POSTGRADUATE PROGRAMMES IN HIGHWAY AND TRAFFIC ENGINEERING

MASTER OF ENGINEERING IN HIGHWAY AND TRAFFIC ENGINEERING

Department of Civil Engineering
Faculty of Engineering
University of Peradeniya

Course Structure

Course code	Title	Compulsory/ Optional	Credits
CE 6101	Research Methods in Civil Engineering	Optional	2
CE 6303	Slope Stability and Earth retaining Structures	Optional	3
CE 662	Basic Soil and Rock Mechanics for Highway Engineering	Compulsory	3
CE 663	Traffic Engineering	Compulsory	3
CE 664	Pavement Design	Compulsory	3
CE 665	Traffic Measurements, Analysis and Design	Compulsory	3
CE 666	Road Safety and Environment	Compulsory	3
CE 760	Highway Planning	Compulsory	3
CE 761	Highway Construction Materials and Methods	Optional	2
CE 762	Evaluation of Pavement Materials and Pavements (Lab Course)	Optional	2
CE 763	Highway Evaluation and Maintenance	Optional	2
CE 764	GIS for Highway and Transportation Engineering	Optional	3
CE 765	Quantitative Methods in Traffic Engineering	Optional	3
CE 766	Traffic Management	Optional	2
CE 767	Traffic Impact Assessment	Optional	1
CE 6103	**Advanced Study**	**Compulsory**	**5**

Number of credits from compulsory courses: 18
Number of credits from optional courses: 7
Number of credits from advanced study: 5
Total number of credits: 30

Course Code	**: CE 6101**
Course Title	**: Research Methods in Civil Engineering**
No. of Credits	**: 2**
Pre-requisites	**: -**
Compulsory/Optional	**: Optional**

Aim(s): To give the skills needed to plan and conduct a research study in order to create new knowledge in the field of Civil Engineering and related disciplines.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

1. Describe the scientific research methods and how this applies to graduate research studies
2. Prepare a literature review on a topic relevant to their area of concentration by critically reviewing published papers
3. Analyse the collected data and identify the appropriate methods for displaying the data.
4. Prepare an extended abstract and present the research findings in an oral/poster format.

Time Allocation (Hours)	Lectures: 18 Tutorials: 02 Practicals: Assignments: 20 Independent learning: 60 (Notional hours=100)

Course Content/Course Description:

Fundamentals of Research:

Definition and Objectives of Research; Qualitative vs Quantitative Research; The Scientific Research Process; Identification, selection, and formulation of research problems; Characteristics of good research problems; Review of literature

Data Collection, Analysis and Presentation:

Methods and techniques of data collection; Design of Experiments; Sampling and sampling designs; Statistical modelling and analysis including introduction to statistical package; Probability Distributions; Multivariate methods; Concepts of correlation and regression, error analysis; Effective presentation of information using Tables, illustrations, graphs, etc.

Scientific writing and presentation:

Essential components of abstract, introduction, literature review, materials and methods, results, discussion, and conclusions; Formatting of contents; Methods of referencing and the use of referencing tools, Preparing and presenting a technical presentation.

Recommended Texts

Fellows R.F., Liu A.M.M., (2015). "Research Methods for Construction", 4th edition, Wiley Blackwell.

Thiel D.V, (2014)."Research Methods for Engineers", 1st edition, Cambridge university press.

Wayne C., Booth G.G.C., Joseph M.W., (2008). "The Craft of Research", 3rd Edition University of Chicago Press.

Willie T., (2017). Research Methods: A Practical Guide for Students and Researchers, World Scientific.

Assessment		Percentage Marks
In-Course	Assignments/Course work	100
End of Semester Examinations		-

Course Code	**: CE 6303**
Course Title	**: Slope Stability and Earth Retaining Structures**
No. of Credits	**: 3**
Pre-requisites	**: None**
Compulsory/Optional	**: Compulsory**

Aim(s): To impart knowledge and skills to enable students to analyse stability of slopes and earth retaining structures.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to,

1. classify mass movements, describe factors causing mass movements and propose suitable remedial measures to control mass movements.
2. Analyze the stability of slopes using limit equilibrium method and Bishop and Morgenstern chart.
3. Analyze and design various earth retaining structures for internal and external stability.
4. Identify the reason for real field slope and retaining wall failures and propose measures to mitigate such failures in the future.

