MASTER OF SUSTAINABLE BUILT ENVIRONMENT

Department of Civil Engineering
Faculty of Engineering
University of Peradeniya

Course Structure

Course code	Title	Compulsory/ Optional	Credits
CE690	Fundamentals of Architecture and Economics for Sustainable Planning	Compulsory	3
CE691	Infrastructure Planning for Sustainable Cities	Compulsory	3
CE692	Global Environmental Issues and Built Environment	Compulsory	3
CE693	Building Services Engineering	Compulsory	3
CE694	Green^{SL} Rating System for Built Environment	Compulsory	3
CE696	Sustainable Construction	Compulsory	3
CE 6101	Research Methods in Civil Engineering	Optional	2
CE 6205	Water Resources Project Planning	Optional	3
CE 6207	Climate Change Impact and Adaptation in Water Sector	Optional	2
CE 6210	GIS and Remote Sensing in Water Resources	Optional	2
CE 6214	Integrated Water Resource Management	Optional	2
CE 6314	Mitigation and Control of Natural Geo-hazards	Optional	2
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 **Course Title** **No. of Credits** **Pre-requisites** **Compulsory/Optional**	**: CE 690** **: Fundamentals of Architecture and Economics for Sustainable Planning** **: 3** **: None** **: Compulsory**

Intended Learning Outcomes: After following the course module the students will be able to:

1. Describe the fundamental concepts of sustainable architecture and landscaping
2. Apply economic appraisal methods and practices of value engineering methods in sustainable built environment

Time Allocation (Hours)	Lectures & Tutorials :35 Assignments & Practical : 10 Independent learning:

Course content/Course Description:

Fundamentals of architecture; sustainable architecture, sustainable landscape practices. Economics for sustainable planning; economic appraisal methods, lifecycle costing, asset management, value engineering, Environmental economics, sustainability and economics. Discussion of case studies.

Assessment		**Percentage Mark**
In-course	Assignment/Projects	30
	Mid Semester Examination	20
End of Semester Examinations		50

Course Code	**: CE 691**
Course Title	**: Infrastructure Planning for Sustainable Cities**
No. of Credits	**: 3**
Pre-requisites	**: None**
Compulsory/Optional	**: Compulsory**

Intended Learning Outcomes: After following the course module the students will be able to:

1. Demonstrate conventional and sustainable practices of infrastructure planning, land-use planning and transportation planning
2. Discuss qualitatively and quantitatively the improvements that may be achieved through changes in land-use, transport and infrastructure set up of a human settlement
3. Discuss qualitative and quantitative aspects in planning of social infrastructure, utility networks and location of facilities
4. Assess the adequacy of buffer facilities of infrastructure in handling emergencies

Time Allocation (Hours)	Lectures & Tutorials :35 Assignments & Practical : 10 Independent learning: 105 (Notional hours=150)

Course content/Course Description:

Fundamentals of Infrastructure Planning
Concept of Sustainability as applied to Infrastructure Planning
Land-Use Planning and Urban Form for Energy-Efficiency (Urban Growth Patterns)
Urban and Rural Transport Planning (Sustainable Accessibility for Cities and Communities)
Social Infrastructure Planning (Shelter Health, Education, Employment, Administration, Safety, Recreation and Cultural),
Utility Networks and Facility Location
Infrastructure Planning for Emergencies
Social Organization and Urban Psychology
Discussion of case studies

Assessment		**Percentage Marks**
In-course	Assignment/Projects	20
	Mid Semester Examination	30
End of Semester Examinations		50

Course Code	**: CE 692**
Course Title	**: Global Environmental issues and built environment Cities**
No. of Credits	**: 3**
Pre-requisites	**: None**
Compulsory/Optional	**: Compulsory**

Intended Learning Outcomes: After following the course module the students will be able to:

1. Discuss the global environmental issues and the contribution from built environment
2. Apply the concept of sustainability in relation to the built environment
3. Describe importance and available methods for sewage and wastewater treatment
4. Use solid waste management in built environments
5. Distinguish the sources and health effects of indoor air pollution, and apply possible solutions
6. Apply ISO14001 in construction industry

