publishing Company Ltd., Third Edition, New Delhi, Pp.432.
4. Lilysand T.M., and Kiefer R.W. (2002). *Remote Sensing and Image Interpretation*. John Wiley and Sons, Fourth Edition, New York, Pp.724.
5. Sabins F.F. Jr. (1978). *Remote Sensing Principles and Interpretations.* W.H. Freeman and Company, San Francisco, Pp. 426.
6. Tor Bernhardsen. (2002). *Geographical Information System.* Wiley India (P) Ltd., Third Edition, New Delhi, Pp. 428.
7. Hoffman-Wellenhof, B, et al. (1997). *GPS Theory and Practice.* Fourth Edition, Springer Wein, New York.

MAJOR PROJECT PHASE-I

Instruction	**: 6 periods per week**
CIE	**: 20 marks**
SEE	**: 100 marks**
Credits	**: 10**

Course Objectives:
- Define the statement of research problem.
- Update the literature in chosen area of research and establish scope of work.
- Develop the study methodology
- Carryout basic theoretical study/experiment.

Course Outcomes:
- Detailed literature review and collection of relevant material
- Narrowing the suitable dissertation topic
- Framing the objectives
- Prepare technical reports and presentations

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.4	0.15	0.15	0.15	0.1	.05
CO2	0.4	0.15	0.15	0.15	0.1	.05
CO3	0.6	0.15	0.15	-	0.1	-
CO4	0.6	-	-	0.4	-	-

Each student will be attached to a faculty member who will monitor the progress of the work. The student will carry out the project which may be development of Software / Hardware / Simulation studies / Design analysis / Experimental related to his/her specialization. The work will be monitored regularly by the guide. At the end of the semester the student is required to submit a technical write-up, presentation of their study (about 20 minutes) followed by a discussion . At least two faculty members will be associated with the seminar presentation to evaluate and award marks. The sessional marks will be awarded jointly by these examiners based on the report, presentation and viva voice

SEMESTER-IV

With effect from the academic year 2019-20

MAJOR PROJECT PHASE-II

Instruction	:	**32 Periods per week**
University Examination	:	**Viva Voice**
Marks	:	**200**

Course Objectives:

- Expand on the defined research problem in dissertation.
- Conduct laboratory/analytical studies.
- Analyse data, develop models, offer solutions and give conclusions.

Course Outcomes

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

- Solve complex problems by applying appropriate techniques and tools.
- Prepare technical reports and presentations
- Exhibit good communication skill to engineering community and society.
- To publish paper on research work

CO-PO Articulation matrix

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6
CO1	0.6	0.2	0.2	-	0.1	-
CO2	0.6	-	-	0.4	-	-
CO3	-	-	-	0.6	0.2	0.2
CO4	0.45	0.1	0.1	0.15	0.1	0.1

Each student will be attached to a faculty member who will monitor the progress of the student. The student will carry out the project which may be development of Software / Hardware / Simulation studies / Design analysis / Experimental related to his/her specialization. The work will be monitored regularly by the guide. The student is required to submit a technical writeup, presentation of their study (about 20 minutes) followed by a discussion. The dissertation shall be internally scrutinized by a Viva-Voce committee consisting of the Head of the Department, Chairman Board of Studies, Supervisor and Examiner. The final marks will be allotted based on the report, presentation and viva voce conducted by the external examiner whose name is suggested by Chairman BOS.

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 Structural Engineering

(With effect from the academic year 2019– 2020)
(As approved in the faculty meeting held on25-06-2019)

Issued by

Dean, Faculty of Engineering

Osmania University, Hyderabad – 500 007

2019

SCHEME OF INSTRUCTION & EXAMINATION
M.E. (Civil Engineering) – I Semester
Specialization in Structural 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	-
Practical/ Laboratory Courses										
7	Lab	Laboratory – I	-	-	2	2	50	-	3	1
8	PC 1154 SE	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 Structural 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	-	4	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	-
Practical/ Laboratory Courses										
6	Lab	Laboratory – II	-	-	2	2	50	-	3	1
7	Lab	Laboratory – III	-	-	2	2	50	-	3	1
8	PC 1155 SE	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 StructuralEngineering

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 1156 SE	Major Project Phase – I	-	-	20	20	100	-	3	10
		Total	**06**	**-**	**20**	**26**	**160**	**140**		**16**

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

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 1157 SE	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.E. (SE) 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 subjects of Professional Core

S. No.	Course Code	Course Title
1	PC 1101 SE	Advanced Structural Analysis
2	PC 1102 SE	Advanced Solid Mechanics
3	PC 1103 SE	FEM in Structural Engineering
4	PC 1104 SE	Structural Dynamics

List of subjects of Professional Electives I to V

S. No.	Course Code	Course Title
1	PE 1116 SE	Theory of Plates
2	PE 1117 SE	Advanced Reinforced Concrete Design
3	PE 1118 SE	Theory of Structural Stability
4	PE 1119 SE	Advanced Steel Design
5	PE 1120 SE	Structural Health Monitoring
6	PE 1121 SE	Retrofitting and Rehabilitation of Structures
7	PE 1122 SE	Earthquake Resistant Design of Structures
8	PE 1123 SE	Bridge Engineering
9	PE 1124 SE	Composite Construction
10	PE 1125 SE	Advanced Concrete Technology
11	PE 1126 SE	Design of High Rise Structures
12	PE 1127 SE	Design of Prestressed Concrete Structures
13	PE 1128 SE	Theory of Shells and Folded Plates
14	PE 1129 SE	Structural Optimization
15	PE 1130 SE	Fracture Mechanism in Concrete Structures

List of Mandatory Courses

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

List of Open Electives

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 subjects 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 subjects of Audit Course-II

S. No.	Course Code	Course Title
1	AD 9011 HS	Constitution of India and Fundamental Rights
2	AD 9012 HS	Pedagogy Studies
3	AD 9013 HS	Stress Management by Yoga
4	AD 9014 HS	Personality Development through life Enlightenment Skills

List of Laboratory Courses

S. No.	Course Code	Course Title
1	PC 1151 SE	Structural Design Lab
2	PC 1152 SE	Advanced Concrete Lab
3	PC 1153 SE	Virtual Smart Structures and Dynamics Lab

Course Code	Course Title						Core/Elective
PC 1101 SE	**Advanced Structural Analysis**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives

- Understand the concepts of matrix methods of analysis and equip them with the knowledge to independently handle the problems of structuralanalysis.
- Enhance the competency level in analysis of continuous beam, portal frames, pin jointed structures by flexibility and stiffness matrixmethods.
- Understand the formation of global stiffness matrix from local stiffness matrix and equation solving techniques using direct stiffnessmethod.
- Gain an insight into the nonlinear analysis ofstructures.
- Learn the concepts of beams on elasticfoundation.

Course Outcomes

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

1. Analyse the continuous beams, rigid jointed frames and pin jointed structures by stiffnessmethod.
2. Analyse the continuous beams, rigid jointed frames and pin jointed structures by flexibility method.
3. Formulate the element and global stiffness matrices by direct stiffness method and learn equation solutiontechniques.
4. Understand and differentiate between the linear and nonlinearanalyses.
5. Solve the problems pertaining to beams on elasticfoundation.

UNIT-I

Introduction to Matrix Methods of Analysis: Static indeterminacy and kinematic indeterminacy, Coordinate systems, displacement and force transformation matrices, element and structure stiffness matrices, equivalent joint loads and fixed endforces.

Stiffness Method: Stiffness of prismatic member, Analysis of bar element, plane truss, continuous beams, plane frames and grid frames, also dealing with effect of settlements, internal hinges and guided fixed end supports.

UNIT-II

Flexibility Method: Flexibility of prismatic member, Analysis of bar element, plane truss, continuous beams, plane frames and grid frames, also dealing with effect of settlements, internal hinges and guided fixed endsupports.

UNIT-III

Direct Stiffness Method: Assemblage of global stiffness matrix, Analysis of plane truss, continuous beams, plane frame and grid frames, also dealing with effect of settlements, internal hinges and guided fixed end supports.

UNIT-IV

Introduction to Nonlinear Analysis: Geometric and material nonlinearity, P-Δ effect, Effects of axial force on flexural stiffness – buckling of ideal columns, buckling behaviour of real columns, flexural behaviour of beam columns, flexural stiffness measures for braced prismatic beam columns, effect of axial tension, flexural stiffness measures for unbraced prismatic beam columns. Slope-deflection method of analysis – slope deflection equations for prismatic beam-columns, fixed end moments inbeam-columns.

Matrix method of Analysis – Stiffness matrix for prismatic beam column elements, estimation of critical elastic buckling loads, second order analysis.

UNIT-V

Beams on Elastic Foundations: Introduction-Modulus of foundation & Basic equation. Beams of infinite length under concentrated & uniformly distributed loads, Analysis of semi-infinite beams making use of functions for infinite beams.