Time Allocation (Hours)	Lectures: 40 Tutorials: Practicals: Assignments: 10 Independent learning: 100 (Notional hours = 150)

Course Content/Course Description:

Mass movements:

Classification, causative factors, instrumentation, preventive, remedial and control measures

Slope Stability Analysis using EC7:

EC7 guidelines for slope stability analysis, Design of slopes to EC7, Limit equilibrium methods, Bishop and Morgenstern Chart

Design of rigid and flexible earth retaining structures using EC7:

Lateral earth pressure: Rankine's and Coulomb's theory, Introduction to earth retaining structures, EC7 guidelines for designing earth retaining structures, Design of mass concrete retaining wall and cantilever retaining wall to EC7

Introduction to sheet pile walls (Cantilever and anchored sheet pile walls), EC7 guidelines for sheet pile wall design, Fixed and free earth support methods of design of anchored sheet pile walls. Analyse internally stabilized earth wall (MSE walls), Soil nailing

Case study on slope and retaining failure:

Case studies on slope and retaining wall failures

Recommended Texts

Abramson L.W., (2002). "Slope Stability and Stabilization Methods", 2nd edition, John Wiley & Sons.

Budhu M., (2008). "Foundations and Earth Retaining Structures", John Wiley & Sons, Inc., New York, 483 pp.

Smith, I. (2014). "Smith's elements of soil mechanics", 9th Edition, John Wiley & Sons.

Assessment		**Percentage Marks**
In-Course	Assignments/Course work/Design	40
	Mid Semester Examination	-
End of Semester Examinations		60

Course Code	**: CE 662**
Course Title	**: Basic Soil and Rock Mechanics for Highway Engineering**
No. of Credits	**: 3 Credits**
Pre-requisites	**: None**
Compulsory/Optional	**: Core**

Aim(s): To provide the students with basic soil and geological knowledge in order to select suitable routes for adopting stability measures where required and select suitable methods for road construction.

Intended Learning Outcomes: At the end of this course, students should be able to:

1. Investigate the soil properties of the sub grade soil and soil improvement techniques.
2. Identify rock types and surface features of earth, and describe geological structures and processes and their influence on Civil Engineering works.
3. Classify rock masses for Highway Engineering and determine the most suitable route for road construction.
4. Find relevant Engineering properties of rocks and evaluate the suitability of rock as a road construction material.
5. Analyze the rock structures using field data and steronets.

Time Allocation (Hours)	Lectures: 38 Tutorials: 01 Practicals: 04 Assignments: 08 Independent learning: 99 (Notional hours=150)

Course Content/Course Description:

- Introduction to soil, soil formation and composition, soil types and structure.
- Field Investigations, compaction, determination of CBR from DCP test, soil improvement.
- Rock types, geological structures, geological processes and surface features of earth.
- Engineering classification of rock masses and suitability of sites for engineering projects and road constructions.
- Engineering properties of rocks and rock as a construction material.
- Stereonet analysis.
- Laboratory Tests
  - Los Angeles Abrasion value test
  - Rock Identification

Recommended Texts

1. Goodman R.E.,1983.Engineering Geology. USA:John Wiley and Sons.

Assessment		**Percentage Marks**
In-Course	Practical and Assignments	30
	Mid Semester Examination	20
End of Semester Examinations		50

Course Code	**: CE 663**
Course Title	**: Traffic Engineering**
No. of Credits	**: 3 Credits**
Pre-requisites	**: None**
Compulsory/Optional	**: Core**

Aim(s): To provide the students with advanced knowledge of traffic flow theory and its application
methods for capacity analysis so that they will be able to design, manage, operate and select control method for road traffic facilities with regard to traffic performance and safety.

Intended Learning Outcomes: At the end of this course, students should be able to:

1. Select traffic measuring procedures and data processing methods to estimate the traffic indicators.
2. Apply the knowledge of mathematics to manipulate traffic data and presenting the results as traffic indicators.
3. Choose the appropriate traffic indicators for designing and planning of a traffic system.

Time Allocation (Hours)	Lectures: 35 Tutorials: 05 Practicals: 10 Assignments: Independent learning: 100 (Notional hours=150)

Course Content/Course Description:

Traffic variables and traffic flow theory:
Fundamental parameters and relations of traffic flow - speed, density, volume, travel time, headway, spacing, time- space diagram, time mean speed, space mean speed and their relation, relation between speeds, flow, density, fundamental diagrams); Traffic stream models: Greenshield's model, Greenberg's logarithmic model, Underwood's exponential model, pipe's generalized model, multi-regime models

Traffic measurement procedures:
Measurement at a point: Traffic volume measurement, equipment for flow measurements, data analysis, concepts of ADT,AADT
Measurement over a short section: Speed measurements, 15th and 85th percentile speeds, design speed, speed distributions Measurement along a length of road: Density measurement, travel time measurement, Automated traffic measurement : GPS devices, loop detectors, video analysis, and other technologies.

