Department of

CIVIL ENGINEERING

STUDENT HANDBOOK 2022

Faculty of Engineering
University of Moratuwa, Sri Lanka

DEPARTMENT OF CIVIL ENGINEERING HANDBOOK 2022

Draft - 01.09.2023

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1 INTRODUCTION

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1. INTRODUCTION

1.1 WELCOME BY THE HEAD OF DEPARTMENT

The field of Civil Engineering is very broad, covering many areas such as planning, design, construction of buildings, highways, bridges, irrigation schemes, water supply schemes, wastewater disposal, hydropower projects, transmission towers for electricity, telecommunication towers, tunnels, underground powerhouses, etc. It is a broad field where technology has been developing very fast that has enabled more and more sophisticated lifestyles for people despite the continuous increase in the global population.

Therefore, civil engineers can be considered as professionals who will lead development projects locally and internationally. Owing to the diverse spectrum of civil engineering, those who practice it have to face great challenges and they are expected to face such challenges by producing out of box thinking based on very creative and innovative solutions while being conscious about the need to ensure a significant degree of sustainability with all such solutions.

With such a vast spectrum of scope, it is with great pleasure that I welcome you to the website of the Department of Civil Engineering. Our Department is one of the strongest and most well-established academic departments in the Sri Lankan university system with an academic cadre of 50 full-time lecturers. The current academic staff strength of 10 Senior Professors, 9 Professors and 10 Senior Lecturers Grade I, 8 Senior Lectures Grade II and 5 other Lecturers (they also have Ph.D. s) makes it academically very strong matching the civil engineering departments of many internationally well recognized universities.

At present, the department accommodates 500 undergraduates (125 in each batch) and more than 250 fulltime and part-time postgraduate students. While the flagship programme of the department is the Bachelor of Science of Engineering Honours Degree (B.Sc. Eng. Hons.) programme, we also offer postgraduate degree programmes covering over six disciplines of Civil Engineering. The Continuing Professional Development (CPD) programmes conducted by the department further strengthen the collaborations with the industry. Academic staff of the department actively engages in research and development activities in addition to the consultancy work carried out on major projects in the country. One salient feature is the individual undergraduate research projects undertaken over three semesters by all 125 students, most of which culminate by producing research papers for reputed local and international conferences and journals.

The Bachelor of Science of Engineering Honours Degree (B.Sc. Eng. Hons.) programme (Civil Engineering specialization) offered by the Department is well-established. It has been conducted since 1972 and the Department has to date produced over 4500 graduates. The B.Sc. Engineering Degree programme has been continuously revised in keeping up with changes in the educational system and needs of the profession. At present, the programme offered by the Department of Civil Engineering extends over 8 semesters and covers the basics of the entire field of Civil Engineering, while permitting students to specialize in a narrower sub-discipline if they desire. The curriculum enables students to

acquire knowledge, a deep understanding of fundamentals, develop skills in practical applications and hence leading to a high degree of intellectual development while achieving the hands on skills needed to practice as a very capable professional civil engineer.

The programme has the flexibility so that students could make their own choices and provides an environment that prepares students for the world of work. The department strives to provide a very attractive learning environment so that students could gain familiarity with the state of the art technology and practices. An effort is taken to ensure that the desirable engineering graduate attributes are achieved through teaching coupled with advanced learning and assessment schemes. The department has maintained accreditation with the Washington Accord through the Institution of Engineers, Sri Lanka (IESL) and the Joint Board of Moderators (JBM/ICE, United Kingdom). The Department has a fully developed Outcome Based Education (OBE) system in order to provide a very attractive and effective educational experience to the students and fall in line with the system of engineering education in more developed countries.

I wish you a very pleasant stay in the Department of Civil Engineering. The staff and I will make every effort to provide an education that will make you a competent Civil Engineer with significant knowledge and skills in design, analysis, synthesis, application, management, etc. who will be able to serve the Civil Engineering profession within and outside Sri Lanka with confidence and distinction..

1.2 DEPARTMENTAL VISION AND MISSION STATEMENT

The Vision of the Department of Civil Engineering is to be a centre of excellence of higher learning, research and related activities with emphasis on national relevance, international recognition, innovation and creativity in Civil Engineering.

The Mission of the Department of Civil Engineering is to develop educational programmes that provide educational, research and professional experiences that enable our graduates to become leaders in their professional careers, to pursue excellence in research and to serve the profession, community and nation, and be competitive in the international arena.

1.3 WHY STUDY CIVIL ENGINEERING?

Civil Engineers plan, design, construct, operate, and maintain facilities and systems that serve the basic needs of society. These include buildings, bridges, tunnels, roadways, railways, airports, harbours, dams, pipelines, and water and wastewater systems. Engineering, in general, is a problem-solving profession, and Civil Engineers focus their problem-solving capabilities on making our surroundings better places to live. Civil Engineers are frequently involved in city planning and in managing the use of natural resources. They face the challenges of meeting society's needs while protecting the environment thus ensuring sustainable development. Civil Engineering is a people-serving profession that provides a great deal of pride and achievement.

On graduation, there are numerous opportunities for students to pursue higher degrees covering a wide range of subjects. These include taught programmes leading to Master of

Engineering or Master of Science degrees or research degrees leading to MSc/MPhil/PhD. These degrees provide students diverse opportunities in the industry and academia. Moreover, students graduating from the Civil Engineering Degree programme secure research scholarships to pursue the doctoral studies in leading universities in the world each year.

Obtaining the Civil Engineering Degree at University of Moratuwa ensures progression towards becoming a Corporate Member of the Institution of Engineers Sri Lanka and a Chartered Engineer designated by the IESL. In addition, our degree is recognized by the Washington Accord, enabling graduates to obtain memberships of Civil Engineering institutions in 18 member countries.

1.4 CAREER OPPORTUNITIES

Civil Engineers could work either in the private sector or state sector organisations. Career opportunities for Civil Engineering graduates range from small companies employing less than half a dozen civil engineers to international companies with branches in many parts of the world and employing many thousands of Civil Engineers and engaged in diverse projects.

Civil Engineers could work for a client, a consultant or a contractor. Organisations that commission a project are called clients. Not all clients however, would employ in-house engineers. Consultants are those civil engineers who plan and design projects. They translate the client's requirements into a feasible, cost effective project. Much of the work in a consulting firm is office based and would typically include preparation of tenders and drawings and design calculations. Contractors are those who employ labour, equipment and materials and transform the consultant's drawings into reality within the required time frame. Civil Engineers working for a contractor essentially manage the project on site.

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2 DEPARTMENT ORGANISATION AND ADMINISTRATION

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2. DEPARTMENT ORGANISATION AND ADMINISTRATION

2.1 HISTORY

The origin of the Department of Civil Engineering at University of Moratuwa can be traced back to year 1966 with the establishment of Ceylon College of Technology (CCT) at the present premises of the University. The CCT was converted to Katubedda Campus of the University of Sri Lanka in 1972 and the Department of Civil Engineering commenced its first Degree programme leading to Bachelor of the Science of Engineering in the same year. From the very beginning of the establishment of the Katubedda Campus, the Department of Civil Engineering has been the largest academic Department in the campus with respect to student and staff numbers. With the commitment and enthusiasm of academics qualified in diverse areas of study and with the assistance of UNESCO, the Department was able to commence postgraduate programmes as early as in 1976.

The Katubedda Campus was converted to the University of Moratuwa in 1978 making it an autonomous University and since then the Department grew rapidly to its present state. Due to its large size and expertise in diverse areas, the Department operates under six Groups, all of whom conduct postgraduate taught programmes and research programmes leading to Masters and PhD qualifications. The quantum of teaching, research and consultancy activities handled by the Department perhaps makes it one of the most active Departments in the University.

From 1985 the Department is housed in its own building complex at a picturesque site bordering the North-Eastern boundary of the University, fringed by the Bolgoda Lake. The Civil Engineering building complex has many features of Civil Engineering design and construction and consists of a total built area of nearly 8000 m^2.