Suggested Readings:

1. Advanced Structural Analysis by Ashok.K. Jain, New Channel Brothers.
2. Devdas Menon, “Advanced Structural Analysis", Narosa Publishing House,2009.
3. Asslam Kassimali, “Matrix Analysis of Structures", Brooks/Cole Publishing Co., USA,1999.
4. Amin Ghali, Adam M Neville and Tom G Brown, “Structural Analysis: A Unified Classical and Matrix Approach", Sixth Edition, 2007, Chapman &Hall.
5. William Weaver, Jr &James M. Gere, Matrix Analysis of Framed Structures, CBS Publishers & Distributors, Delhi. 2. Wang C.K., Matrix methods of Structural Analysis McGraw Hill book Company, New Delhi.3.
6. Advanced mechanics of solids & structures, N. Krishna Raju, D.R Gururaja Narosa publishing house NewDelhi.
7. Advanced Mechanics of Materials, Seely and Smith

Course Code	Course Title						Core/Elective
PC 1102 SE	**Advanced Solid Mechanics**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives

- Understand the concepts of elasticity and equip them with the knowledge to independently handle the problems ofelasticity.
- Enhance the competency level and develop the self-confidence through quality assignments in theory ofelasticity.
- Inculcate the habit of researching and practicing in the field ofelasticity.

Course Outcomes

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

1. Solve the problems of 3-D elasticity withconfidence.
2. Work independently with the problems of 2-D elasticity in Cartesian/polarcoordinates.
3. Familiarize with the use of Airy's stress function in 2-D problems of elasticity in Cartesian/polar coordinates.
4. Equip with the knowledge of various theories of torsion of prismatic bars of various cross sections and can solve the problems oftorsion.
5. Interpret and apply the theory of elasticity to practical problems of structuralengineering.

UNIT – I

Introduction: Definition and notation for forces and stresses, components of stress and strain, Generalized Hooke's law, Stress-strain relations in three directions, Plane stress and plane strain, Equations of equilibrium and compatibility in two and three dimensions, Stress components on an oblique plane, Transformation of stress components under change of co-ordinatesystem.

UNIT – II

Principal stresses and principal planes: Stress invariants, Mean and Deviator stress, Strain energy per unit volume, Distortion strain energy per unit volume, Octahedral shear stress, Strain of a line element. Principal strains, Strain invariants, Volume strain, Principle of superposition, reciprocal theorem.

UNIT – III

Two dimensional problems in Cartesian co-ordinates: Solution by polynomials, St. Venant's Principle, Uniqueness of solution, Stress components in terms of Airy's stress function. Applications to Cantilever, simply supported and fixed beams with simple loading.

UNIT – IV

Two dimensional problems in Polar co-ordinates: Stress-strain components, Equilibrium equations, Compatibility equations, Applications using Airy's strain functions in polar co-ordinates for stress distributions symmetric about an axis, Effect of hole on stress distribution in a plate in tension, Stress due to load at a point on a semi-infinite straight boundary, Stresses in a circular disc under diametrical loading.

UNIT – V

Torsion: Torsion of various shapes of bars, Stress function method of solution applied to circular and elliptical bars, Torsion of rectangular bars, Solution of Torsional problems by energy method, use of soap films in solving torsion problems, Prandtl's membrane analogy. Solution of torsion of rectangular bars by
(i) Raleigh Ritz method and (ii) Finite differencemethod.

Suggested Readings:

1. Theory of Elasticity, S. Timoshenko & N. Goodier, Mc GrawHill.
2. Theory of Elasticity, Valiappan, McGrawHill.
3. Theory of Elasticity, Sadhu Singh, Khannapublishers

Course Code	Course Title						Core/Elective
PC 1103 SE	**Finite Element Methods in Structural Engineering**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**1**	**-**	**-**	**30**	**70**	**4**

Course Objectives

The objectives of this course is to impart knowledge of

- Learn the rudiments of finite element analysis.
- Study the fundamentals of domain discretization, interpolation, application of boundaryconditions, assembly of global matrices, and solution of the resulting algebraicsystems.
- Explain the core concepts of variational and weighted residual methods inFEM.
- Derive the element stiffness matrix for 1-D, 2-D and 3-Dproblems.
- Formulate the simple structural problems in to finiteelements.

Course Outcomes

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

1. Build and analyse the FEA models for various engineeringproblems.
2. Identify the information requirements and sources for analysis, design andevaluation.
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 – Stress-strain relation for 2-D / 3-D – Plane stress / Plane strainproblems.

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 totwo.

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.

Triangular Elements: Displacement models / criterion for convergence / geometric invariance / conforming and non-conforming elements - 3-node triangular elements (CST) / determination of strain- displacement matrix / area coordinates-shape functions / determination of element stiffness and load matrices, assembling global stiffness and load matrices / Problems with kinematic indeterminacy not exceedingthree.

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: Construction of shape functions using natural coordinates/Strain-displacement matrices/Load matrices for body force and surface traction/ Expressions for stiffness matrix, load matrices for 4-noded quadrilateral elements/ Gauss Quadrature of numerical integration / Problems with rectangular elements, kinematic indeterminacy not exceedingthree.

2nd Order Quadrilateral elements: - Determination of shape functions for 2nd order quadrilateral elements and for elements of with serendipity / Strain-displacement matrices / Load matrices for body force and surfacetraction.

UNIT – IV

Method of Weighted Residuals:

Galerkin's Method of Weighted Residuals – Application to problems of mathematics / structural engineering, number of trial functions not exceeding two.

Galerkin's Finite Element Method – Weak form of Trial Function - Application to problems of mathematics / structural engineering, number of elements limited to two.

Axi-symmetric Problems: Strain-displacement relationship/stress-strain relationship / determination of stiffness matrix for 3-noded ring element and load matrices for body force and surface traction/ Problems with kinematic indeterminacy not exceeding three for 3-noded ring elementsonly.

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. Cook, R. D. (1981). Concepts and Application of Finite Element Analysis, John Wiley andSons.
2. Zienkiewicz, O. C. and Taylor, R. L, (1989). The Finite Element Method, Vol.1, McGraw Hill Company Limited, London.
3. Reddy, J. N, (1993). An Introduction to the Finite Element Method, McGraw Hill, NewYork.
4. Chandrupatla, T. R. and Belegundu, A. D, (2001). Introduction to Finite Elements in Engineering, Prentice Hall of India, New Delhi.
5. Seshu. P, (2003). Finite Element Analysis, Prentice Hall of India Private Limited, NewDelhi.
6. David V. Hutton, (2005). Fundamentals of Finite Element Analysis, Tata McGraw-Hill Publishing Company Limited, NewDelhi.
7. Bathe, K. J, (2006). Finite Element Procedures, Prentice Hall of India, NewDelhi.

Course Code	Course Title						Core/Elective
PC 1104 SE	**Structural Dynamics**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Study the various types as well as characteristics of loading and formulate the equations ofmotion.
- Learn the response of un-damped and damped SDOF and MDOF systems under variousloadings.
- Employ the approximate and iterative methods to model continuous vibratorysystems.
- Use the seismic codes in analysis and design of civil engineeringstructures.
- Understand the dynamic response by numericalmethods.

Course Outcomes

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

1. Know the fundamental theory of dynamic equation of motions and analysis methods for dynamic systems.
2. Understand the modelling approach of dynamic response in civil engineeringapplications.
3. Create the simple computer models for engineering structures using knowledge of structural dynamics.
4. Evaluate the dynamic response analysis results and understand the possible error sources. Interpret the dynamic analysis results for design, analysis and researchpurposes.
5. Apply the structural dynamics theory to earthquake analysis, response, and design ofstructures.

UNIT – I

Introduction to Structural Dynamics: Objectives of dynamic analysis – Types of prescribed dynamic loading – Characteristics of a dynamic problem – Methods of discretization: Lumped mass Procedure / Consistent mass procedure/generalised displacements – Single Degree Freedom Systems – Formulation of Equation of Motion: D'Alembert's Principle / Method of Virtual Work / Hamilton‘s Principle – Influence of Gravity Forces and Ground Motion on equation of motion – Generalised SDOF systems: Rigid Body Assemblage/Distributed Flexibility.

UNIT – II

Single Degree of Freedom Systems: Response of Un-damped/Damped free vibrations of SDOF systems – Un-damped/Damped vibrations of SDOF systems subjected to Harmonic loading: Dynamic equilibrium / Accelero Meters / Displacement Meters / Resonant Response / Vibration Isolation – Un- damped / Damped vibrations of SDOF systems subjected Periodic loading – Response of SDOF systems subjected Impulse loads: Half-sine pulse/Rectangular pulse/Triangular Pulse/ Shock spectra / Approximate method of impulse load analysis – Un-damped / Damped vibrations of SDOF systems subjected General dynamic loading / Duhamel Integral - Un-damped / Damped vibrations of SDOF systems subjected arbitrary dynamic loading.

UNIT – III

Multi Degree Freedom Systems: Formulation of Equations of Motion / Evaluation of Lumped Mass Matrix and consistent mass matrix/ Evaluation of Stiffness Matrix.

Un-damped Free Vibrations: Analysis of Frequency matrix and mode shape matrices using detrimental equation/Flexibility Formulation/Orthogonality Conditions/ Normalizing Mode shapes/Analysis of Dynamic Response/Normal Coordinates/ Uncoupled Equations of Motion for un-damped systems/Conditions for damping orthogonality – Mode super position procedure for damped forced vibrations – Time History Analysis – Direct Integration Methods due to New Mark(average acceleration, linear acceleration), Wilson theta correction.