Highway Capacity Estimation:
Capacity and Level of service LOS: Definitions, highway capacity, factors affecting LOS, HCM methods, Capacity and LOS calculations on Urban Street, Two lane highways , Multilane highways, Freeways.

Traffic intersection control:
Principles of traffic control, Traffic signs and road markings, Uncontrolled intersection, Channelization, Traffic rotary, Grade separated intersection

Traffic signal design:
Elements of traffic signal: Design principles of a traffic signal, Evaluation of a traffic signal

Specialized traffic studies:
Parking Studies, Accident Studies, Fuel consumption and emission studies, Congestion studies, Toll operation, Pedestrian studies
Intelligent Transport Systems

Recommended Texts

1. Garber, N.J. & Hoel L.A., 2014. Traffic & Highway Engineering. 5th ed.. USA.,
2. Fricker,J.D. & Whitford, R.K., 2004.Fundamental!s of Transportation Engineering. Pearson: Prentice Hall

Assessment		**Percentage Marks**
In-Course	Tutorials and Practical Mid Semester Examination	40 20
End of Semester Examinations		40

Course Code	**: CE 664**
Course Title	**: Pavement Design**
No. of Credits	**: 3 Credits**
Pre-requisites	**: None**
Compulsory/Optional	**: Core**

Aim(s): Introduce students to highway function, types of highways, travel demand forecasting, design criteria, and cross sections so that students will be able to plan and design a highway network for future demand.

Intended Learning Outcomes: At the end of this course, students should be able to:

1. Predict traffic loading for the design life using standard methods
2. Determine stresses and strains due to traffic loading
3. Design surface and subsurface drainage systems for highways
4. Conduct economic analysis and select best option out of alternative designs
5. Design flexible and rigid Pavements
6. Consider sustainable engineering concepts and include them in highway design

Time Allocation (Hours)	Lectures: 40 Tutorials: 02 Practicals: Assignments: 06 Independent learning: 102 (Notional hours=150)

Course Content/Course Description:

Introduction and Description of Pavements

Importance, Functions, Design and Construction, Maintenance and Rehabilitation

Traffic

Different Types of Highway Traffic, Measurement of Traffic Loads, Effect of Load and Tire Pressure

Drainage

Source and Effect of Water, Estimating Flow, Surface Drainage System, Subsurface Drainage System, Use of Software for Design of Drainage Structures.

Distress and Performance

Distresses in Asphalt Pavements, Consideration of Performance

Economic Analysis and Cost-Saving Concepts.

Engineering Economy, Concept of Life Cycle Cost, Probabilistic versus Deterministic Approach, Software for Running Life Cycle Cost Analysis

Sustainable Pavement Engineering

Need for Pavements, Design of Layout of Pavements, Construction of Pavements, Use of Waste and Byproducts in Pavement , workers, Pavement-Building-Nature-Symbiosis, Regulatory Bodies and Impetus for Sustainability, Human Factor

Structural design of Flexible pavements

Traffic and Load Distribution Concept, Materials and Layers, Theoretical Considerations for Structural Design: mechanistic and empirical design, Computer methods

Structural Design of Rigid Pavements

Theoretical Considerations, Different Methods, Limiting Criteria, Longitudinal Reinforcement Design Procedure, Computer methods for Rigid Pavements

Recommended Texts

1. Fricker, J.D. & Whitford, R.K., 2004. Fundamentals of Transportation Engineering. Pearson: Prentice Hall.
2. Garber, N.J. & Hoel, L.A., 2014.Traffic& Highway Engineering. 5th ed. USA.
3. AASHTO, 2011.A Policy on Geometric Design of Highways and Streets.6thed.Washinton.
4. Yang, H. Huang, 2003, Pavement Analysis and Design, 2nd ed., Prentice Hall.

Assessment	**Percentage Marks**

In-Course	Tutorials and Assignments Mid Semester Examination	30 20
End of Semester Examinations		50

Course Code	**: CE 665**
Course Title	**: Traffic Measurements, Analysis and Design**
No. of Credits	**: 3 Credits**
Pre-requisites	**: None**
Compulsory/Optional	**: Core**

Aim(s): To introduce traffic flow parameters, traffic data collection methods, and appropriate analysis techniques so that students will be able to select and utilize those methods and analysis techniques in estimating traffic flow parameters.