The main building of the Department of Civil Engineering houses many lecture halls, drawing rooms, a seminar room, a student study room, several purpose-built laboratories, a drawing office, a workshop, a graduate computer room and a computer centre and an auditorium which can accommodate 300 persons. It also provides office space for over 40 academic staff. Facilities are also made available for research staff and graduate students. The rock mechanics laboratory is located on the ground floor of a separate building which also has three lecture rooms on the upper floor each with a capacity of 35 students. The Civil Engineering Research Centre was completed in 2011. The Environmental Engineering Laboratory is re-located in the new building. The building has 2 lecture halls, each with a capacity for 150 students, a computer laboratory for 100 students, a GIS centre, space for research students and staff, and a canteen.

The 3-storied building for the UNESCO Madanjeet Singh Centre for South Asia Water Management (UMCSAWM), attached to the Department of Civil Engineering and funded by the South Asia Foundation (SAF), has been constructed at a location adjacent to the other buildings of the Department. The UMCSAWM is the newest member to join the UNESCO Madanjeet Singh Institutions of Excellence established with the objective of promoting regional cooperation through South Asian Water Management Education and a landmark in the Sri Lankan university history as the first regional centre established to conduct full-time postgraduate degree programmes. The centre building has 2 lecture

rooms with a capacity of 30 students, a computer room, study area and library space for postgraduate students, space for academic staff, research students and research assistants of the programme. Further, an outdoor experimental area is available to conduct research as well as to demonstrate practical applications in three distinct water specialties, namely, Irrigation, Urban Storm Water Drainage, and Riverine and Estuary Ecosystems. An automated weather station, capable of measurement of prevailing climatic conditions in real-time and uploading to the web through satellite transmission networks, is set up at the Centre premises.

The latest addition to the Civil Engineering Department Complex is the Pavement Research Building. The Advanced Bitumen Testing and Accelerated Pavement Testing Laboratories are located in the building. The labs are equipped with the latest testing facilities to conduct research in bituminous materials, pavement mix deign and accelerated pavement testing. The laboratories have close collaborations with the industry conducting several CPD programmes on material testing and construction technology, involvement in investigating road construction materials and pavement designs, etc.

2.2 DEPARTMENT ORGANISATION

The Department has six specialised groups functioning for academic and research purposes. These Groups are:

- Building and Structural Engineering
- Construction Engineering and Management
- Environmental Engineering
- Geotechnical Engineering
- Hydraulic and Water Resources Engineering
- Transportation Engineering

2.2.1 BUILDING AND STRUCTURAL ENGINEERING GROUP

The Building and Structural Engineering group comprises thirteen academic staff members, qualified at postgraduate level from leading universities in Australia, Canada, Japan, the United Kingdom and United States of America. It has three Senior Professors, three Professors, four Senior Lecturers and three Lecturers, among six of them are chartered engineers. The Group is responsible for conducting courses relating to structural engineering in all four years of the undergraduate programme. The Group contributes to the continuing professional development of the practising Civil and Structural Engineers in a significant way, by conducting a regular highly sought after Postgraduate Diploma / Master of Science Degree Programme in Structural Engineering on a part time basis; and many training programmes on specialised topics as and when required.

The staff members are actively engaged in research both in supervisory capacity at undergraduate and postgraduate levels and as research partners in sponsored research projects. The Group has established links with industry through these research

programmes and also through the wide range of consultancy assignments undertaken. The Colombo Lotus Tower and the iconic Altair Towers are two landmark structures that the staff have been involved in. Much of the experimental research and consultancy assignments are carried out in well-equipped laboratories. Some of these have facilities, which are the only one of their kind in Sri Lanka. The most recent laboratories in the group are the Structural Dynamics and Health Monitoring Laboratory, with a shaking table and Computational Mechanics Laboratory for advanced computer simulations. Apart from research in established structural engineering research areas, new areas of research include structural health monitoring, fire and blast resistance, fibre reinforced polymers for structural retrofitting and deployable structures.

The expertise of the staff in this group is sought in the preparation of regulatory standards and related documents. The staff also serve on committees of learned societies thereby further enhancing the University – Industry collaboration. In particular, they are very actively involved in the Society of Structural Engineers, which is a professional body of structural engineers in the country incorporated by an Act of Parliament. Members of the group have also authored technical books that are widely used by students and practitioners.

2.2.2 CONSTRUCTION ENGINEERING AND MANAGEMENT GROUP

The Construction Engineering and Management Group consists of seven academic staff members, qualified at postgraduate level from University of Moratuwa and leading universities in Canada, Japan, Singapore and the United Kingdom. It has four Senior Professors, one Professor and two Senior Lecturers who obtained their postgraduate qualifications in the field of Construction Engineering and Management (CEM). Members are also well qualified, experienced and hold administrative, consultancy and advisory leadership roles in government, non-government and business management sectors.

The group's high-quality undergraduate and postgraduate research outputs have been the source for solving many industrial issues related to construction engineering and management. Excellent research impact of the group attracted research partners and sponsors in national and international arenas to establish long-term collaborations in both research and industrial consultancy. Specifically, the ongoing impactful research in the group in areas such as project management, construction productivity, construction materials and methods, disaster management, digitalisation of construction industry, smart construction, sustainable design and construction practises, has been able to produce high-quality research publications in peer-viewed journals and international conferences.

The CEM group provides the necessary Construction Engineering and Management inputs to the Civil Engineering undergraduate course and other postgraduate courses conducted by both Department of Civil Engineering and other departments in the University. Group's flagship Master's degree (MSc) in Construction Project Management has attracted both national and international practising engineers to rise up in their professional careers. The Construction Engineering and Management Group at Moratuwa

is considered as one of the best places in the industry for construction engineering and management advice.

2.2.3 ENVIRONMENTAL ENGINEERING GROUP

Environmental Engineering Group has a solid resource base, including three Professors with postgraduate qualifications, well-equipped laboratories and trained laboratory staff. It is one of the leading groups of Environmental Engineering academics in Sri Lanka, having obtained qualifications, training, research and working experience in Japan, New Zeeland, and the United Kingdom. Because the subject area of the environment has a broader scope and various specialities, the Group works very closely with other groups in the Department, Departments in the University and various state universities and private institutions in Sri Lanka.

The staff members of the Group conduct two compulsory modules and several elective modules in the undergraduate programme. The Environmental Engineering Group also conducts two postgraduate Diploma/MSc programmes: one in Environmental Engineering and Management and another in Environmental Management. There are also research students who pursue their research works in the field of Environmental Engineering, leading to MSc, MPhil and PhD degrees. These postgraduate programmes are sought after by many practising engineers and engineering professionals to build up their careers specialised in Environmental Engineering and Management. Research outputs and impact of this Group are highly commendable as those works directly contribute to the related communities in Environmental Engineering research across the globe. Specifically, the Group's research is highlighted in the areas, certainly not limited to, environment engineering, sustainable practices, water pollution, environmental monitoring, water quality enhancement etc.

Further, the staff regularly conducts many consultancies and applied research assignments for industries and government institutions, such as conducting Strategic Environmental Assessments for Development Plans, Environmental Impact Assessments (EIA) for various projects, designs of water supply and wastewater treatment schemes, helping stakeholders and decision-makers in evaluation and analysis of environmental issues. The staff members within this Group have also undertaken various foreign-funded international collaborative research. They also participate in various meetings, seminars, and workshops to disseminate their knowledge on environmental matters and for capacity building in state organisations.

2.2.4 GEOTECHNICAL ENGINEERING GROUP

The Geotechnical Engineering Group has five senior academic staff members in total one Senior Professor, two Professors, one Senior Lecturer and a Lecturer with postgraduate qualifications obtained from Universities in Australia, Canada and Japan. They are well-versed in research and consultancy through numerous projects handled both in Sri Lanka and overseas. Under the domain of Geotechnical Engineering, the group collaborates with partners from industry and other academic institutions to solve engineering problems in numerous fields such as slope stability, soil failure remedies, landslide analysis, earth retaining structures, and ground improvements etc.