UNIT – IV

Practical Vibration Analysis: Stodola Method, Holtzer Method – Fundamental mode only, Reduction of degrees of freedom, basic concepts in matrix iteration.

Variational Formulation of Equations of Motion: Generalized coordinates, Lagrange's Equations of Motion, Application to simple un-damped and damped problems of 2-DOF systems.

UNIT – V

Distributed Parameter Systems: Partial Differential Equation of Motion – Beam Flexure (Elementary case) – Undamped free vibrations (Elementary case) – Analysis of dynamic response – normal coordinates.

Earthquake Resistant Design: Brief exposure to relevant IS Codes of Practice, Response Spectra method.

Suggested Readings:

1. Walter C. Hurty & Moshe F. Rubinstein, (1964). Dynamics of Structures, Prentice HallIndia.
2. Clough, Ray. W, and Penzien, Joseph (1982). Dynamics of Structures, McGraw Hill Company Limited, NewDelhi.
3. Mario Paz, (1987). Structural Dynamics, CBSPublishers.
4. Chopra, A. K, (1996). Dynamics of Structures, Prentice HallIndia.

Course Code	Course Title						Core/Elective
PE 1116 SE	**Theory of Plates**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
PC 1102 SE	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Learn the analysis of rectangular and circular plates subjected to various loading conditions with different boundaryconditions.
- Understand fundamentals of buckling ofplates.
- Know the concepts of small deflection theory of laterally loadedplates.
- Study the approximate methods of analysis of rectangular plates.
- Derive the governing differential equations for orthotropic plates and apply them to practical problems.

Course Outcomes

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

1. Analyse the rectangular and circular plates subjected to various loadingconditions.
2. Decipher the problems of buckling of plates with different edgeconditions.
3. Work out the problems of small deflection theory of laterally loaded plates with different edge conditions.
4. Understand the various numerical and approximate methods for analysis of plateproblems.
5. Apply the concepts of orthotropic plates to simply supportedstructures.

UNIT-I

Bending of Rectangular Plates: Pure and Cylindrical bending, differential equation, cylindrical bending of uniformly loaded rectangular plates with simply supported and built-in edges. Relations between slope and curvature of slightly bent plates, Moment-curvature relations in pure bending. Strain energy in pure bending.

Bending of circular plates: Symmetrical bending, differential equation of equilibrium, uniformly loaded plates at center, Circular plates with circular holes at the center.

UNIT-II

Buckling of Plates: Differential equation for bending of plate under the combined action of in-plane loading and lateral loading, Calculation of critical loads, buckling of simply supported rectangular plates uniformly compressed in one and two directions with different edgeconditions.

UNIT-III

Small deflections of laterally loaded plates: Differential equation of equilibrium, Boundary conditions, Solution of simply supported rectangular plates under various loading conditions viz. uniformly distributed load (full or partial), concentrated load by Navier‘s approach, Levy type solution for rectangular plates under U.D.L with all four edges simply supported or two opposite edges simply supported and other two fixed.

UNIT-IV

Approximate methods for Rectangular Plates: Finite difference method for simply supported or fixed rectangular plates carrying UDL (full or partial) or central point load, Strain energy approaches Rayleigh-Ritz method.

UNIT-V

Bending of Orthotropic Plates: Differential equation of the bent plate. Application of the theory to simply supported rectangular (i) laminates; (ii) RC slabs (iii) grids.

Suggested Readings:

1. Theory of plates and shells, S. Timoshenko and W. Krienger, Mc GrawHill.
2. Theory of plates and shells, R.H.Wood.
3. Theory of plates and shells, Zienkiwicz, Mc Graw HillCo.

Course Code	Course Title						Core/Elective
PE 1117 SE	**Advanced Reinforced Concrete Design**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Learn the analysis and design of beams curved in plan and deepbeams.
- Design and detail the deepbeams.
- Analyse, design and detail the domes, water tanks, bunkers andsilos.
- Analyse and design the raft, pile and machinefoundations.

Course Outcomes

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

1. Design the beams curved in plan and deepbeams.
2. Propose the deep beams, domes and various type watertanks.
3. Differentiate and design the bunkers andsilos.
4. Formulate the raft, pile and machinefoundations.

UNIT-I

Beams Curved in Plan: Introduction - design principles – Terminologies, structural design of beams curved in plan of circular and rectangular type.

UNIT-II

Deep Beams: Introduction to deep beams, Flexural and Shear stresses in deep beams, IS Code provisions - design of deep beams.

UNIT-III

Domes: Introduction - Stresses and forces in domes - design of spherical and conical domes.
Water Tanks: Types, Codal specifications, Design of circular, rectangular and Intze type water tanks.

UNIT-IV

Bunkers and Silos: Introduction - Design principles and theories Code provisions - design of square and circular bunkers - design of cylindrical silos. IS specifications.

UNIT-V

Raft and Pile Foundations: Introduction, need for the design, Design principles - Structural design of raft and pile foundations including the design of pile caps.
Machine Foundations: Introduction, Types, Design Principles, Case studies, detailed designs.

Suggested Readings:

1. "Advanced Reinforced Concrete Design", by N. Krishna Raju, CBS Pub.1986.
2. "Reinforced Concrete", by H.J. Shah, Charotar Pub. Vol. II.2000.
3. "R.C.C. Designs" by B.C. Punmia, Laxmi Pub.1998.

Course Code	Course Title						Core/Elective
PE 1118 SE	**Theory of Structural Stability**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Learn the buckling of columns, analysis using equilibrium, energy and approximatemethods.
- Know the stability analysis of beam-columns and frames with differentloads.
- Analyse for torsional, flexural and lateral buckling ofbeams.
- Perform the buckling analysis of thin plates using differentapproaches.
- Study the inelastic buckling analysis ofplates.

Course Outcomes

1. Understand the analysis of buckling of columns using appropriatemethod.
2. Analyse the practical problems of beam-columns andframes.
3. Analyse the beams for torsional, flexural and lateralbuckling.
4. Perform buckling analysis of thinplates.
5. Analyse the plates for inelastic buckling and understand the post-buckling behaviour ofplates.

UNIT-I

Buckling of columns: States of equilibrium - Classification of buckling problems - concept of equilibrium, energy, imperfection and vibration approaches to stability analysis - Eigen value problem. Governing equation for columns - Analysis for various boundary conditions - using Equilibrium, Energy methods. Approximate methods - Rayleigh Ritz, Galerkin's approach - Numerical Techniques - Finite difference method - Effect of shear on buckling.

UNIT-II

Buckling of beam-columns and frames: Theory of beam column - Stability analysis of beam column with single and several concentrated loads, distributed load and end couples Analysis of rigid jointed frames with and without sway - Moment distribution - Slope deflection and stiffness method.

UNIT-III

Torsional and lateral buckling: Torsional buckling - Torsional and flexural buckling - Local buckling. Buckling of Open Sections. Numerical solutions. Lateral buckling of beams, pure bending of simply supported beam and cantilever beam.

UNIT-IV

Buckling of plates: Governing differential equation - Buckling of thin plates, various edge conditions - Analysis by equilibrium and energy approach - Approximate and Numerical techniques.

UNIT-V

Inelastic buckling: Double modulus theory - Tangent modulus theory – Shanley's model – Eccentrically loaded inelastic column. Inelastic buckling of plates - Post buckling behavior of plates

Suggested Readings:

1. Timoshenko, S., and Gere., Theory of Elastic Stability, McGraw Hill Book Company,1963.
2. Chajes, A. Principles of Structures Stability Theory, Prentice Hall,1974.
3. Ashwini Kumar, Stability Theory of Structures, Tata McGraw Hill Publishing Company Ltd., New Delhi,1995.
4. Iyenger.N.G.R., Structural stability of columns and plates, Affiliated East WestPress,1986.
5. Gambhir, Stability Analysis and Design of Structures, Springer, NewYork

Course Code	Course Title						Core/Elective
PE 1119 SE	**Advanced Steel Design**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of and problem solving skills in

- Learn the fundamentals of design of steel tanks and grillage foundations.
- Solve the practical problems pertaining to steel tanks and grillagefoundations.
- Study the concepts of analysis and design of various members of tubularstructures.
- Gain knowledge of the design of bunkers and silos using appropriate method and solve the practical problems pertaining toit.
- Study the fundamentals of design of transmission line towers and solve the practical problems pertaining toit.
- Learn the concepts of analysis and design of various members of light-gauge steelstructures.

Course Outcomes

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

1. Design and detail the rectangular plated and pressed steeltanks.
2. Propose the grillage foundations forstructures.
3. Design and detail the hollow rectangular, square and circular tubular members in a truss including itsjoints.
4. Formulate the rectangular and square bunkers and silos using appropriatemethod.
5. Proposethegeometryandanalyseanddesignthetransmissiontowerssubjectedtovariousloads.
6. Design the light gauge steel compression and flexuralmembers.