Intended Learning Outcomes: At the end of this course, students should be able to:

1. Explain the traffic flow parameters.
2. Choose the data collection methods and analyze the data using statistical methods
3. Arrange and conduct a traffic survey
4. Apply traffic analysis results to design traffic controls

Time Allocation (Hours)	Lectures: 24 Tutorials: Practicals: 40 Assignments: 02 Independent learning: 84 (Notional hours=150)

Course Content/Course Description:

- Traffic parameters(e.g.Speed, Flow,and Density) and Measuring Methods
- Traffic Surveys(Turning Movement Counts, Speed Surveys)Transportation Surveys(e.g. Person Trip Surveys, Bus loading, Origin-Destination Surveys, Travel Time Surveys)
- Parking Surveys, Data analysis, and Parking facility Designs
- Accident Data Collection, Black Spot analysis, Safe Designs
- Pedestrian Surveys, Pedestrian Data Analysis, Pedestrian Facility Design
- Public transport surveys and non-motorized transportation
- Traffic System Design Project(Individual)

Recommended Texts

1. Garber,N.J.& Hoel, L.A.,2014.Traffic & Highway Engineering.5thed.USA.
2. Papacostas,C..S. & Prevedouros, P.D., 2007. Transportation Engineering and Planning. 3rd ed. Prentice Hall

Assessment		**Percentage Marks**
In-Course	Assignments and Practical	20
	Individual Project (Viva and Report)	30
End of Semester Examinations		50

Course Code	**: CE 666**
Course Title	**: Road Safety and Environment**
No. of Credits	**: 3 credits**
Pre-requisites	**: None**
Compulsory/Optional	**: Core**

Aim(s): To introduce the fundamental concepts of mad safety issues so that students will be able to propose methods to minimize the danger on highways.

Intended Learning Outcomes: At the end of this course, students should be able to:

1. Explain traffic safety concepts
2. Summarize various safety management systems and different safety countermeasures
3. Analyze accident data using statistical tools
4. Choose appropriate countermeasures and evaluate their effectiveness

Time Allocation (Hours)	Lectures: 30 Tutorials: 01 Practicals: Assignments: 28 Independent learning: 91 (Notional hours=150)

Course Content/ Course Description:

Introduction to road. Safety Importance of road safety: Local and global statistics of road traffic crashes

Crash reporting and collision diagrams: Different crash reporting systems Concepts of collision diagrams Extracting important data for analyzing.

Basics of crash statistics: Basic statistics to treat crash data, Data presentations Predictions, regression analysis

GIS Applications inroad: Safety Basics of GIS. GIS applications

Factors that influence safety and analysis of safety data: Identify reasons for crashes. Introduce accident black spots. Introduce spatial distribution, time distribution and road user group distribution

Safety counter measures: Introduction to various counter measures. Selection of suitable counter measures. Effectiveness of safety counter measures. Implementing safety counter measures

Highway geometry and safety: Horizontal and vertical curve designs Access roads. Junctions

Road signing and marking: Standard road signings and marking. Effect of road signing and marking for safety and convenience. Modifications necessary to meet local conditions.

Road safety audits: Basic concepts in road safety auditing. Different stages in road safety auditing

Issues related to pedestrian safety: Introduction to Pedestrian facilities. Knowledge and Attitudes towards pedestrians facilities of different road user groups. Possible improvement to enhance the safety of pedestrians

Road Safety Management

Recommended Texts

<table>
<tr><td colspan="3">1. Ogden, K.Vl.,1996.SaferRoads:A Guide to Road Safety Engineering. Averbury Technical Press: Ashgate Publishers.
2. Elvik,R. & Vaa.T.,2004.TheHand book of Road Safety Measures. Elsevier
3. Pline, J., ed., 1999. Transportation Engineering Handbook. 5th ed. Institute of Transportation Engineers: Prentice Hall.</td></tr>
<tr><td colspan="2">Assessment</td><td>Percentage Marks</td></tr>
<tr><td>In-Course</td><td>Tutorials and Assignments
Mid Semester Examination</td><td>40
20</td></tr>
<tr><td colspan="2">End of Semester Examinations</td><td>40</td></tr>
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Course Code	**: CE 760**
Course Title	**: Highway Planning**
No. of Credits	**: 3**
Pre-requisites	**: None**
Compulsory/Optional	**: Compulsory**

Aim(s): To impart knowledge to plan a sustainable highway network considering social, environmental, engineering, and economic considerations for highway planning.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

1. Perform travel demand forecasting methods to estimate future traffic demands
2. Develop proper sight distance criteria and intersection criteria for route networks
3. Identify environmental impacts and decide cost effective countermeasures
4. Design horizontal and vertical curves of highways
5. Design desirable super elevation for highways
6. Utilize appropriate guidelines and manuals for planning
7. Consider environmental impact mitigation concepts and practices for planning