The Group has well-equipped laboratories of Soil Mechanics and Rock Mechanics that are capable of conducting all the standard laboratory tests for the determination of; basic soil characteristics, compressibility (consolidation) properties and strength (Direct shear and Triaxial) characteristics and engineering properties of rocks. Moreover, the group is furnished with the equipment needed to conduct many field tests such as; Vane Shear Test and Plate Bearing Test. With possession of such standard laboratory facilities and the prowess of the staff members, this group is frequently invited for various industrial consultations and partnerships. Few of such expert-level contributions include slope stability analysis and rectification designs for; the Southern expressway, central expressway, Kandy-Mahiyangana road, design of ground improvements for; the Southern Expressway, Colombo-Katunayaka expressway, analysis of failures in bridges, design of Earth retaining systems for roads, schools and deep excavations.

The Group is responsible for conducting several compulsory and elective modules in the undergraduate programme. The group has conducted 8 Postgraduate Diploma /MEng programmes in Geotechnical Engineering and Foundation Engineering. There are research students who pursue their research works in the field of Geotechnical Engineering leading to MSc, MPhil and PhD degrees.

2.2.5 HYDRAULIC AND WATER RESOURCES ENGINEERING GROUP

The Hydraulic and Water Resources Engineering Group comprises five senior academic staff members, qualified at postgraduate level from leading universities in Japan and Thailand. Well qualified and experienced academic staff members with one Professor and four Senior Lecturers, this group carries the responsibility of teaching and research in Hydraulics, Water Resources Engineering, Coastal Engineering and related areas at both undergraduate and postgraduate levels. It also provides consultancy services for the industry and conducts industry driven short duration training programmes. Strong links with the industry and other academic institutions in both national and international arenas, the group has earned a good reputation for high-impact research, high-quality teaching and excellent project consultancy.

Members of this group have actively contributed to various projects, mainly as field-expert consultants. Detailed design of salinity barrier at Ambathale (Kelani river), impact assessment of the Colombo Port city on groundwater hydrogeology, Kandakadu diversion structure in Mahaweli river and preparation of coastal conservation and tourism development master plan are only few of the numerous expert-level consultancy work undertaken by the group members.

The Group has conducted over 10 postgraduate programmes in Hydraulic Engineering and Water Resources Engineering and Management since 1982 leading to the Postgraduate Diploma and/or Master of Science Degree. It has also embarked on research development related to Water Resource Engineering and by setting up a research centre dedicated for water resources related research called UNESCO Madanjeet Singh Centre for South Asia Water Management (UMCSAWM).

2.2.6 TRANSPORTATION ENGINEERING GROUP

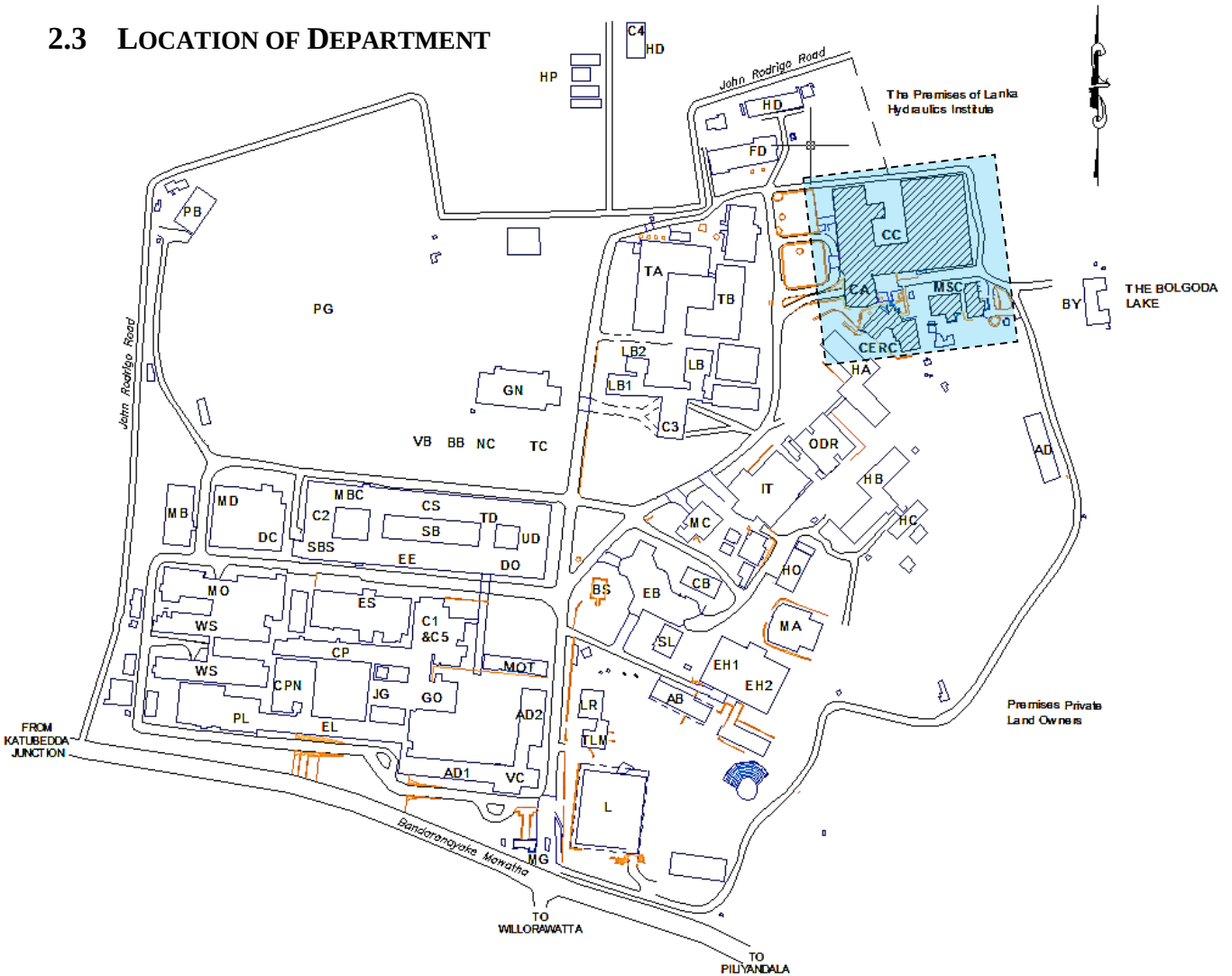
The Transport Engineering Group is an integral part of the Department of Civil Engineering. It is comprised of one Senior Professor, one Professor and three Senior Lecturers who have obtained post-graduate qualifications in different areas of transportation engineering that include traffic engineering, highway engineering and transport planning. The group members have gained their postgraduate qualifications in Australia, Canada, Singapore and United States of America. It is a leading academic group in Transport and Highway Engineering within Sri Lanka.

The Group is responsible for conducting lectures, practical sessions, field visits and research for civil engineering undergraduates under the domain of transportation engineering. The Group also conducts two postgraduate programmes; MEng/PG Diploma in Highway and Traffic Engineering and MSc/PG Diploma in Transportation. The academic staff undertakes the supervision of full-time PhD/MPhil/MSc. research students and around 8 to 10 research students, work on different areas of research at any given time. An increased Transportation Engineering component was introduced to the BSc Civil Engineering curricular in 1992 and subsequently revised in 2000 and 2009.

Under the new curriculum, 'Transportation Engineering' stream to the Civil Engineering degree program is offered from the 2020 intake onwards. Students have the option of qualifying for the specialization stream by selecting elective modules in transportation engineering offered in the final two semesters and conducting their research project in a relevant area. The department also added three new elective modules: Railway and Airport Engineering, Intelligent Transport Systems, Operations Research for Infrastructure Systems as elective modules to the curriculum as part of the introduction of the new stream. Students are also introduced to advanced computer packages such as CUBE, VISSIM, CIRCLY, HDM4 and AutoCAD Civil 3D during the modules.