UNIT-I

Steel Tanks: Introduction, Types, Loads, Permissible stresses, Detailed design of elevated rectangular and pressed steel tanks including columns.

UNIT-II

Grillage Foundations: Introduction, Necessity of grillage foundation, Various types, Grillage foundations for single and double columns.

Tubular Structures: Introduction, Permissible stresses, Design considerations, Design of tension members, compression members and flexural members, Design of tubular trusses including joints.

UNIT-III

Bunkers and Silos: Introduction, General design principles, Design theories for bunkers and silos, Detailed design of bunkers and silos.

UNIT-IV

Transmission Line Towers: Classification, Economical spacing, Design loads, IS codal provisions, Calculation of wind loads, Permissible stresses, Overall arrangement and design procedure, detailed design including foundations.

UNIT-V

Design of Light Gauge Steel Structures: Introduction, Forms of light-gauge sections, Behaviour of compression elements, Effective width for load and deflection calculation, Behaviour of unstiffened and stiffened elements, Design of compression members, Design of laterally supported beams and laterally unsupported beams, Connections.

Suggested Readings:

1. S.K. Duggal, Design of Steel Structures, Tata McGraw Hill,2009.
2. B.C Punmia, Design of Steel Structures, Laxmi Publications,2001.
3. Ram Chandra, Design of Steel Structures, Vol. I & II, Standard Book House,1989.
4. P. Dayaratnam, Design of Steel Structures, Orient Longman Publications,1987.
5. I.C. Syal and S. Singh, Design of Steel Structures, Standard Book House,2000

Course Code	Course Title						Core/Elective
PE 1120 SE	**Structural Health Monitoring**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Learn the fundamentals of structural healthmonitoring.
- Study the various vibration-based techniques for structural healthmonitoring.
- Learn the structural health monitoring using fiber-optic and Piezoelectricsensors.
- Study the structural health monitoring using electrical resistance and electromagnetictechniques.

Course Outcomes

1. Understand the fundamentals of maintenance and repairstrategies.
2. Diagnose for serviceability and durability aspects ofconcrete.
3. Know the materials and techniques used for repair ofstructures.
4. Decide the appropriate repair, strengthening, rehabilitation and retrofitting technique required for a case studybuilding.
5. Use an appropriate health monitoring technique and demolitiontechnique.

UNIT-I

Introduction to Structural Health Monitoring: Definition of structural health monitoring (SHM) – Objectives- Need –Steps involved in SHM-Motivation for SHM - SHM as a way of making materials and structures smart - SHM and biomimetics - Process and pre usage monitoring as a part of SHM - SHM as a part of system management - The most remarkable characters of SHM Birth of the SHM community.

UNIT-II

Vibration-Based Techniques for SHM: Basic vibration concepts for SHM -Local and global methods - Damage diagnosis as an inverse problem -Model-based damage assessment - General dynamic behavior - State- space description of mechanical systems - Neural network approach to SHM - The basic idea of neural networks - Detection of delamination in a CFRP plate withstiffeners.

UNIT-III

Fiber-Optic Sensors: Classification of fiber-optic sensors - Intensity-based sensors - Phase- modulated optical fiber sensors - or interferometers -Wavelength based sensors - or Fiber Bragg Gratings (FBG) - The fiber Bragg grating as a strain and temperature sensor - Orientation of the optical fiber optic with respect to the reinforcement fibers - Fiber Bragg gratings as damage sensors for composites -Measurement of strain and stress variations.

UNIT-IV

SHM with Piezoelectric Sensors: The use of embedded sensors as Acoustic Emission (AE) detectors - Available industrial AE systems- New concepts in acoustic emission - State-the-art and main trends in piezoelectric transducer-based acousto-ultrasonic SHM research –The full implementation of SHM of localized damage with guided waves in composite materials - Available industrial acousto ultrasonic systems with piezoelectric sensors.

UNIT-V

SHM Using Electrical Resistance: Composite damage - Electrical resistance of unloaded composite - Percolation concept - Anisotropic conduction properties in continuous fiber reinforced polymer - Influence of temperature - Composite strain and damage monitoring by electrical resistance -Randomly distributed fiber reinforced polymers - Damagelocalization.

Low Frequency Electromagnetic Techniques: Theoretical considerations on electromagnetic theory, Maxwell‘s equations, Dipole radiation, Surface impedance, Diffraction by a circular aperture, Eddy currents, Polarization of dielectrics, Applications to the NDE/NDT domain, Dielectric materials, Conductive materials, Hybrid method, Signal processing, Time-frequency transforms, The continuous wavelet transform, The discrete wavelet transform, Multi resolution, Denoising, Application to the SHM domain, General principles, Magnetic method, Electric method, Hybridmethod.

Suggested Readings:

1. Daniel Balageas, Claus-Peter Fritzen, Alfredo Güemes, Structural Health Monitoring, Wiley-ISTE, 2006.
2. Douglas E Adams, Health Monitoring of Structural Materials and Components-Methods with Applications, John Wiley and Sons,2007.
3. J.P. Ou, H.Li and Z.D. Duan, Structural Health Monitoring and Intelligent Infrastructure, Vol-1, Taylor and Francis Group, London, U.K,2006.
4. Victor Giurglutiu, Structural Health Monitoring with Wafer Active Sensors, Academic Press Inc, 2007.
5. M.V. Gandhi and B.D. Thompson, “Smart Materials and Structures,” Springer,1992.
6. Fu Ko Chang, “Structural Health Monitoring: Current Status and Perspectives”, Technomic, Lancaster,1997.

Course Code	Course Title						Core/Elective
PE 1121 SE	**Retrofitting and Rehabilitation of Structures**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Learn the fundamentals of maintenance and repairstrategies.
- Study the quality assurance, serviceability and durability ofconcrete.
- Know the various materials and techniques used for repair ofstructures.
- Educate the different repair, strengthening, rehabilitation and retrofittingtechniques.
- Instruct the various health monitoring and demolitiontechniques.

CourseOutcomes

1. Understand the fundamentals of maintenance and repairstrategies.
2. Diagnose for serviceability and durability aspects ofconcrete.
3. Know the materials and techniques used for repair of structures.
4. Decide the appropriate repair, strengthening, rehabilitation and retrofitting technique required fora case studybuilding.
5. Use an appropriate health monitoring and demolitiontechniques.

UNIT - I

Maintenance: Repair and Rehabilitation, Facets of Maintenance, importance of Maintenance various aspects of Inspection, Assessment procedure for evaluating damaged structure, causes of deterioration.

Repair Strategies: Causes of distress in concrete structures, Construction and design failures, Condition assessment and distress-diagnostic techniques, Assessment procedure for Inspection and evaluating a damaged structure.

UNIT - II

Serviceability and Durability of Concrete: Quality assurance for concrete construction, concrete properties – strength, permeability, thermal properties and cracking. – Effects due to climate, temperature, chemicals, corrosion – design and construction errors – Effects of cover thickness and cracking.

UNIT - III

Materials and Techniques for Repair: Special concretes and mortar, concrete chemicals, special elements for accelerated strength gain, Expansive cement, polymer concrete, sulphur infiltrated concrete, ferro cement, Fibre reinforced concrete. Bacterial concrete, Rust eliminators and polymers coating for rebars during repair, foamed concrete, mortar and dry pack, vacuum concrete, Gunite and Shotcrete, Epoxy injection, Mortar repair for cracks, shoring and underpinning. Methods of corrosion protection, corrosion inhibitors, corrosion resistant steels, coating and cathodic protection

UNIT - IV

Repair, Rehabilitation and Retrofitting Techniques: Repairs to overcome low member strength, Deflection, Cracking, Chemical disruption, weathering corrosion, wear, fire, leakage and marine exposure, Repair of Structure – Common Types of Repairs – Repair in Concrete Structures – Repairs in Under Water Structures – Guniting – Shot Create – Underpinning. Strengthening of Structures – Strengthening Methods – Retrofitting – Jacketing.

UNIT – V

Health Monitoring and Demolition Techniques: Long term health monitoring techniques, Engineered demolition techniques for dilapidated structures, Use of Sensors – Building Instrumentation.

Suggested Reading:

1. Concrete Technology by A.R. Santakumar, Oxford Universitypress
2. Defects and Deterioration in Buildings, E F & N Spon,London
3. Non-Destructive Evaluation of Concrete Structures by Bungey - SurreyUniversity
4. Maintenance and Repair of Civil Structures, B.L. Gupta and Amit Gupta, StandardPublications.
5. Concrete Repair and Maintenance Illustrated, RS Means Company Inc W. H. Ranso,(1981)
6. Building Failures: Diagnosis and Avoidance, EF & N Spon, London,B
7. Mehta, P.K and Montevic. P.J., Concrete- Microstructure, Properties and Materials, ICI,1997.
8. Jackson, N., Civil Engineering Materials, ELBS,1983.