Time Allocation (Hours)	Lectures: 35 Tutorials: 5 Practical: Assignments: 10 Independent learning: 100 (Notional hours=150)

Course Content/Course Description:

History and finance, and Highway Classification
Transportation and forecasting (Trip generation, trip distribution, modal split, trip assignment)
Driver, vehicle and roadway characteristics
Highway capacity for two lane roads, basic geometric concepts, horizontal curve design,
Vertical curve design, Super elevation, Transition curves (spirals), Cross sectional elements
Highway safety and roadside design
Intersection and interchanges
Using International Standards for Highway Design
Traffic control devices
Environmental Mitigation in Transportation Projects

- How Transportation Impacts the Environment
- Model for Assessing Impacts and Developing Mitigation
- Measures
- Project Conception
- Impact Assessment
- Alternatives Analysis
- Public Involvement and Review
- Enforcement and Post-Project Monitoring

Transportation Planning and Regional Mitigation Approaches

Recommended Texts

1. Fricker, J.D. & Whitford, R.K., 2004. Fundamentals of Transportation Engineering. Pearson: Prentice Hall.Bottom of Form
2. Garber, N.J. & Hoel, L.A., 2014. Traffic & Highway Engineering. 5th ed. USA.
3. AASHTO, 2011. A Policy on Geometric Design of Highways and Streets. 6th ed. Washington.

Assessment		**Percentage Marks**
In-Course	Assignments/Presentations	30

	Mid Semester Examination	20
End of Semester Examinations		50

Course Code	**: CE 761**
Course Title	**: Highway Construction Materials and Methods**
No. of Credits	**: 2 Credits**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): To introduce the soils, asphalt, and concrete components of highway, production and construction methods so that the students will be able to select proper materials and construction methods in highway planning.

Intended Learning Outcomes: At the end of this course, students should be able to:

1. Choose basic physical properties of highway materials for proper design and construction.
2. Prepare material specifications for flexible and rigid pavements.
3. Evaluate the production process and required properties of highway construction materials.
4. Select appropriate construction materials for flexible and rigid pavements based on environmental factors.

Time Allocation (Hours)	Lectures: 27 Tutorials: 03 Practicals: Assignments: Independent learning: 70 (Notional hours=100)

Course Content/Course Description:

Granular Material for Pavement Construction

Mass-Volume Relationships, Grain Size Distribution: Gradation, Effect of Water, Stiffness and Strength of Soils, Soil Stabilization Concepts and Methods: Chemical and Mechanical, Parent Rock, and Types, Aggregate Production and Aggregate Tests.

Bitumen

Cut back Bitumen, Emulsion and Bitumen Testing

Asphalt

Asphalt Binder, Safe Delivery, Storage, and Handling of Asphalts, Asphalt Binder Properties, Asphalt Binder Properties and Pavement Distress and Performance, Recovery of Asphalt Binder from Asphalt Mix, Asphalt Emulsions

Concrete

Concrete, Aggregates, Cement, Water, Hydration and Steel in Concrete

Construction of Asphalt Pavements

Production, Transportation and Laydown, Description and Requirements of Components in Hot Mix, Asphalt-Producing Plants, Equipment Used for Transportation, Laydown, and Compaction, Important Factors, Specification, Quality Control and Quality Assurance

Construction of Concrete Pavements

Concrete Production, Preparation of Subgrade and Base, Presetting Reinforcements such as Dowel Bars, Tiebars and Continuous Reinforcement, Paving, Concrete Placement, Finishing, Quality Assurance Quality Control (QC/QA).

Recommended Texts

Mallick,R.B. & El-Korchi,T.,2008..Pavement Engineering: Principles and Practices.2nd ed.
Delatte,N., 2007.Concrete Pavement Design, Construction, and Performance.2nd ed. London: Taylor & Francis.

Assessment		**Percentage Marks**
In-Course	Tutorials	30
	Mid Semester Examination	20
End of Semester Examinations		50

Course Code	**: CE 762**
Course Title	**: Evaluation of Pavement materials and Pavements**
No. of Credits	**: 2 Credits**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): To introduce testing and characterization of road construction materials; soils, asphalt, aggregate and concrete components of pavements so that students will be Able to choose the test1ng methods for pavement materials and pavements to the appropriate standards.

Intended Learning Outcomes: At the end of this course, students should be able to:

1. Evaluate performance related properties of primary components of pavement and their impacts on pavement performance.
2. Understand and utilize basic principles of destructive and non-destructive testing of pavement materials.
3. Perform tests, and interpret results from tests on various components of highway pavements.
4. Select material characterization, testing and statistical analysis for interpreting test data.
5. Perform forensic analysis of failure of pavements to determine causes of failure.