In addition to conducting the undergraduate and postgraduate course of studies, the Transportation Engineering Group has been carrying out fully-fledged research and consultancy programmes. Emphasis has been on applied research and the determination of applications for Sri Lanka. Research is also carried out at different levels of the academic programme in order to inculcate the principles and practice of research among the students. The Transportation Engineering Group also undertakes transport studies, traffic surveys, highway design, design of rigid and flexible pavements, feasibility studies, assessments and highway material testing. An emphasis is made on collaborative studies such as capacity building with private and state sector organisations. The Group is also conducting Continuing Professional Development Programmes (CPD) in all areas of transport. Transportation Engineering Group has four laboratories; highway engineering laboratory, traffic engineering laboratory, road safety and intelligent systems laboratory, and advance bituminous testing and accelerated pavement testing laboratory. It also maintains a resource centre which has an extensive collection of transport related literature including books, research thesis, project reports, design manuals, journals/conference proceedings etc.

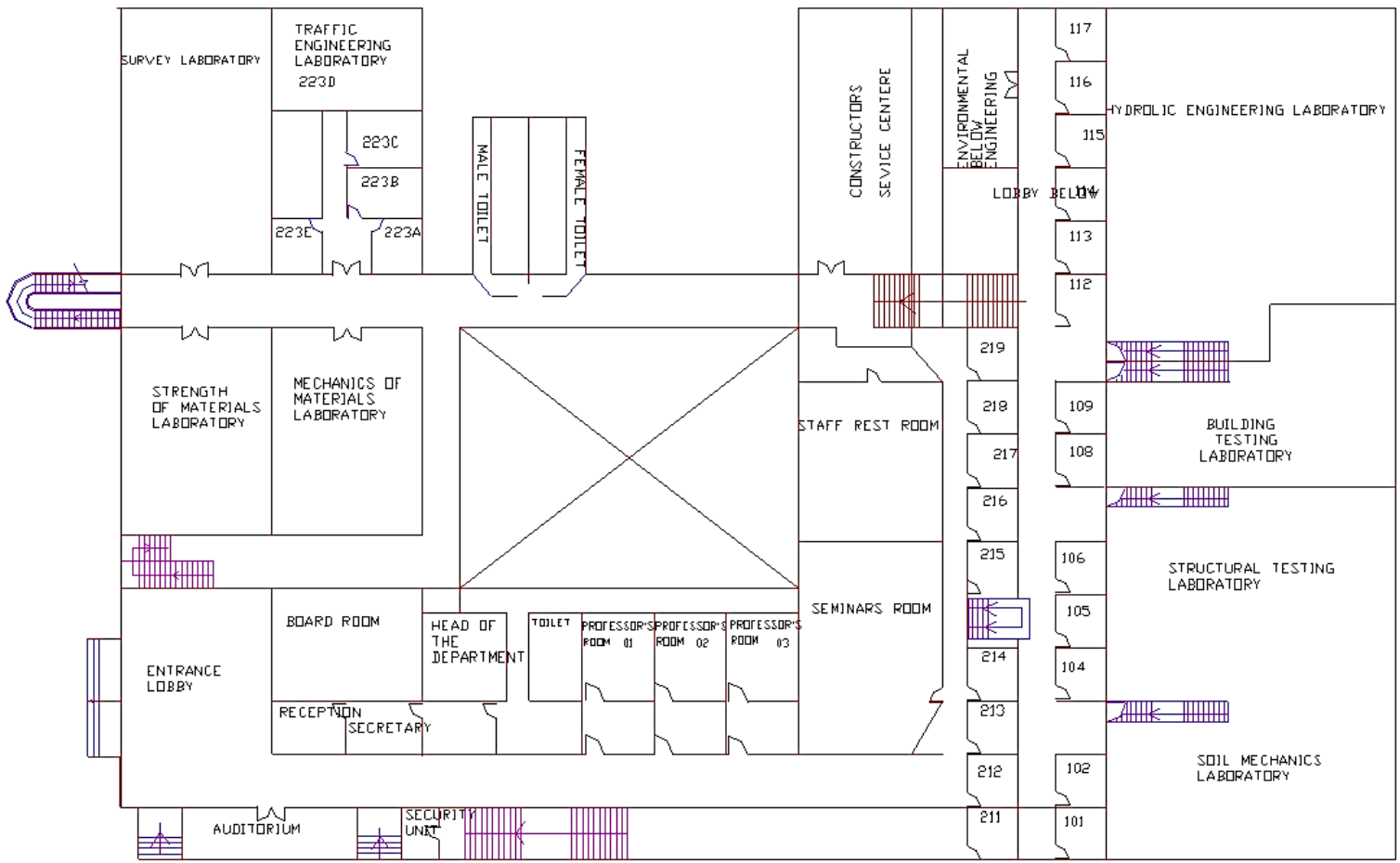
2.3 LOCATION OF DEPARTMENT



REFERENCE

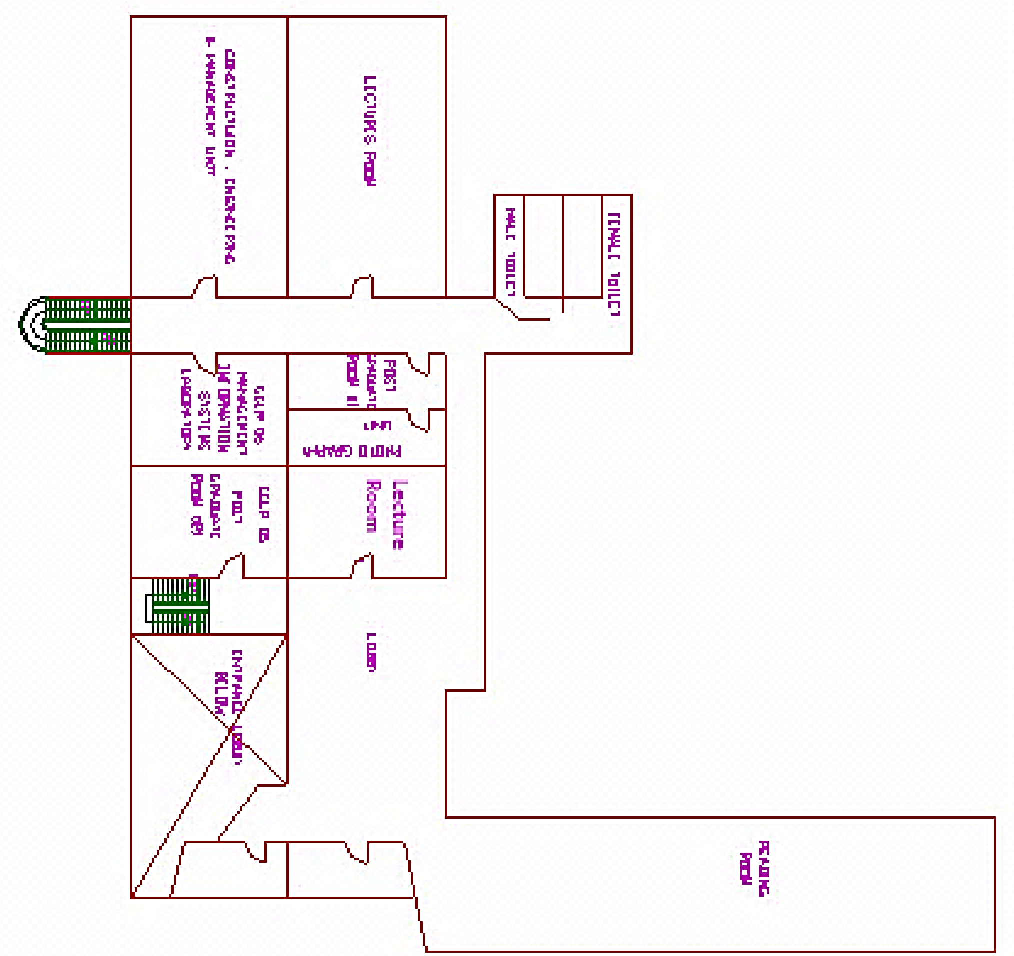
Administration building No.01	AD1
Administration building No.02	AD2
Architecture Building	AB
Architecture Design	AD
Basketball Court	BB
Boat Yard	BY
Buddha Statue	BS
Canteen No. 1	C1
Canteen No. 2	C2
Canteen No. 3	C3
Canteen No. 4 Hostel village	C4
Canteen No. 5	C5
Canteen (Civil Complex)	SBC
Canteen (Snack Bar Staff)	SBS
Canteen (Milk Bar)	MBC
Canteen (ODR)	ODR
Chemical & Process Eng.	CP
Chemical & Process Eng. (New)	CPN
Civil Complex	CC
Civil Auditorium	CA
Classroom Blocks	CB
Computer Science & Eng.	CS
Dean Office	DO
Design Center	DC
Earth Resource Eng.	ES
Electrical Eng.	EE
Electrical & Tele. Eng.	EB
Elementary Labs	EL
English Department	LB2
Exam Hall 1	EH1
Exam Hall 2	EH2
Fashion Design	FD
Gymnasium (New)	GN
Gymnasium (Old)	GO
Hostel	HA
Hostel	HB
Hostel C	HC
Hostel D	HD
Hostel in First Lane	HF
Hostel Patuwathawithana	HP
Hostel Rahula Mawatha	HR
Hostel Office	HO
IT Building (New)	IT
James George Hall	JG
L-Block	LB
Lecture Room Block	LR
Library	L
Madanjeet Singh Centre	MSC
Main Gate	MG
Management of Technology	MOT
Marine Building	MB
Materials Eng.	AS
Mathematics Department	LB1
Mechanical Drawing Office	MD
Mechanical Office	MO
Medical Center	MC
Multipurpose Auditorium	MA
Netball Court	NC
Pavilion Building	PB
Play Ground	PG
Polymer Laboratory	PL
Postgraduate Studies Div.	AD2
Staff Lodge	SL
Sumanadasa Building	SB
Tennis Court	TC
Textile & Clothing Technology	TB
Textile Auditorium	TA
Training Division	TD
Transport & Log. Mn	TLM
Undergraduate Studies Div.	UD
Vc's Office	VC
Volleyball Court	VB
Work Shop Mechanical Eng.	WS