Time Allocation (Hours)	Lectures & Tutorials :36 Assignments & Practical : 09 Independent learning: 105 (Notional hours=150)

Course content/Course Description:

Global Environmental Issues: Global warming & climate change, Acid rains, Ozone layer depletion, overconsumption of resources, Loss of biodiversity

Environmental Impact from Construction Industry: Direct and indirect impacts, evaluation of overall impacts through LCA and carbon footprint

Mitigation of impacts: introduction to sustainable construction industry

Management and treatment of waste in built environments: Sustainable resource consumption, Prevention and reduction of waste generation, Wastewater and sewage treatment, Solid waste management

Mitigation of indoor air pollution: causes of indoor air pollution, health effect and mitigation of **indoor air pollution;**

Environmental Management systems: ISO14001 in construction industry..

Assessment		**Percentage Marks**
In-course	Assignment/Projects	20
	Mid Semester Examination	30
End of Semester Examinations		50

Course Code	**: CE 693**
Course Title	**: Building Services Engineering**
No. of Credits	**: 3**
Pre-requisites	**: None**
Compulsory/Optional	**: Compulsory**

Intended Learning Outcomes: After following the course module the students will be able to:

1. Describe the basic aspects of building services engineering
2. Apply energy auditing and energy performance improvement methods in buildings
3. Illustrate alternative energy sources and new energy saving technologies
4. Apply ISO50001 in built environment.

Time Allocation (Hours)	Lectures & Tutorials :35 Assignments & Practical : 10 Independent learning: 105 (Notional hours=150)

Course content/Course Description:

Introduction to building services engineering: HVAC Systems and thermal comfort, Fire and safety, Acoustics, Lighting, Electromechanical systems, Building Management Systems (BMS), Preventive Maintenance for sustainable operations

Building energy: New energy saving techniques, Renewable energy, Energy storages

Energy management systems: ISO50001 in built environment, Introduction to energy auditing methods

Industrial case studies

Assessment		**Percentage Marks**
In-course	Assignment/Projects	30
	Mid Semester Examination	20
End of Semester Examinations		50

Course Code	**: CE 694**
Course Title	**: Green SL Rating System for Built Environment**
No. of Credits	**: 3**
Pre-requisites	**: None**
Compulsory/Optional	**: Compulsory**

Intended Learning Outcomes: After following the course module the students will be able to:

1. Illustrate the key components of GreenSL Rating System
2. Apply GreenSL certification process and associated concepts in sustainable built environment
3. Formulate GreenSL strategies and measurements

Time Allocation (Hours)	Lectures & Tutorials :30 Assignments & Practical : 15 Independent learning: 105 (Notional hours=150)

Course content/Course Description:

Management of building systems
Sustainable sites of building systems
Water efficiency
Energy and atmosphere
Materials and resources
Indoor environmental quality
Innovation and design process
Society and Cultural awareness
Industrial case studies

Assessment		**Percentage Marks**
In-course	Assignment/Projects	40
	Mid Semester Examination	20
End of Semester Examinations		40

Course Code	**: CE 696**
Course Title	**: Sustainable Construction**
No. of Credits	**: 3**
Pre-requisites	**: None**
Compulsory/Optional	**: Compulsory**

Intended Learning Outcomes: After following the course module the students will be able to:

1. Practice conventional and sustainable design procedures
2. Design according to the Code of Practice for Energy-Efficient Buildings in Sri Lanka
3. Design with eco-friendly materials

Time Allocation (Hours)	Lectures & Tutorials :39 Assignments & Practical : 06 Independent learning: 105 (Notional hours=150)

Course content/Course Description:

The principles of sustainable construction,
Management of construction waste,
Occupational health and safety,
Modular construction,
Lean construction techniques,
Understanding government procurement procedures,
Working with the supply chain to develop sustainable solutions,
Mitigation of environmental impacts due to construction,
Renovation and retrofitting of structures.
Case studies

Assessment		**Percentage Marks**
In-course	Assignment/Projects	30
	Mid Semester Examination	20
End of Semester Examinations		50

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 6205**
Course Title	**: Water Resources Project Planning**
No. of Credits	**: 3**
Pre-requisites	**: None**
Compulsory/Optional	**: Compulsory**

Aim(s): To provide detailed knowledge for management and planning of water resources development projects.