Time Allocation (Hours)	Lectures: 16 Tutorials: Practicals: 28 Assignments: Independent learning: 56 (Notional hours=100)

Course Content/Course Description:

Laboratory Soil Testing: Grain size analysis, Shear Tests, CBR

In-situ Testing: Determination of filed density of pavement layer, plate bearing test, dynamic cone penetration, Benkelman beam deflection

Aggregate Testing: Aggregate Impact Test, Los Angeles abrasion test, po1ished stone test, Aggregate crushing value test, specific gravity and absorption test, shape test, soundness test

Bitumen Testing: Penetration Test, Ductile and elastic recovery test, softening point test viscosity test, flash and fire point test, water sensitivity test

Asphalt Testing: Specific gravity test on asphalt, Marshall stability test on compacted asphalt

Concrete testing: Concrete Mix design (Cube Test),Work ability, strength and density testing

Recommended Texts

1. Roberts, F.L.et al.,1996..Hot Mix Asphalt, Materials, Mixture Design and Construction. National Asphalt Pavement Association.
2. Portland Cement Association, 2002. Design and Control of Concrete Mixtures. 15th ed.

Assessment		**Percentage Marks**
In-Course	Laboratory and Field Testing	75
	Mid Semester Examination	-
End of Semester Examinations		25

Course Code	**: CE 763**
Course Title	**: Highway Evaluation and Maintenance**
No. of Credits	**: 2 Credits**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): To introduce concepts of pavement preservation through management, evaluation, maintenance and rehabilitation so that students will be able to use this knowledge on highway evaluation and maintenance.

Intended Learning Outcomes: At the end of this course, students should be able to:

1. Apply the concepts of asset management.
2. Develop a database of road conditions through laboratory and field testing.
3. Determine the appropriate maintenance and rehabilitation techniques.

Time Allocation (Hours)	Lectures: 28 Tutorials: Practicals: Assignments: 04 Independent learning: 68 (Notional hours=100)

Course Content/Course Description:

Introduction to Asset Management Systems

Introduces the fundamental principles common to other industries (e.g.trucking,rail) that are applicable to a PMS and how they can be applied to pavements.

Pavement Management Systems Overview

Describes the basic components of a PMS and how the products of can be used as a tool to aid in the development and that system decision-making for the pavement maintenance and construction program for an agency.

Relational Data bases and Location Referencing Systems

Details the principles and concepts behind a relational database including the available technology, such as GIS and GPS

Inventory and History

Defines what types of data should be collected, how it should be collected and how it is used in a PMS.

Pavement Condition Surveys

Describes the use of pavement condition survey data in the PMS, how it can be collected and the state-of-the-art of data collection equipment.

Pavement Condition Indices

Includes the historic development of pavement distress in dices, their basic functions, how they are computed, the different types available along with their advantages and disadvantages, and a discussion of the International Roughness Index (IRI).

ESAL Flow Maps

Participants will be able to more fully appreciate the use and application of: ESALs rather than basic traffic volumes in a PMS.

Rehabilitation needs and introduce the tools used

Performance Models

This module will emphasize the importance of predicting the change in level of service in order to estimate future to predict. future conditions

Remaining Service Life

Participants will gain an understanding of what the remaining service life of a pavement is, how it is used, why it is important, and how it is calculated.

Prioritization

The focus will be on the priority assessment techniques for prediction models to forecast conditions and prioritization as tools to identifythe most cost-effective strategies for various funding levels.

Optimization

Will familiarize the participants with optimization techniques used in a PMS.

Maintenance and Rehabilitation of Asphalt Pavements

Maintenance, Primary Corrective Maintenance Activities, Primary Preventive Maintenance Activities, Recycling

Maintenance and Rehabilitation of Concrete Pavements

Joint and Crack Sealing, Slab Stabilization, Diamond Grinding, Load Transfer Devices, Precast Panels for Repair and Rehabilitation, Portland Cement Concrete Overlays, Warranty Projects

Recommended Texts

1. Malik,.R.B.& El-Korchi, T.,2008.Pavement Engineering: Principles and Practices. .2nded.
2. Delatte,N.,2007.ConcretePavement Design, Construction, and Performance.2nd ed. London: Taylor & Francis.