2.3.1 CIVIL ENGINEERING MAIN BUILDING - GROUND FLOOR PLAN

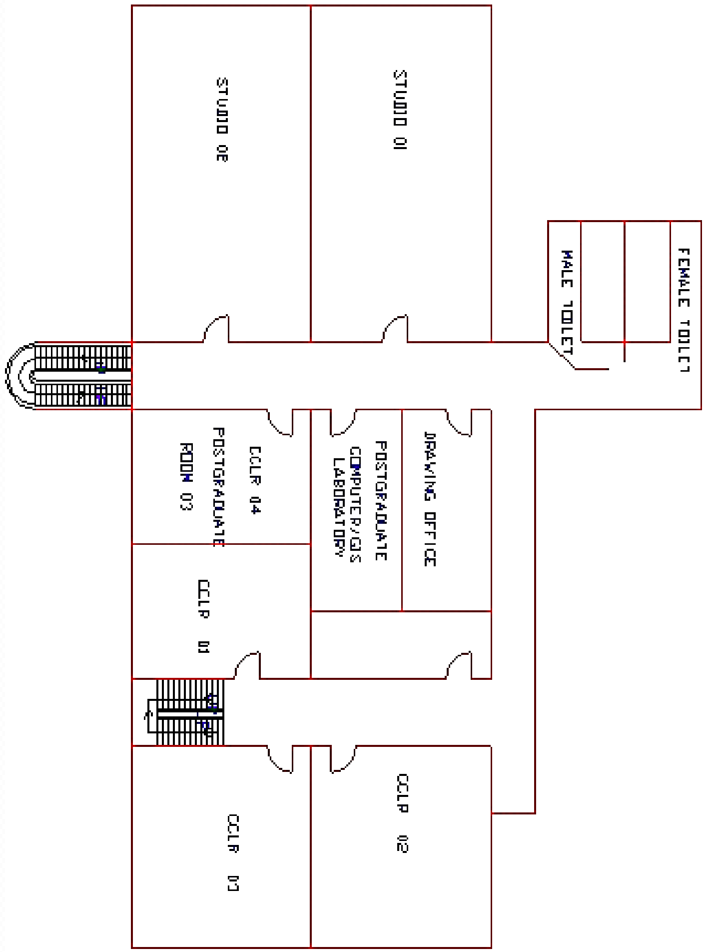


Civil Main Building – Ground Floor

2.3.2 CIVIL ENGINEERING MAIN BUILDING - FIRST FLOOR & SECOND FLOOR PLANS

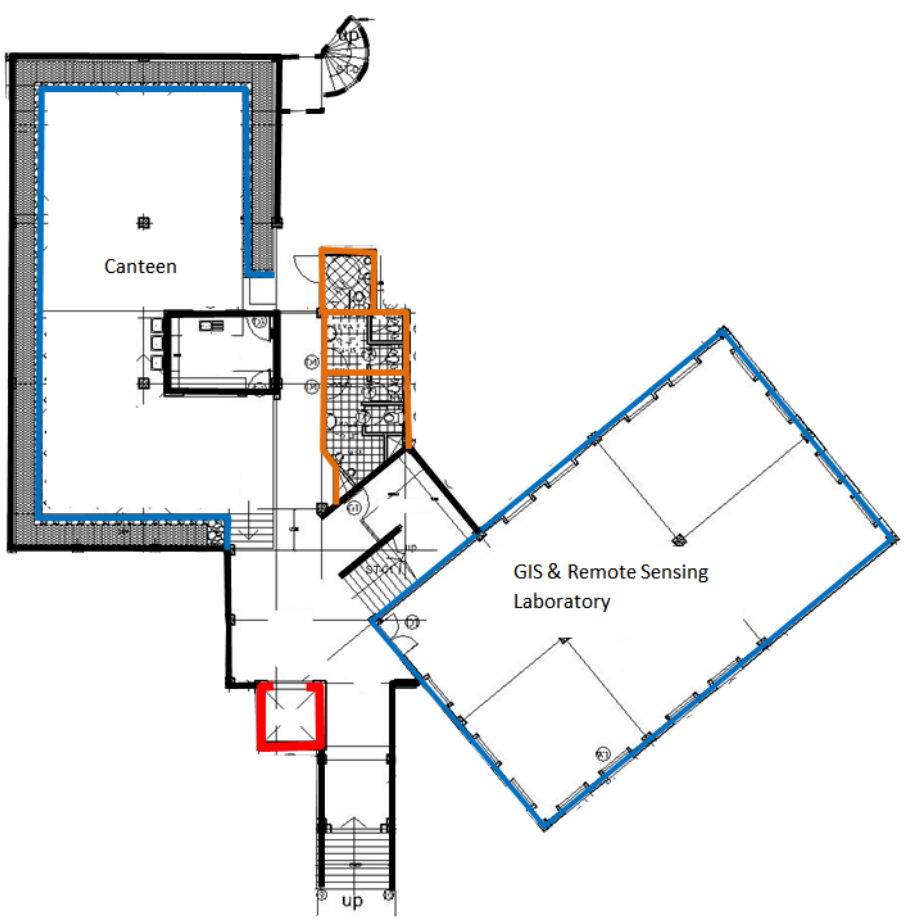


Civil Main Building –First Floor



Civil Main Building –Second Floor

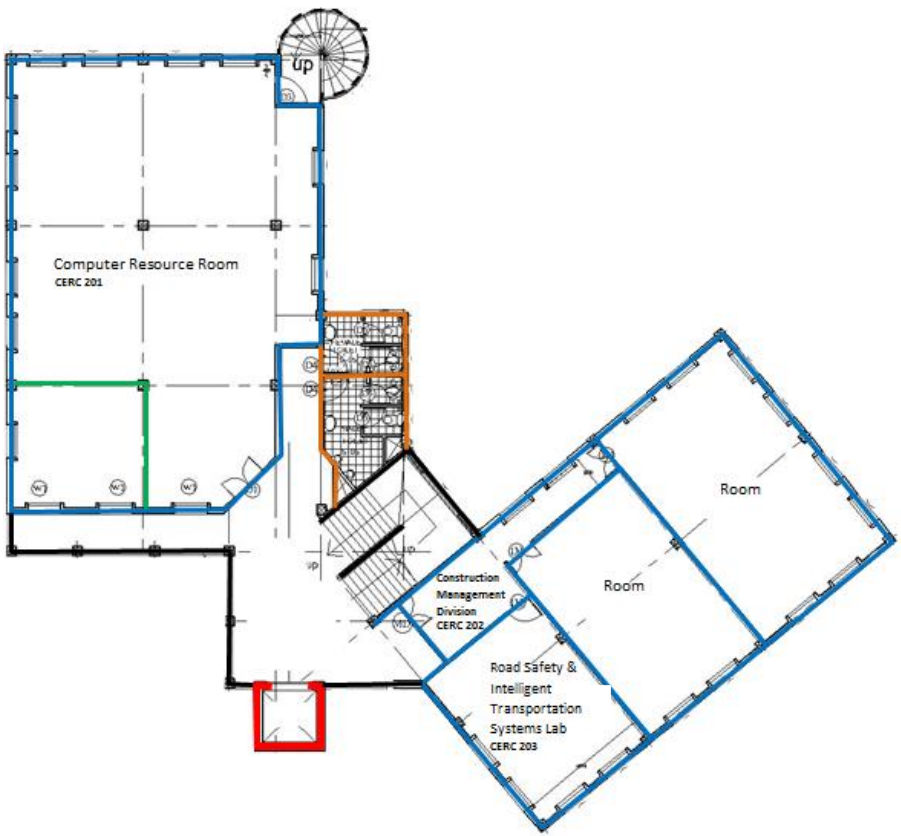
2.3.3 CIVIL ENGINEERING RESEARCH CENTRE – GROUND FLOOR & FIRST FLOOR PLANS



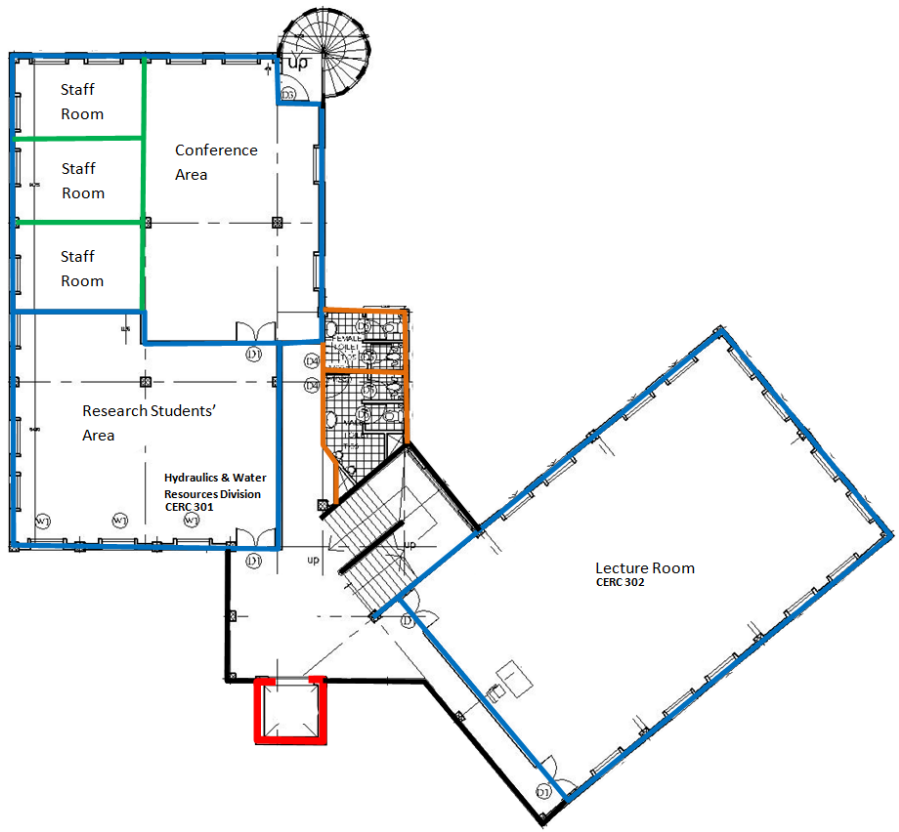
Civil Research Centre - Ground Floor

Civil Research Centre – First Floor

2.3.4 CIVIL ENGINEERING RESEARCH CENTRE – SECOND FLOOR & THIRD FLOOR PLANS

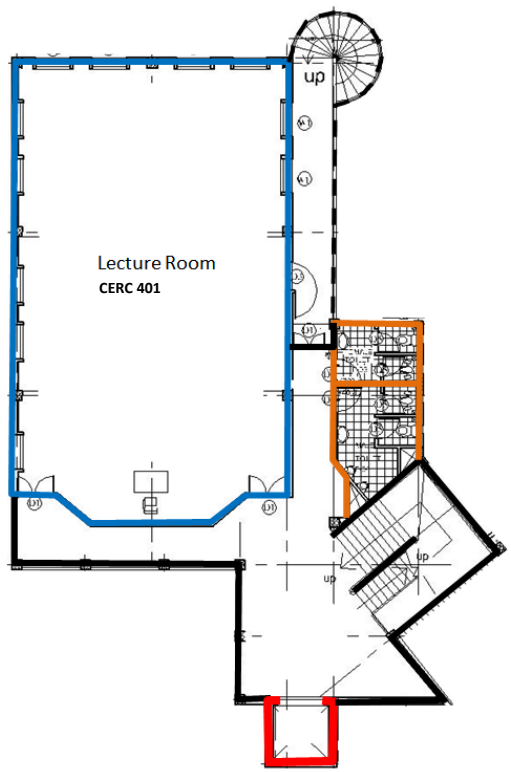


Civil Research Centre – Second Floor



Civil Research Centre – Third Floor

2.3.5 CIVIL ENGINEERING RESEARCH CENTRE – FOURTH FLOOR PLAN



Civil Research Centre – Fourth Floor

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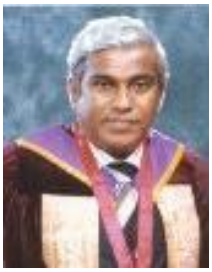