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>PE 1122 SE</td><td colspan="6">Earthquake Resistant Design of Structures</td><td>Elective</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>3</td><td>-</td><td>-</td><td>-</td><td>30</td><td>70</td><td>3</td></tr>
</table>

Course Objectives

- Learn the causes of earthquake and effects of ground motion and modelling ofstructures.
- Study the response spectra and structural dynamics of MDOFsystems.
- Discover the different analysis and design approaches like equivalent lateral force method and inelastic time historyanalysis.
- Be trained in the ductile detailing of reinforced concrete structures as per IS 4326 and IS13920.
- Learn the seismic analysis of masonrybuildings.

Course Outcomes

1. Apply the concepts of structural dynamics of MDOF systems for analysis ofstructures.
2. Model and analyse the structures to resist earthquake forces by differentmethods.
3. Design the various structural elements resisting earthquake forces as per ISCodes.
4. Practice ductile detailing of reinforced concrete and masonry buildings as per codalprovisions.

UNIT-I

Earthquake Ground Motion: Engineering seismology, Seismic zoning map of India, Strong motion studies in India, Strong motion characteristics, Evaluation of seismic design parameters.

Structural Dynamics: Initiation into structural dynamics, Dynamics of SDOF systems, Theory of seismic pickup, Numerical evaluation of dynamic response, Response spectra, Dynamics of MDOF systems.

UNIT-II

Concepts of Earthquake Resistant Design of RCC Structures: Basic elements of earthquake resistant design, Identification of seismic damages in RCC buildings, Effect of structural irregularities on performance of RCC buildings during earthquakes, earthquake resistant building architecture.

UNIT-III

Seismic Analysis and Modelling of RCC Structures: Code based procedure for determination of design lateral loads, Infill walls, Seismic analysis procedure as per IS 1893 code, Equivalent static force method, Response spectrum method, Time history analysis, Mathematical modelling of multi-storey RCC buildings.

UNIT-IV

Earthquake Resistant Design of RCC Structures: Ductility considerations, Earthquake resistant design of multi-storey RCC buildings and shear walls based on IS 13920 code, Capacity based design.

UNIT-V

Earthquake Resistant Design of Masonry Structures: Identification of damages and non-damages in masonry buildings, Elastic properties of structural masonry, Lateral load analysis of masonry buildings, Seismic analysis and design of one-storey and two-storey masonry buildings.

Suggested Readings:

1. Bruce A Bolt, Earthquakes, W H Freeman and Company, New York,2004.
2. C. A. Brebbia, Earthquake Resistant Engineering Structures, WIT Press,2011.
3. Mohiuddin Ali Khan, Earthquake-Resistant Structures: Design, Build and Retrofit, Elsevier Science & Technology,2012.

4. Pankaj Agarwal and Manish Shrikhande, Earthquake Resistant Design of Structures, Prentice Hall of India,2009.
5. Paulay, T and Priestley, M.J.N., Seismic Design of Reinforced Concrete and Masonry buildings, John Wiley and Sons,1992.
6. S K Duggal, Earthquake Resistant Design of Structures, Oxford University Press,2007.

Course Code	Course Title						Core/Elective
PE 1123 SE	**Bridge Engineering**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Learn the hydraulic, geological and geo-technical aspects in bridgedesign.
- Analyse, design and detail the bridge deck and box girder systems, steel and compositebridges.
- Analyse and design the sub-structures, bridge bearings and various long spanbridges.

Course Outcomes

After completing the course, the students will able to

1. Understand the fundamentals and codes of practice of bridgedesign.
2. Design the bridge deck and box girder systems using appropriatemethod.
3. Devise the steel truss and composite steel-concretebridges.
4. Propose the sub-structure components such as pier, abutments, etc. and bridgebearings.
5. Design the various types of long span bridges, curved and skewbridges.

UNIT – I

Introduction:

Types of bridges, materials of construction, codes of practice (Railway and Highway Bridges), aesthetics, loading standards (IRC, RDSO, AASHTO), recent developments box girder bridges, historical bridges (in India and overseas). Planning and layout of bridges, hydraulic design, geological and geo-technical considerations; Design aids, computer software, expert systems.

UNIT – II

Concrete Bridges: Bridge deck and approach slabs, Slab design methods, design of bridge deck systems, slab-beam systems (Guyon-Massonet and Hendry Jaeger Methods), box girder systems, analysis and design. Detailing of box girder systems.

UNIT – III

Steel and Composite Bridges: Introduction to composite bridges, Advantages and disadvantages, Orthotropic decks, box girders, composite steel-concrete bridges, analysis and design, truss bridges.

UNIT – IV

Sub-Structure: Piers, columns and towers, analysis and design, shallow and deep foundations, caissons, abutments and retaining walls. **Bridge appurtenances:** Expansion joints, design of joints, types and functions of bearings, design of elastomeric bearings, railings, drainage system,lighting.

UNIT – V

Long span bridges: Design principles of continuous box girders, curved and skew bridges, cable stayed and suspension bridges, seismic resistant design, seismic isolation and damping devices. Construction techniques (cast in-situ, prefabricated, incremental launching, free cantilever construction), inspection, maintenance and rehabilitation, current design and construction practices.

Suggested Readings:

1. "Bridge Engineering Handbook", Wai-Fah Chen Lian Duan, CRC Press, USA,2000.
2. "Design of Highway Bridges", Barker, P.M. and Puckett, J.A., John Wiley & Sons, New York,1997.
3. "Theory and Design of Bridges", Xanthakos, P.P., John Wiley & Sons, New York,1994.

Course Code	Course Title						Core/Elective
PE 1124 SE	**Composite Construction**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Study the concepts of compositeconstruction.
- Learn analysis and designs of composite beams, floors, columns and trusses as per the recommendations of IS codes ofpractice.
- Apply the concepts for design of multi-storey compositebuildings.
- Scope of analysis is restricted to skeletal structures subjected to prescribed dynamicloads.

Course Outcomes

1. Understand the fundamentals of composite construction, and analysis and designs of composite beams.
2. Analyse and design the composite floors and columns, composite trusses and understand connectiondetails.
3. Analyse and design the multi-storey compositebuildings.

UNIT-I

Introduction of Composite Constructions: Benefits of composite construction, Introduction to IS, BS and Euro codal provisions.

Composite Beams: Elastic behaviour of composite beams, No and Full Interaction cases, Shear connectors, Ultimate load behaviour, Serviceability limits, Effective breadth of flange, Interaction between shear and moment, Basic design consideration and design of composite beams.

UNIT-II

Composite Floors: Structural elements, Profiled sheet decking, Bending resistance, Shear resistance, Serviceability criterion, Analysis for internal forces and moments, Design of composite floors.

UNIT-III

Composite Columns: Materials, Concrete filled circular tubular sections, Non-dimensional slenderness, Local buckling of steel sections, Effective elastic flexural stiffness, Resistance of members to axial compressions, Composite column design, Fire resistance.

UNIT-IV

Composite Trusses: Design of truss, Configuration, Truss members, Analysis and design of composite trusses and connection details.

UNIT-V

Design of Multi-Storey Composite Buildings: Design basis, load calculations, Design of composite slabs with profile decks, composite beam design, design for compression members, vertical cross bracings, design of foundation.

Suggested Readings:

1. R. P. Johnson, Composite Structures of Steel and Concrete, Vol-I, Beams, Columns and Frames in Buildings, Oxford Blackwell ScientificPublications.
2. INSDAG Teaching Resources for Structural Steel Design, Vol-2, Institute for Steel Development and Growth Publishers,Calcutta.

3. INSDAG Handbook on Composite Construction – Multi-Storey Buildings, Institute for Steel Development and Growth Publishers,Calcutta.
4. INSDAG Design of Composite Truss for Building, Institute for Steel Development and Growth Publishers,Calcutta.
5. INSDAG Handbook on Composite Construction – Bridges and Flyovers, Institute for Steel Development and Growth Publishers,Calcutta.
6. IS:11384, 1985 Code of Practice for Composite Construction in Structural Steel and Concrete, Bureau of Indian Standards, NewDelhi

Course Code	Course Title						Core/Elective
PE 1125 SE	**Advanced Concrete Technology**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of

- Learn the concept of cement and its properties, mechanical and thermal properties ofaggregates.
- Study the properties and testing of concrete in fresh and hardenedstate.
- Learn the shrinkage and creep mechanisms, curing and durability ofconcrete.
- Design concrete mix by various methods as per differentcodes.
- Study the different types of admixtures, mix design, properties and applications of specialconcretes.

Course Outcomes

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

1. Learn hydration of cement and tests on properties of cement andaggregates.
2. Comprehend the properties and testing of concrete in fresh and hardenedstate.
3. Understand the shrinkage and creep mechanisms, curing and durability ofconcrete.
4. Design concrete mixes by variousmethods.
5. Familiarize with the types of admixtures, and applications of specialconcretes.

UNIT - I

Cement: Types of cement and their composition, manufacture of Portland cement, hydration of cement and hydration product, structure of hydrated cement, heat of hydration, gel theories, review of tests on properties ofcement.

Aggregate: Classification of aggregates, particle shape and texture, bond and strength of aggregate and its influence on strength of concrete, porosity, absorption and moisture content and their influence, soundness of aggregate, alkali aggregate reaction, sieve analysis and grading of aggregate, review of tests on properties of aggregate.