Assessment		**Percentage Marks**
In-Course	Assignments	20
	Mid Semester Examination	30
End of Semester Examinations		50

Course Code	**: CE 764**
Course Title	**: GIS for Highway and Transportation Engineering**
No. of Credits	**: 3 Credits**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): After following this course student will be able to use potential applications of geographic information systems (GIS) in planning Highway and Transportation Engineering

Intended Learning Outcomes: At the end of this course, students should be able to:

1. Explain the basic principles and procedures in geographic data processing
2. Develop practical skills in GIS data formats, data collection methods, data entry and manipulation, coordinate systems and map projections, methods of spatial and 3D analysis and geovisualization. .
3. Explain the physical principles underlying remote sensing and apply digital image processing techniques
4. Describe the operation of available Global Navigation Satellite Systems (GNSS) and the error sources.
5. Adopt GIS knowledge in planning and designing highway and transportation systems

Time Allocation (Hours)	Lectures: 28 Tutorials: 02 Practicals: 26 Assignments: 04 Independent learning: 90 (Notional hours=150)

Course Content/Course Description:

Introduction to GIS and software: Raster data, Vector data, Data structures, Data manipulation Exploring the interface and file management system

Spatial data structures and sources: Map projections/coordinate system, World and National datum and trans formations, we band other spatial data sources

GIS analysis functions and operations; Creating editing and GIS data Spatial and overlay analysis Distance analysis. Conversion and re-sampling techniques

Layouts, reports, graphs and Data interoperability: Preparing and presenting maps and tables and exporting them to different online formats, Exporting and importing data to and from different formats

Network modeling and analysis: Performing network analyses; developing network **connectivity rules;** network validation and editing Road network analysis.

Model Builder: Creating a model for complex analysis

Remote Sensed Data and Image processing techniques: Use of Elector Magnetic Spectrum in RS. Active and passive remote sensing, SAR data Supervised and unsupervised classification

Introduction to Geographic Positioning Systems: GNSS for GIS data capture, importing and exporting GPS data

Recommended Texts

1. Law, M. & Collins, A., 2013. Getting to Know ArcGIS for Desktop. 3rd ed. Esri press
2. Miller, H.J. & Shaw, S.L., 2001. Geographic Information Systems for Transportation: Principles and Applications. New York: Oxford University Press.

Assessment		**Percentage Marks**
In-Course	Tutorials, practical and Assignments	60
	Mid Semester Examination	-
End of Semester Examinations		40

Course Code	**: CE 765**
Course Title	**:Quantitative methods in Traffic Engineering**
No. of Credits	**: 3 Credits**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): To equip the students with mathematical knowledge in the areas of probability and statistics required for traffic data analysis.

Intended Learning Outcomes: At the end of this course, students should be able to:

1. Identify suitable probability distributions (Discrete and continuous) for a given situation or a data set.
2. Find regression-models to fit traffic data gathered by traffic surveys.
3. Perform required statistical tests to test hypothesis and use statistical software (e.g. Minitab) to analysis traffic data.

Time Allocation (Hours)	Lectures: 29 Tutorials: 09 Practicals: 14 Assignments: Independent learning: 98 (Notional hours=150)

Course Content/Course Description:

Introduction: Concepts of probability, Sample space and events, Random variables, Probability distributions, Cumulative distributions, Expected values.

Discrete probability distributions: Binomial distribution, Poisson distribution

Continuous probability distributions : Normal distribution, Weibull distribution

Sampling distributions: Sampling distribution of sample mean, Central limit theorem, Sampling distribution of sample variance

Inferences on mean and variance: Point estimation, Confidence intervals

Hypothesis testing: Hypothesis testing for mean, variance and proportions Single sample and Two samples tests

Sampling techniques and analysis: Sampling methods, questionnaire preparation, data analysis

Simple and multiple linear regression: Correlation, simple linear regression, multiple linear regression, polynomial regression, use of' Dummy 'variables in multiple regression

Residual Analysis: Outliers, Residual plots, Multicollinearity, Statistical tests for examination of residuals, model validation

Selecting the 'best' regression model: Forward selection, backward elimination, step wise regression, Akaike, Information Criterion and Baysian Information criterion.

Recommended Texts

1. Montgomery, D.C. & Runger, G.C.,2007.Applied Statistics and Probability for Engineers. 4th ed .John Wiley and Sons, Inc.
2. Draper, N.R.& Smith,H.,1998.Applied regression analysis.3rded.New York: Wiley.
3. Scheafter, R.L., Hendall, W. & Ott, L.,1996. Elementary Survey Sampling. 5th ed. wadsworth Publishing Company.
4. Cochran,W.G.,1977.Sampling Techniques. 3rded.JohnWileyandSons, inc..

Assessment		**Percentage Marks**
In-Course	Tutorials and Practical	20
	Mid Semester Examination	30
End of Semester Examinations		50

Course Code	**: CE 766**
Course Title	**: Traffic Management**
No. of Credits	**: 2 Credits**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): An introduction of traffic management concepts, travel demand management (TDM) techniques and evaluate the benefits gained with traffic management so that students will be able to plan a transportation system with appropriate TDM measures.