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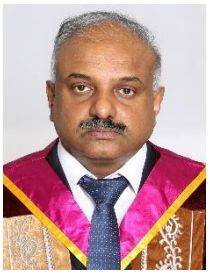
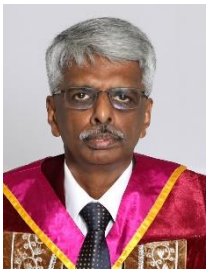
Group: Building and Structural Engineering



Prof. J. M. S. J. Bandara



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Group: Transportation Engineering

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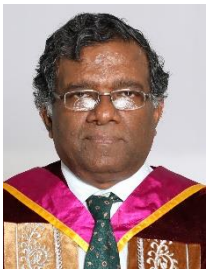
Group: Construction Engineering and Management

Prof. S. A. S. Kulathilaka



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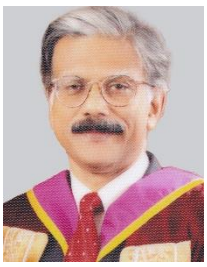
Group: Geotechnical Engineering

Prof. S. M. A. Nanayakkara



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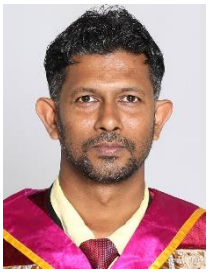
Group: Transportation Engineering

Professors



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Group: Environmental Engineering

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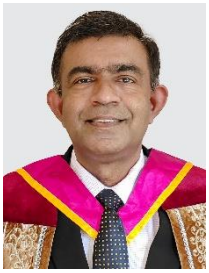
Group: Building and Structural Engineering