UNIT -II

Properties of Concrete: Mixing and batching, workability, factors affecting workability, measurements of workability, various tests and procedures, segregation and bleeding, vibration of concrete, types of vibrators and their influence on composition, analysis of fresh concrete, strength of concrete, water-cement ratio, gel space ratio, effective water in the mix, mechanical properties of concrete, tests and procedure, influence of various parameters on strength of concrete, relationship between various mechanical strengths of concrete.

UNIT - III

Shrinkage and Creep of Concrete: Types of shrinkage, mechanism of shrinkage, factors affecting shrinkage, creep mechanism, factors influencing creep, rheological model, effects of creep.

Curing of Concrete: Methods of curing, maturity concept, influence of temperature on strength of concrete.

Durability of Concrete: Permeability of concrete, chemical attack of concrete, tests on sulphate resistance, effect of frost, concreting in cold weather, hot weather concreting, and air entrained concrete.

UNIT - IV

Mix Design of Concrete: Basic considerations, process of mix design, factors in the choice of mix proportions and their influence, quality control, various methods of mix design, I.S. Code method, British and ACImethods.

UNIT - V

Admixtures: Classification of admixtures, chemical and mineral admixtures, influence of various admixtures on properties of concrete, their applications. Fly Ash Concrete: Mix design, properties and its applications. High Strength Concrete: Mix design, properties and its applications. Fiber Reinforced Concrete: Mix design, properties and its applications. Ferro cement, lightweight concrete, high-density concrete, recycled aggregate concrete and theirapplications.

Suggested Readings:

1. Neville. A.M, (1988), Properties of Concrete, English Language Book Society/Longman Publications.
2. Mehta. P.K and Paulo. J.M.M, (1997), Concrete – Microstructure – Properties and Material, McGraw-Hill.
3. Krishna Raju. N., (1985), Design of Concrete Mix, CBSPublications

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>PE 1126 SE</td><td colspan="6">Design of High Rise Structures</td><td>Elective</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>3</td><td>-</td><td>-</td><td>-</td><td>30</td><td>70</td><td>3</td></tr>
</table>

Course Objectives

- To study the functioning and behaviour of high risebuildings.
- To understand the characteristics and effect of wind loads on buildings.
- To understand the effect of earthquake on buildings and to learn the techniques for earthquake resistance.
- To analyse tall buildings subjected to lateralloads.
- To understand the interaction between the various structural components of high risestructures.

CourseOutcomes

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

1. Understand the concepts of high rise buildingstructures.
2. Analyse and design high rise structures subjected to windloads.
3. Familiarize with the different structural systems used in high risebuildings.
4. Analyse and design high rise structures subjected to earthquakeloads.
5. Understand the behaviour and response of slab columnframes.

UNIT-I

Introduction: Design Principles for Lateral Load resistance, ductility considerations in earthquake resistant design of concrete buildings, construction methods, choice of materials, cladding systems and their design principles, types of foundations for tall buildings.

UNIT-II

Wind: Introduction to wind, characteristics of wind, impact on structures, wind pressure, internal and external wind, dynamic action of wind, aerodynamic forces, natural frequencies, wind tunnels, types of wind tunnel tests, Introduction to computational fluid dynamics, behaviour of tall buildings subjected to wind, National standards, maximum design loads for buildings and other structures. Calculation of wind loads, special winds, gust, wind speed data and importance. Wind resistant design.

UNIT-III

Earthquake: Introduction to earthquake, characteristic, impact of earthquake on ground, foundations and structural elements, response of elements attached to buildings, ground motion, quasi-static approach, dynamic analysis, performance criteria, Vibration Control – active control and passive control, liquefaction effects of earthquakes, Introduction to time history analysis and pushover analysis.

UNIT-IV

Structural Systems: Necessity of special structural systems for tall buildings, Structural Systems for Steel Buildings - Braced frames, Staggered Truss System, Eccentric Bracing System, Outrigger & Belt truss system, Tube Systems; Structural Systems for Concrete Buildings - shear walls, frame tube structures, bundled tube structures; Design of shear wall as per IS code.

UNIT-V

Special Topics: Second order effects of gravity loading, Creep and shrinkage in columns, Differential shortening of columns, Floor levelling problems, Panel zone effects, P-Delta analysis.

Suggested Readings:

1. Tall Building Structures: Analysis and Design, Smith, B. S. and Coull, A., John Wiley & Sons,1991.
2. Reinforced Concrete Design of Tall Buildings, Taranath, B. S., CRC Press,2010.
3. Tall Building Design: Steel, Concrete and Composite Systems, Taranath, B. S., CRC Press,2017.
4. Wind Effect on Structures: Modern Structural Design for Wind, Simiu, E. and Yeo, D., Wiley Blackwell,2019.
5. Handbook of Concrete Engineering, M. Fintel, Von Nostrand Reinhold Company,1985.
6. Design of Earthquake Resistant Structures, Emilio Rosenblueth, Pentech Press Ltd.,1990.

Course Code	Course Title						Core/Elective
PE 1127 SE	**Design of Prestressed Concrete Structures**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of

- Learn the concept of pre-stressed concrete, methods and systems of pre-stressing, losses of pre-stress.
- Analyse and design the sections for flexure, torsion and shear using differentmethods.
- Learn the design of sections for bond and anchorage and deflections of pre-stressed concrete beams.
- Study the analysis and design of statically indeterminatebeams.

Course Outcomes

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

1. Familiarize with fundamentals of pre-stressed concrete, methods and systems of pre-stressing and losses ofpre-stress.
2. Analyse and design the sections for flexure, shear bond andanchorages.
3. Estimate the deflections of pre-stressed concrete elements.
4. Know the circular pre-stressing, analysis and design of statically indeterminatebeams.
5. Solve the problems pertaining to axial members, slabs and gridfloors.

UNIT-I

Introduction: Basic concepts, materials, permissible stress – Advantages and types of prestressing, Systems and devices of pre-stressing and post-tensioning, Prestressing steel

Losses in pre-stress: Loss of prestress in pre-tensioned and post-tensioned members – Analysis of sections for flexure

UNIT-II

Deflections: Importance of deflections, factors influencing deflections, codal provisions, short term and long term deflections.

Shear: Shear in principal stresses – cracked and un-cracked sections **-** codal provisions – Design of shear reinforcement.

Torsion: Torsion for cracked and un-cracked sections, codal provisions and design.

UNIT-III

End Blocks: Nature of stresses, Stress distribution – IS Code Method **-**codal provisions **-** Design.

Continuous beams: Advantages of Continuous members – Code provisions – Design of two span Continuous beams – concordant cable profiles.

UNIT-IV

Tension Members: Introduction, Ties, Circular pre-stressing – Design of PSC pipes.

Compression Members: Introduction – Design of PSC columns.

UNIT-V

Slabs: Introduction – Types – rectangular and flat slabs – Codal provisions – Design of PSC floor slabs **-** one way and two way slabs, and simple flat slabs. Grid Floors: Introduction.

Suggested Readings:

1. Prestressed Concrete‖ by N. Krishna Raju, Tata Mc Graw Hill,2001.
2. Prestressed Concrete‖ by G.S. Pandit and S.P. Gupta, CBS Pub.,1995.
3. Design of Prestressed Concrete‖ by Arthur H. Nilson, John Wiley,1987

Course Code	Course Title						Core/Elective
PE 1128 SE	**Theory of Shells and Folded Plates**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
PC 1102 SE	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- Learn the analysis and design of cylindrical shells, short and longshells.
- Study the concepts of bending theory using D.K.J. equations and Schorertheory.
- Understand the beam theory and beam archanalysis.
- Gain knowledge of the analysis and design of different shells of double curvature and axi-symmetrical shells by membranetheory.
- Analyse different types of folded plates using Simpson's and Whitney'smethods.

Course Outcomes

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

1. Analyse the cylindrical shells and design the short and longshells.
2. Solve the problems of bending theory using appropriateequations.
3. Evaluate and design the different shells using beam theory and membranetheory.
4. Analyse the numerous types of folded plates using pertinentmethod.

UNIT-I

Introduction: definition and classification of shells.

Cylindrical Shells: Membrane Theory – Equilibrium equations for differential shell elements – Calculation of stresses and displacement due to dead loads and snow loads for circular cylindrical shell.

UNIT-II

Bending Theory: Necessity of bending theory (i) D.K.J theory Assumption – Equilibrium equations for a differential element - stress strain relations - Moment curvature relations – Derivation of D.K.J. Differential and characteristics equations – Roots of the Characteristic equation – Expression for defection. (ii) Schorer theory – assumptions – Equilibrium equations for a differential shell element – stress strain relations – Moment curvature relations – Derivation of Schorer differential and characteristic equation – Roots of the characteristic equation – Expression of defection.

UNIT-III

Beam Theory of cylindrical shells: Assumptions and range of their validity – Outline of the beam arch analysis – Advantages of beams theory over other theories.

UNIT-IV

Shells of Doubles Curvature: Membrane theory of shells of revolution- Equilibrium equations for a differential shell element – Calculation of stresses in a spherical dome due to uniform load over the surface and due to concentrated load around a skylight opening. Shells of translation equilibrium equations for a differential shell element. Pucher's stress function, derivation of a differential equation from equations of equilibrium using Pucher's stress function calculation of stresses in hyperbolic parabolids with straight edges under uniform load over the surface.