Intended Learning Outcomes:

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

1. Carryout feasibility studies for complex water resources projects.
2. Use system analysis and economic analysis techniques in planning and management of water resources development projects.
3. Prepare schedules for the implementation of water resource projects.
4. Appraise water law and policy, and discuss how it influences regional and national decision making on water resource use.

Time Allocation (Hours)	Lectures: 34 Tutorials:03 Practical: Assignments:16 Independent learning: 97 (Notional hours=150)

Course content/Course Description:

Water resources systems analysis and modelling:

General concepts of systems analysis, planning, designing and operation of water resources systems, Application of simulation, optimization and multi-criteria decision analysis models

Multipurpose river basin planning:

Inter-basin and inter-provincial water resources planning and management, Shared water resources and conflict management

Water policy and governance:

Water law and policy, Water rights, Institutional aspects, Water allocation laws

Economic analysis and project financing:

Economic and financial evaluations, Financial models,benefit cost analysis, risk and uncertainty, multipurpose development and cost allocations

Project planning:

Feasibility studies, Planning techniques and project scheduling, Environmental and social aspects, Environmental audit, Project monitoring and post project evaluation, Commissioning and follow-up action.

Recommended Texts

Katko T., Juuti P.S., Schwartz K., (2013). "Water Services Management and Governance, Governance and Management for Sustainable Water Systems Series", IWA publishing, London.

Loucks D.P.,Beek E.V.,(2005)."Water Resources Systems Planning andManagement: An Introduction to Methods, Models and Applications", UNESCO, Paris.

Taylor J., (2007)."Project Scheduling and Cost Control: Planning, Monitoring and Controlling - Planning Monitoring and Controlling the Baseline", J. Ross Publishing.

Vedula S., Mujumdar P.P., (2005). "Water Resources Systems Modelling Techniques and Analysis", Tata-McGraw Hill, New Delhi.

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

Course Code	**: CE 6207**
Course Title	**: Climate Change Impacts and Adaptation in Water Sector**
No. of Credits	**: 2**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): To provide knowledge on climate change impacts and adaptation techniques in water sector.

Intended Learning Outcomes:

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

1. Explain climate change referred to science of climate system and drivers.
2. Describe the techniques available for downscaling of GCM predictions for basin scales.
3. Explain the anticipated impacts and propose climate change adaptation techniques with special reference to water resources management.

Time Allocation (Hours)	Lectures: 25 Tutorials: 02 Practical: Assignments:06 Independent learning: 67 (Notional hours=100)

Course content/Course Description:

Science of climate change:

Climate system, Drivers of climate change, Climate modelling and climate change projections, GCMs

Impacts of climate change:

Impacts on hydrologic cycle, Impacts on regional climate and water resources, Impacts on water infrastructure, agriculture, food security, health and other sectors

Adaptation for resilience:

Exposure, vulnerability and risk of climate change, Regional and local adaptations in water sector, Resilience and traditional systems, Governance and policy framework

Climate projection downscaling:

Statistical downscaling, Dynamic downscaling, Applications in designs of hydraulic structures and water management

Recommended Texts

Fung C.F., Lopez A., New M., (2016). "Modelling the Impact of Climate Change on Water Resources", Wiley-Blackwell.

Shrestha S., Babel M.S., Pandey V.P., (2014). "Climate Change and Water Resource", CRC Press.

Turral H., Burke J., Faurès J.M., (2011). "Climate Change, Water and Food Security", Food and Agriculture Organization of the United Nations, Italy.

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

Course Code	**: CE 6210**
Course Title	**: Geographic Information Systems and Remote Sensing in Water Resources**
No. of Credits	**: 2**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): To equip students with knowledge and skills on the applications of geographic information systems (GIS) and Remote Sensing (RS) in water resources management and planning.

Intended Learning Outcomes:

On successful completion of the course, the student 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.