Prof. U. P. Nawagamuwa



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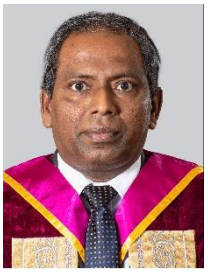
Group: Hydraulic and Water Resources Engineering

Prof. C. S. Lewangamage



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Group: Building and Structural Engineering

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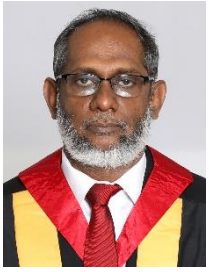

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Group: Hydraulic and Water Resources Engineering

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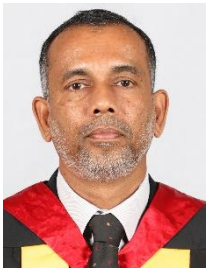

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Group: Hydraulic and Water Resources Engineering

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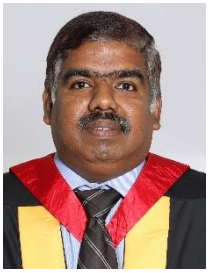

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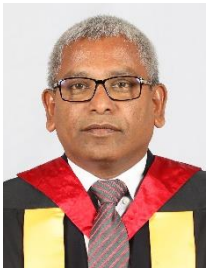

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Group: Geotechnical Engineering

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Group: Building and Structural Engineering

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Group: Building and Structural Engineering

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System Analyst - Grade I

Mrs. V. P. Wickramatunga

BSc (Hons) in IT (SLIIT)

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System Analyst - Grade II

Mr. E. K. Zoysa

BSc (Biotechnology/Genetics/Chemistry)- Bangalore,
MSc (Analytical Chemistry)- Colombo, (L.I.Chem.C.)

Ext: 2531

Analytical Chemist

2.6 EQUIPMENT AND FACILITIES

2.6.1 MECHANICS OF MATERIALS LABORATORY

Lecturer in Charge : Dr. H. M. S. T. Herath

Technical Officer in Charge : Mrs. P. A. I. D. Perera

Equipment	Application
Timber Testing Machine	Testing of timber for compressive strength, flexural strength, shear strength and impact strength
Tensometer (Capacity - 2 Tons)	Tensile testing of standard circular specimens, flat plates and wires
Bending moment apparatus	This experimental apparatus provides visualization and proof of the basic theory of bending moments in a beam. Using this apparatus, students can investigate the variation of bending moment at a point away from the point of loading of a simply supported beam.
Shear force apparatus	This experimental apparatus provides visualization and proof of the basic theory of shear forces in a beam. Using this apparatus, students can investigate the variation of shear force at a point away from the point of loading of a simply supported beam.
Biaxial bending	An experimental apparatus to allow students to investigate the difference between axis of bending and axis of bending moment when the applied moment is about a non-principal axis of the section.
Shear centre apparatus	An experimental apparatus for determining the shear centre of a cross-section of a given specimen
Shear force apparatus	An experimental apparatus to allow students to investigate the variation of shear force on a supported specimen
Torsion apparatus	An experimental apparatus to allow students to investigate the relationship between torque and twist in the elastic region of solid circular sections in various materials.
Buckling of struts apparatus	An experimental apparatus to allow students to investigate the deflection and stability of struts under various end conditions.

Mechanics of Materials Laboratory

2.6.2 BUILDING MATERIALS LABORATORY

Lecturer in Charge : Dr. K. Baskaran

Technical Officer in Charge : Mr. T. P. D. G. I. Yohan

Equipment	**Application**
Universal Testing Machine	To determine the tensile strength of steel
	Compressive strength and flexural strength of concrete.
Versa Tester	To perform Tensile test and compression test
Heat of Hydration Calorimeter	To determine the heat of hydration of cement
Blaine fineness apparatus	To determine the fineness of cement
Vicat Apparatus	To determine the setting time of cement
Le Chatelier Apparatus	To determine the soundness of cement
Aggregate crushing value test apparatus	To determine the mechanical properties of coarse aggregate
10% Fines value test apparatus	
Aggregate Impact test apparatus	
Test sieves (BS & ASTM)	To determine the particle size distribution of coarse and fine aggregates
Air Entrainment Meter	To determine the air content in fresh concrete
Slump cone/Compacting Factor Apparatus	To determine the workability of fresh concrete
V-B Consistometer	
Setting time of Concrete test apparatus	To determine the initial and final setting time of concrete in accordance with ASTM specifications
Humidity cabinet/ Length comparator	To determine shrinkage of concrete, mortar and cement paste under controlled humidity and temperature conditions.
Concrete Core cutting m/c	To extract concrete cores of dia. 2" – 4"
Mortar Mixer	To mix mortar

Building Materials Laboratory

2.6.3 STRUCTURAL TESTING LABORATORY

Lecturer in Charge : Dr. T. G. P. L. Weerasinghe

Technical Officer in Charge : Mr. D. M. N. L. Dissanayaka

Equipment	Application
Universal Testing Machine (1,000 kN)	To test steel (circular specimens, flat plates and wires) for tensile strength. Testing of concrete cubes, cylinders for compressive strength.
Amsler Testing Machine (2000 kN)	To Test concrete cubes, cylinders for compressive strength. Testing of wall panel for compressive strength. Testing of concrete beams for bending strength.
Compression Testing Machine (digital)(2,000 kN)	To Test concrete cubes, cylinders for compressive strength.
Test Rig mounted on 750 mm thick strong floor (capacity: 1000 kN)	To test wall panel for compressive strength. To test concrete beams for bending strength. To load test manhole covers, welded rails. To conduct three edge bearing test for hume pipes.
Concrete Cover Meter	To measures the depth of cover over reinforcement bars.
Data Logger (TDS 530)	To record continuous measurements of strain gauges, thermocouples, strain gauge based (full bridge) transducers and DC voltage.
Data Logger DL2e	For thermal measurements.
Ultrasonic Pulse Velocity Tester	For quality control and inspection of concrete.
Rebound Hammer	To determine the surface hardness of concrete.
Digital Resistivity Meter	To measure the electrical resistivity of concrete.
Proving Rings (10 kN, 30 kN, 100 kN, 300 kN, 2000 kN)	For compressive load measurements.
Mechanical Dynamometer	To determine tension force.
Hydraulic Jacks and Pumps (100 kN, 250 kN, 500 kN)	For loading.
Laser Displacement Sensors	For displacement measurements.
50 kN overhead crane	For erecting loading frame and positioning heavy specimens.

Structural Testing Laboratory

2.6.4 STRUCTURAL DYNAMICS & HEALTH MONITORING LABORATORY

Lecturer in Charge : Dr. H. G. H. Damruwan

Technical Officer in Charge : Mr. W. G. I. N. B. Abeyrathne

Equipment	Application
Servo Electric Shaking Table	Uni-axial shaking table for earthquake simulations
Vibrometer	Acceleration and noise measurements

Uniaxial shaking table

Vibrometer

2.6.5 BUILDING SCIENCE LABORATORY

Lecturer in Charge : Dr. P. L. N. Fernando

Technical Officer in Charge : Mr. D. M. N. L. Dissanayaka

Equipment	Application
Digital Aerosol Monitor	All equipment are used for undergraduate and postgraduate research work in Building Science. These equipment are also used for demonstration purposes to students following the modules Building Engineering, HVAC & Building Automation.
Digital Sound Level Meter	
Data Logger	
Moisture Analyser	
Humidifier & Controller	
Anemometer	
Microsoft Project	
Primavera	
Sunshine Reader	
Photometric Sensor and Measuring Unit	
Ultraviolet Measuring Unit	
Whirling Hygrometer	
Stevenson Screen	
Sound Level Meter with Sound Calibration	
Sound Level Meter Kit	
Thermo Hydrograph	
PM Meter	
VOC Meter	

2.6.6 COMPUTATIONAL MECHANICS LABORATORY

Lecturer in Charge : Prof. H. M. Y. C. Mallikarachchi

Technical Officer in Charge : Mrs. D. N. Ranawaka

Equipment/Software	Application
High-performance workstations	Advanced computer modelling of complex structures and experimental verification Teaching computational mechanics
Mola Structural Kit	
Abaqus FEA package	
LS Dyna FEA package	

2.5.1 MANAGEMENT INFORMATION SYSTEMS (MIS) LABORATORY

Lecturer in charge : Dr C.S.A. Siriwardana

Technical Officer : Mrs. U. Rukma

Software Package	**Application**
Microsoft Project	To estimate the planning and monitoring of construction projects
Primavera	To estimate the planning and monitoring of construction projects
Billets	For cost estimation and tendering
Design Builder/Energy plus	For energy modelling, thermal analysis, and simulation of the environment
Envimat	For energy modelling, thermal analysis, and simulation of the environment
Derob	For energy modelling, thermal analysis, and simulation of the environment
AutoCAD Civil 3D	For Design of Civil Engineering Structures
AutoCAD Revit MEP	For design and construction documentation solution for mechanical, electrical and plumbing (MEP) Engineering
AutoCAD Revit Architecture	For design and building information modelling for a project.
Autodesk Architecture	For building drawings (2D and 3D)
Microsoft Share Point Services	This is a multipurpose set of web application platforms for file management , collaboration, websites, and enterprise, etc.