UNIT-V

Folded Plates: Assumptions – Structural behavior – Resolutions of ridge loads – Edge shears – Stress distribution – Plate deflections and rotations. Effect of joint moments – Analysis of V shaped folded plates using (i) Simpson and (ii) Whitney methods.

Suggested Readings:

1. Theory of plates and shells, S. Timoshenko and W. Krienger, Mc GrawHill.1959
2. Design and construction of concrete shell roofs, G.S. Ramaswamy, CBS Pub1986
3. Thin Shells Theory and Problems, J. Ramchandran, Universities press,1993.

<table>
<tr><td>Course Code</td><td colspan="4">Course Title</td><td colspan="2"></td><td>Core/Elective</td></tr>
<tr><td>PE 1129 SE</td><td colspan="6">Structural Optimization</td><td>Elective</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>3</td><td>-</td><td>-</td><td>-</td><td>30</td><td>70</td><td>3</td></tr>
</table>

Course Objectives

- Learn the optimization techniques and linear optimization.
- Study the non-linear optimization and non-linear constrainedoptimization.
- Understand the dynamic programming, decision theory andsimulations.
- Apply optimization techniques for simplestructures.

Course Outcomes

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

1. Become confident at optimization techniques, linear optimization, algorithm,etc.
2. Learn the nonlinear optimization and one dimensional minimizationmethods.
3. Study the non-linear optimization-II by differentmethods.
4. Use the optimization techniques for simplestructures.

UNIT – I

Introduction to optimization: Introduction, basic theory and elements of Optimization, Terminology and definitions, Basic principles and procedure of optimization, Engineering applications of Optimization.

Classical Methods of Optimization: Trial and error method, Monte-Carlo method, Lagrangian multiplier method, illustrative examples

Linear Programming: Introduction, terminology, formulation of LPP, graphical and algebraic methods of solving LPP, standard form and canonical form of linear programming, geometrical interpretation, illustrativeexamples.

UNIT – II

Linear Programming: Simplex methods, Artificial variable techniques, solution of simultaneous equations, Dual formulations - illustrative examples.

Network analysis: Modifications and improvements on CPM/PERT

Transportation and Assignment problem: Introduction, terminology, formulation and solution of mathematical models, illustrative examples.

UNIT – III

Non-Linear Programming: local and global optimum, problem formulation, Unconstrained and constrained methods of Optimization-Kuhn Tucker conditions, Lagrangian Multiplier methods, graphical method, Univariate search method, Steepest Descent Methods, quadratic programming problem, Wolfs modified simplex method, illustrative examples.

UNIT – IV

Dynamic programming: Introduction, terminology, need and characteristics of dynamic programming, formulation, solution of LPP, applications, illustrative examples

Decision theory: Introduction, types, decision trees.

Simulation: Introduction, advantages, limitations, types, applications.

UNIT – V

Structural Optimization: Optimum structural design of rectangular timber beam, reinforced concrete rectangular, T and L beams, concrete mix proportioning, reinforced concrete deep beams, planner trusses, Procedure of optimization for structural grid and slab.

Suggested Readings:

1. Engineering Optimization‖, S.S. Rao, New Age Internationals(1999).
2. Systems Analysis for Civil Engineers‖, Paul, J.O., john Wiley&Sons(1988)
3. Fundamentals of Optimum Design in Engineering‖ S.S. Bhavikatti, New Age International Publishers.
4. Operation Research‖, S. Kalavathy, Vikas Publishing house Pvt Ltd. Secondedition

Course Code	Course Title						Core/Elective
PE 1130 SE	**Fracture Mechanism in Concrete Structures**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of the course are to impart knowledge of the:

- Identify and classify cracking of concrete structures based on fracturemechanics.
- Implement stress intensity factor for notchedmembers.
- Apply fracture mechanics models to high strength concrete and FRCstructures.
- Compute J-integral for various sections understanding the concepts ofLEFM.

Course Outcomes

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

1. Recognise cracks in concrete structures based on fracturemechanics.
2. Recognise type of failures in concretestructures.
3. Determine stress intensityfactors.
4. Develop different materialmodels.
5. Develop numericalmodels.

UNIT - I

Introduction: Basic fracture mechanics, crack in a structure, mechanisms of fracture and crack.

UNIT - II

Growth, cleavage fracture, ductile fracture, fatigue cracking, environment assisted cracking, service failure analysis

UNIT - III

Stress at crack tip: Stress at crack tip, linear elastic fracture mechanics, Griffith's Criteria, Stress intensity factors, crack tip plastic zone, Erwin's plastic zone correction, R curves, compliance, J integral, concept of CTOD and CMD

UNIT - IV

Material Models: General concepts, crack models, band models, models based on continuum

UNIT - V

Damage Mechanics: Applications to high strength concrete, fibre reinforced concrete, crack concepts and numericalmodelling.

SuggestedReadings:

1. Fracture Mechanics, Suri, C.T. and Jin, Z. H., 1st Edition, Elsevier Academic Press,2012.
2. Elementary Engineering Fracture Mechanics, Broek David, 3rd Edition, Springer,1982.
3. Fracture Mechanics of Concrete Structures – Theory and Applications, Elfgreen, L., RILEM Report, Chapman and Hall,1989.
4. Fracture Mechanics – Applications to Concrete, Victor, Li C., Bazant Z. P., ACI SP118, ACI Detroit,1989.

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
4. Analyse problem by statistical techniques: ANOVA, F-test,Chi-square
5. 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 of writing 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 Gogia LawAgency
5. Ajit Parulekar and Sarita D'Souza, Indian Patents Law – Legal & Business Implications, Macmillan India Ltd,2006

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, New Delhi
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, aerospaceetc.
- 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 ARMcore
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 a fuel.
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. WereKo-Brobby and 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

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>AD 9001 HS</td><td colspan="6">English for Research Paper Writing</td><td>Audit I</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>2</td><td>-</td><td>-</td><td>-</td><td>30</td><td>70</td><td>-</td></tr>
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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 Floods and 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-IV

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 treatmentonly)

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, Motilal Banarsidass 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 Rama Verma, 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 for Nationaldevelopment.
- 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 practice‖, Oxford University Press, New Delhi,1998.
2. Jaya Dayal Goyandaka, Srimad Bhagavad Gita with Sanskrit Text, Word Meaning and Prose Meaning‖, Gita Press,Gorakhpur,2017.

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>AD 9011 HS</td><td colspan="6">Constitution of India and Fundamental Rights</td><td>Audit II</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>2</td><td>-</td><td>-</td><td>-</td><td>30</td><td>70</td><td>-</td></tr>
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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 tension throughasanas.
5. Improve work performance andefficiency.

UNIT -I

Meaning and Definition of Yoga - Historical perspective of Yoga - Principles of Astanga Yoga 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, “Rajayoga or Conquering the Internal Nature”, Advaita Ashrama(Publication Department),Kolkata.
3. Nagendra H.R and Nagaratna R, “Yoga Perspective in Stress Management”, SwamiVivekananda 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 Swarupananda Advaita Ashram (Publication Department),Kolkata
2. Bhartrihari's Three Satakam(Niti-sringar-vairagya), P.Gopinath, Rashtriya Sanskrit Sansthanam, NewDelhi

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

Course Code	Course Title						Core/Elective
PC 1151 SE	**Structural Design Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**50**	**-**	**1**

Course Outcomes
After completing this course, the student will be able to:
1. Design and detail all the structural components of frame buildings for seismic and windforce.
2. Design and detail complete multi-storeybuilding.

Syllabus Content:

Seismic & Wind Analysis and Design:
1. Calculation of design seismic force by static and dynamic methods of IS1893.
2. Calculation of lateral force distribution as per Torsion provisions of IS1893.
3. Beam design of an RC frame building as per IS13920.
4. Column design of an RC frame building as per IS13920.
5. Beam-column joint design of an RC frame building as per IS13920.
6. Complete manual seismic analysis, design and detailing of a simple G+3 storied building and its comparison with any structural analysis and designsoftware.
7. Calculation of wind pressures and design forces on walls and roof of a rectangularbuilding.
8. Calculation of design wind forces on a RC building using force coefficientmethod.
9. Calculation of design wind forces on a RC building using Gust FactorApproach.
10. Complete manual wind analysis and design of a simple G+3 storied structure using any structural analysis and design software and its comparison with any structural analysis and designsoftware.

Note: All the experiments/assignments should be done manually by individual student and the analysis & design results should be compared using latest structural analysis and design software.