Time Allocation (Hours)	Lectures: 15 Tutorials: Practical: 15 Assignments: 15 Independent learning: 55 (Notional hours=100)

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 transformations, Web and other spatial data sources

GIS analysis functions and operations:

Creating editing and GIS data, Spatial and overlay analysis , Distance analysis, Application of Hydrology tools

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

Remote Sensed Data and Image processing techniques:

Use of Elector Magnetic Spectrum in RS, Active and passive remote sensing, Supervised and unsupervised classification, remote sensing application in water resources

Introduction to Geographic Positioning Systems:

GNSS for GIS data capture, importing and exporting GPS data

Recommended Texts

Johnson L.E., (2009). "Geographic Information Systems in Water Resources Engineering", 1st edition, Taylor & Francis Group.

Law M., Collins A., (2013). "Getting to Know ArcGIS for Desktop", 3rd edition, Esri press.

Assessment		**Percentage Marks**
In-course	Assignment/ Course work	60
End of Semester Examinations		40

Course Code	**: CE 6214**
Course Title	**: Integrated Water Resources Management**
No. of Credits	**: 2**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): To equip the students with the knowledge for improved water resources management through the implementation of applicable and effective integrated management tools and techniques.

Intended Learning Outcomes:

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

1. Interpret and recommend improved water resources management measures through the implementation of applicable and effective integrated management tools and techniques.
2. Critically analyse the principles of governance, planning, adaptive management and capacity building in local, regional and transboundary water resources regimes.
3. Assess the concept of integrated water resources management in relation to climate change.

Time Allocation (Hours)	Lectures:25 Tutorials:03 Practical: Assignments:04 Independent learning: 68 (Notional hours=100)

Course content/Course Description:

Basic concepts:

Components and dimensions of IWRM

Protection of water resources:

Demand and supply management, Catchment management and recycling and reuse.

Gender in IWRM:

Mainstreaming gender and IWRM nexus, Gender differential roles

Climate change and impacts on water

Water governance:

Regulations and policy, Management of shred water resources.

Water and ecosystems:

Ensuring water quality, Water supply, Sanitation and health, Pollution control and prevention of waterborne diseases

Recommended Texts

Adamowski J., Zyla C., Cuenca E., Medema W., Clamen M., Reig P., (2013).“Integrated and Adaptive Water Resources Planning, Management, and Governance”, Water Resources Publications LLC, Littleton, Colorado, USA.

Grigg N.S., (2016).“Integrated Water Resources Management: An Interdisciplinary Approach”,Palgrave Macmillan, UK.

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

Course Code	**: CE 6314**
Course Title	**: Mitigation and Control of Geo Hazards**
No. of Credits	**: 2**
Pre-requisites	**: None**
Compulsory/Optional	**: Optional**

Aim(s): To provide knowledge on identification, risk assessment, mitigation and control of geo-hazards.

Intended Learning Outcomes:

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

1. Classify major types of geo-hazards.
2. Perform reliability/risk analyses.
3. Apply suitable mitigation and control measures.

Time Allocation (Hours)	Lectures: 25 Tutorials: Field Visit:08 Assignments: 02 Independent learning: 65 (Notional hours=100)

Course Content/Course Description:

Introduction to Geo-hazards :

Different types of geo-hazards, causes for geo-hazards, case studies.

Rock falls and Landslides:

Classification of mass movements of soils and rocks, failure mechanisms, Investigation and instrumentation, Prevention, control and mitigation, Early warning systems

Land Subsidence and Sinkholes:

Sinkholes, ground water depletion

Volcano and Earthquakes :

Theory of plate tectonics, Volcanoes and Earthquakes

Salinity intrusion:

Types, causes, mitigation methods

Manmade hazards:

Eg. - Underground storage of hazardous waste, spill of hazardous materials, mining, land fills

Recommended Texts

Bolt B.A., Horn W.L., MacDonald G.A., Scott R.F, (1975).“Geological Hazards, Earthquakes-Tsunamis - Volcanoes, Avalanches - Landslides – Floods”, Springer.

Davies T.,ShroderJr.J.F.(2004). “Landslide Hazards, Risks, and Disasters”, Elsevier.

McCallG., LamingD., ScottS., (1992). “Geohazards, Natural and Man-Made”, Springer.

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

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