Intended Learning Outcomes: At the end of this course, students should be able to:

1. Demonstrate how TDM measures are used to control a traffic system
2. Recommend the traffic management techniques for urban and local environments
3. Apply knowledge of TDM and intelligent traffic management techniques to control a transportation system

Time Allocation (Hours)	Lectures: 22 Tutorials: Practicals: 16 Assignments: Independent learning: 62 (Notional hours=100)

Course Content/Course Description:

1. Introduction to traffic management, Travel Demand Management (TDM).
2. Urban traffic management techniques, local area traffic management.
3. Managing non-motorizes transport, bus priority theorem.
4. Road signs and markings traffic calming and speed control, Traffic demand management and road pricing, HOV promotion, junction control.
5. Parking management and its applications.
6. User information systems and intelligent traffic management systems.

Recommended Texts

1. Rodney Tolley and Brian Turton, 1995 Transport Systems, Policy and Planning, A geographical Approach, Wiley and Sons, Inc. USA
2. Garber, N.J. & Hoel, L.A., 2014. Traffic & Highway Engineering. 5th ed. USA.

Assessment		**Percentage Marks**
In-Course	Tutorials and Practical	20
	Mid Semester Examination	30
End of Semester Examinations		50

Course Code	**: CE767**
Course Title	**: Traffic Impact Assessment (TIA)**
No. of Credits	**: 1 Credit**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): The aim of this course is to provide the students with knowledge and planning to perform a TIA for a proposed development project in an urban area.

Intended Learning Outcomes: At the end of this course, students should be able to:

1. Decide the traffic data necessary to conduct a proper TIA.
2. Choose the methods to collect data and conduct the required traffic surveys for a TIA.
3. Analyze and interpret results of traffic surveys using mathematical techniques.
4. Evaluate the traffic impact based on the outcome of the traffic surveys.

Time Allocation (Hours)	Lectures: 08 Tutorials: Practicals: 0 Assignments: 14 Independent learning: 28 (Notional hours=50)

Course Content/Course Description:

Introduction to TIA: Major Components of a Traffic Impact Study

Traffic Data Collection, Highway Inventory, Parking counts, Bus loading and Pedestrians Counts, Travel time Data collection.

Intersection Analysis: Capacity estimation.

Traffic forecasting and impact assessment.

Parking standards and regulations.

TIA case study.

Recommended Texts

1. Papacostas, C.S. & Prevedouros, PD.,2007. Transportation Engineering and Planning. 3rd ed. Prentice Hall.

Assessment		**Percentage Marks**
In-Course	Assignment	50
	Mid Semester Examination	-
End of Semester Examinations		50

Course Code	: CE 6103
Course Title	: Advanced Study
No. of Credits	: 5
Pre-requisites	: None
Compulsory/Optional	: Compulsory

Aim(s): To train the students to carry out literature review, identify a knowledge gap/complex engineering problem, formulate a methodology, execute the methodology and present the findings.

Intended Learning Outcomes:

On successful completion of the course, the student should be able to;

1. search for technical literature, formulate a research problem based on the identified knowledge gap/complex engineering problem and develop appropriate methodology.
2. carry out a comprehensive analysis to solve the identified research problem/complex engineering problem.
3. write the report and present the research findings/solution to the complex engineering problem in a precise and coherent manner.

Time Allocation (Hours)	Notional hours = 500

Course Content/Course Description:

Self-studies:

Search of technical literature, identify the knowledge gap/complex engineering problem, formulate aim, objectives and scope, develop a methodology, collect data, comprehensive analysis of the research problem/complex engineering problem and present the findings in the form of presentations and a report.

Meetings with supervisor:

Conduct progress meetings with the supervisor, discuss the progress, and receive feedback from the supervisor for the presentation and report.

Recommended Texts

Geoffrey R.M., David D., David F., (2005). "Essentials of Research Design and Methodology", John Wiley & Sons.

Creswell J. W., David J. C., (2017). "Research Design: Qualitative, Quantitative, and Mixed Methods", John SAGE Publications.

Assessment	**Percentage Mark**
In-Course **Progress evaluations:** **Four progress evaluations:** Progress evaluation 1: Oral presentation 1 Progress evaluation 2: Oral presentation 2 Progress evaluation 3: Oral presentation 3 Progress evaluation 4: Oral presentation 4 (After submission of detailed proposal)	40
Detailed Proposal: Detailed Proposal (after three progress presentations) defended before continuing with the advanced study	10

Final Evaluation:	
Final report	30
Presentation	20