Course Code	Course Title						Core/Elective
PC 1152 SE	**Advanced Concrete Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**50**	**-**	**1**

Course Outcomes

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

1. Understand the rheology of special Concrete- fly ash based Concrete- geo-polymer Concrete and Fibre ReinforcedConcrete.
2. High strength – Mixdesign
3. Conduct cube, cylinder strength and modulus of rupture of highstrength
4. Conduct of NDT ofconcrete

List of Experiments

1. To design the mix for High StrengthConcrete.
2. To determine fresh properties of High StrengthConcrete.
3. Study of stress-strain curve of high strength concrete, correlation between cube strength, cylinder strength, split tensile strength and modulus ofrupture.
4. Behaviour of beams under flexure andshear.
5. Mix proportion on fly-ash based concrete for compressivestrength.
6. Mix proportion on Geo-polymer concrete for compressivestrength.
7. Mix proportion on FRC for compressivestrength.
8. Cube compressive strength of fly-ash and geo polymer concrete.
9. Split tensile strength and modulus of rupture for fly-ash concrete/geo-polymerconcrete.
10. Development of correlation between Non-Destructive and Destructive Tests using Rebound Hammer and UPV instruments

Course Code	Course Title						Core/Elective
PC 1153 SE	**Virtual Smart Structures and Dynamics Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
Structural Dynamics	**-**	**-**	**-**	**2**	**50**	**-**	**1**

Course Outcomes

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

1. Understand the behaviour of structures subjected to dynamic loadings like wind, earthquake and blasting.
2. Understand the dynamic characteristics of structures instrumented with smart piezoelectricsensors.
3. Visualize shear lag effect and Rebar Corrosion
4. Draw response spectrum curve for givencondition
5. Measure displacements usingPhotogrammetry

List of Experiments:

Simulation based:

1. Free Vibration of S.D.O.FSystem
2. Forced Vibration of S.D.O.FSystem
3. Impulse Response of S.D.O.FSystem
4. Concept of ResponseSpectrum
5. Vibration of M.D.O.FSystem
6. Behaviour of RigidBlocks
7. Torsional Response ofBuilding
8. ContinuousSystems
9. VibrationControl
10. Modes of Vibration of Simply Supported Beam UnderFlexure
11. Modes of Vibration of Simply SupportedPlate
12. Damage Detection and Qualitative Quantification Using Electro-Mechanical Impedance (EMI) Technique
13. Dynamics of Bandra Worli Sea LinkBridge
14. Piezoelectric Energy Harvesting and Structural Health Monitoring Using Thin Surface Bonded PZT Patches.
15. Shear Lag Effect in Electro-Mechanical Impedance (EMI)Technique
16. Rebar Corrosion Detection and Assessment Using Electro-Mechanical Impedance (EMI)Technique.

Simulationbased:

17. Vibration Characteristics of Aluminium Cantilever Beam Using PiezoelectricSensors
18. Identification of High Frequency Axial Modes of Beam in "Free-Free" Condition Using Electro-Mechanical Impedance (EMI)Technique
19. Forced Excitation of Steel Beam Using PortableShaker
20. Photogrammetry for DisplacementMeasurement

e-resources:

1. http://sd-iiith.vlabs.ac.in/Introduction.html (For Experiments 1 to9)
2. http://vssd-iitd.vlabs.ac.in/home.html (For Experiments 10 to20)

Course Code	Course Title						Core/Elective
PC 1154 SE	**Seminar**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**50**	**-**	**1**

Course Outcomes

1. Develop the habit of referring the journals for literaturereview.
2. Understand the gist of the researchpaper.
3. Identify the potential for furtherscope.
4. Present the work in an efficientmanner.
5. Write the documentation in standardformat.

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 1155 SE	**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 modelling based/Experimental investigations or Numerical modelling.
- 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

<table>
<tr><td>Course Code</td><td colspan="5">Course Title</td><td colspan="2">Core/Elective</td></tr>
<tr><td>PC 1156 SE</td><td colspan="5">Major Project Phase – I</td><td colspan="2">Core</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td>20</td><td>100</td><td>-</td><td>10</td></tr>
</table>

Course Outcomes

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

1. Exposed to self-learning varioustopics.
2. Learn to survey the literature such as books, journals and contact resource persons for the selected topic of research.
3. Learn to write technicalreports.
4. Develop oral and written communication skills topresent.
5. 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.

<table>
<tr><th colspan="3">Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100</th></tr>
<tr><th>Evaluation by</th><th>Max. Marks</th><th>Evaluation Criteria / Parameter</th></tr>
<tr><td rowspan="2">Supervisor</td><td>30</td><td>Project Status / Review(s)</td></tr>
<tr><td>20</td><td>Report</td></tr>
<tr><td rowspan="5">Departmental Committee (Chairperson BoS, O.U. and Head, Supervisor & Project coordinator from the respective department of the institution)</td><td>10</td><td>Relevance of the Topic</td></tr>
<tr><td>10</td><td>PPT Preparation</td></tr>
<tr><td>10</td><td>Presentation</td></tr>
<tr><td>10</td><td>Question and Answers</td></tr>
<tr><td>10</td><td>Report Preparation</td></tr>
</table>

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

Course Code	Course Title						Core/Elective
PC 1157 SE	**Major Project Phase – II (Dissertation)**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**32**	**-**	**200**	**16**

Course Outcomes

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

1. Usedifferentexperimentaltechniquesandwillbeabletousedifferentsoftware/computational /analytical tools.
2. Design and develop an experimental set up/ equipment/testrig.
3. Conduct tests on existing set ups/equipments and draw logical conclusions from the results after analysingthem.
4. Either work in a research environment or in an industrialenvironment.
5. Conversant with technical report writing and will be able to present and convince their topic of study to the engineeringcommunity.

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

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. N o.	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

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>PC 1401 TE</td><td colspan="6">Pavement Materials and Characterization</td><td>Core</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>3</td><td>1</td><td>-</td><td>-</td><td>30</td><td>70</td><td>4</td></tr>
</table>

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.

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>PC 1402 TE</td><td colspan="6">Urban Transportation Systems Planning</td><td>Core</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>3</td><td>-</td><td>-</td><td>-</td><td>30</td><td>70</td><td>3</td></tr>
</table>

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.

<table>
<tr><td>Course Code</td><td colspan="4">Course Title</td><td colspan="2"></td><td>Core/Elective</td></tr>
<tr><td>PE 1419 TE</td><td colspan="6">Analysis of Transportation Systems</td><td>Elective</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>3</td><td>-</td><td>-</td><td>-</td><td>30</td><td>70</td><td>3</td></tr>
</table>

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.

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>OE 9103 EC</td><td colspan="6">Embedded System Design</td><td>Open Elective</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>3</td><td>-</td><td>-</td><td>-</td><td>30</td><td>70</td><td>3</td></tr>
</table>

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.

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>AD 9002 CE</td><td colspan="6">Disaster Management</td><td>Audit I</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>2</td><td>-</td><td>-</td><td>-</td><td>30</td><td>70</td><td>-</td></tr>
</table>

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.

<table>
<tr><td>Course Code</td><td colspan="4">Course Title</td><td colspan="3">Core/Elective</td></tr>
<tr><td>PC 1455 TE</td><td colspan="6">Mini Project with Seminar</td><td>Core</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td>4</td><td>50</td><td>-</td><td>2</td></tr>
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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

<table>
<tr><td colspan="3">Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 50</td></tr>
<tr><td>Evaluation by</td><td>Max. Marks</td><td>Evaluation Criteria / Parameter</td></tr>
<tr><td rowspan="2">Supervisor</td><td>20</td><td>Progress and Review</td></tr>
<tr><td>05</td><td>Report</td></tr>
<tr><td rowspan="5">Departmental Committee</td><td>05</td><td>Relevance of the Topic</td></tr>
<tr><td>05</td><td>PPT Preparation</td></tr>
<tr><td>05</td><td>Presentation</td></tr>
<tr><td>05</td><td>Question and Answers</td></tr>
<tr><td>05</td><td>Report Preparation</td></tr>
</table>

<table>
<tr><td>Course Code</td><td colspan="6">Course Title</td><td>Core/Elective</td></tr>
<tr><td>PC 1456 TE</td><td colspan="6">Major Project Phase – I</td><td>Core</td></tr>
<tr><td rowspan="2">Prerequisite</td><td colspan="4">Contact Hours per Week</td><td rowspan="2">CIE</td><td rowspan="2">SEE</td><td rowspan="2">Credits</td></tr>
<tr><td>L</td><td>T</td><td>D</td><td>P</td></tr>
<tr><td>-</td><td>-</td><td>-</td><td>-</td><td>20</td><td>100</td><td>-</td><td>10</td></tr>
</table>

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.

<table>
<tr><td colspan="3">Guidelines for awarding marks in CIE (Continuous Internal Evaluation): Max. Marks: 100</td></tr>
<tr><td>Evaluation by</td><td>Max. Marks</td><td>Evaluation Criteria / Parameter</td></tr>
<tr><td rowspan="2">Supervisor</td><td>30</td><td>Project Status / Review(s)</td></tr>
<tr><td>20</td><td>Report</td></tr>
<tr><td rowspan="5">Departmental Committee (Chairperson BoS, O.U. and Head, Supervisor & Project coordinator from therespective department of theinstitution)</td><td>10</td><td>Relevance of the Topic</td></tr>
<tr><td>10</td><td>PPT Preparation</td></tr>
<tr><td>10</td><td>Presentation</td></tr>
<tr><td>10</td><td>Question and Answers</td></tr>
<tr><td>10</td><td>Report Preparation</td></tr>
</table>

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