Equipment	**Applications**
Portable VOC meter	To take real-time measurements of Volatile Organic Compounds (VOC), ambient temperature, relative humidity, dew point and wet bulb temperatures
Portable CO_2 meter	To measure CO_2 levels, temperature, relative humidity of the environment
Anemometer	To monitor the wind velocity
Environmental Particulate Air Monitor	To monitor particulates in ambient air

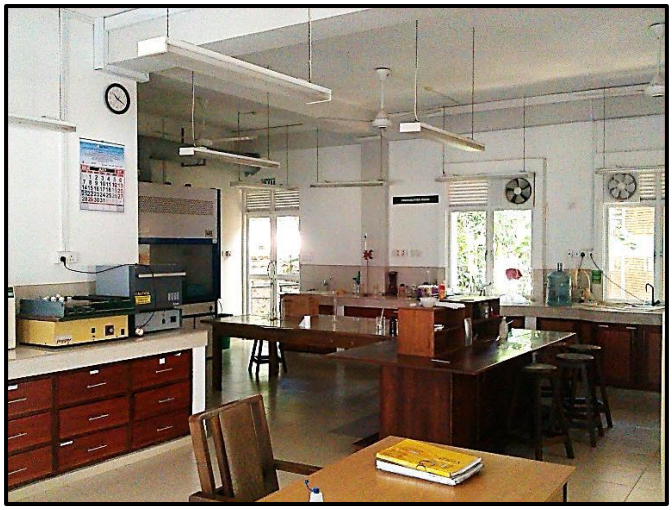
2.6.7 ENVIRONMENTAL ENGINEERING LABORATORY

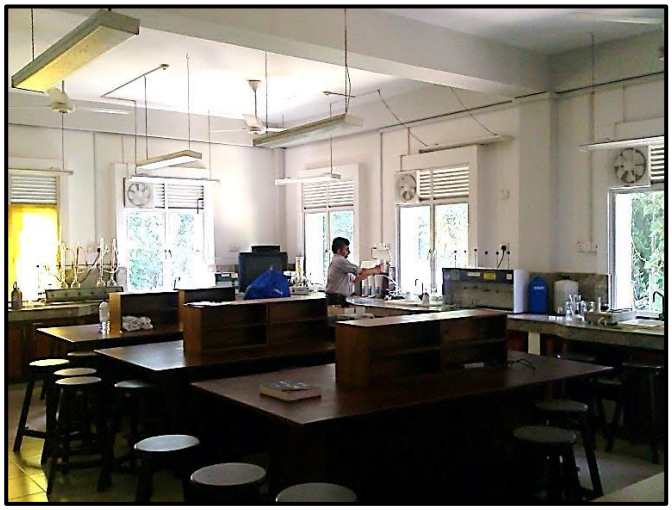
Lecturer in Charge : Prof. J. M. A. Manatunge

Technical Officer in Charge : Mrs. N. S. Gunathilake

Analytical Chemist : Mr. E. K. Zoysa

Equipment	**Application**
Atomic Absorption Spectrophotometer	To determine the content of Heavy Metals
UV VIS Spectrophotometer	To determine the Total Phosphorus, Total Nitrogen, Total Iron, Chlorophyll, Analysis of Kinetics of chemical reaction
Ion Chromatography Instrument	Determination of Anions
Centrifuge unit	Sample preparation
Turbidity Meter	To measure Turbidity
Portable water quality Meter	To measure in-situ field parameters eg. pH, Conductivity, TDS, DO, Salinity, Temperature
Conductivity Meter	To measure Conductivity
pH Meter	To measure pH
Titration Equipment	To measure Alkalinity, Dissolved Oxygen
Muffle Furnace	To determine the content of Volatile Suspended Solids, Sulphates
Deionizer	To produce deionised water for reagent preparation
Distilled Water Plant	To produce distilled water for reagent preparation
Fume Hood	To conduct extraction/ distillation under safe environment
Microbiological Incubator	Microbiological Examinations: Total and Faecal Coliforms
Colony counter	To count microbial colonies
Filtration Equipment	To determine Total Suspended Solids
Drying Oven/Hot box oven	Sample drying
Autoclave instrument	Sample sterilization
Binocular microscope with camera	Microbiology study
Cooled Incubator	To determine Biochemical Oxygen Demand
COD apparatus	COD digestion and analysis
Kjeldhal Instrument	Determination of kjeldhal Nitrogen
Gas Chromatography/Mass Spectrometer	To determine concentration of volatile organic substances / extraction of organic substances from soil and other media.
Jar-Test apparatus	To determine optimum coagulation dose
Four and Five decimal balance	Mass determination (Gravimetric methods)
Water sampler	Field water sampling
Refrigerator	Sample storage
Laboratory Fume Hood	Safety from toxic gas
Laminar Air Flow cabinet	Safety from microbial contaminations
Safety shower	Safety/Emergency clean-up
Rotary Evaporators	Liquid sample extraction





Environmental Engineering Laboratory

2.6.8 SOIL MECHANICS LABORATORY

Lecturer in Charge : Prof. L. I. N. De Silva

Technical Officer in Charge : Mr. H. A. M. I. T. Hettiarachchi

Equipment	Application
Classification Tests	
Casagrande Apparatus	To determine the Liquid Limit and Plastic Limit
Sieve Set	To perform Particle Size Analysis
Hydrometer	To perform Hydrometer Analysis
Specific Gravity Bottle Test	To determine the Specific Gravity
Vibrating Table	To determine the Relative Density
Strength Tests	
Triaxial Testing Apparatus (with or without electronic data acquisition)	To perform Unconsolidated Undrained Triaxial Test
	To perform Consolidation Drained Triaxial Test
	To perform Consolidated Undrained Triaxial Test with Pore Water –pressure Measurement
Unconfined Compression Test Apparatus	To perform Unconfined Compression Test
Direct - Shear Test (with or without electronic data acquisition)	To conduct Direct Shear Tests on soils
Compressibility and Permeability	
Consolidation Test Apparatus	To perform One Dimensional Consolidation Test
	To determine the Swelling Index
Rowe Cell	To measure both settlement and pore water pressure during consolidation
Falling Head Apparatus	To perform Falling Head Permeability Test
Constant Head Apparatus	To perform Constant Head Permeability Test
Compaction Test	
Proctor Compaction Apparatus (Standard and Modified)	To perform Proctor Compaction Test
CBR Laboratory Test Apparatus	To perform CBR test Under Soaked or Unsoaked Condition
In-situ tests	
Core Cutter Apparatus	To determine the In-situ Density
Sand Cone Apparatus	To determine the In-situ Density
Vane Shear Apparatus	To perform Vane Shear Test
Field CBR Test Apparatus	To perform Field CBR Test
Cone Penetrometer	To perform Cone Penetration Test
Mackintosh Probe Test Apparatus	To perform Mackintosh Probe Test
Plate Loading Test Apparatus	To perform Plate Loading Test to assess bearing Capacity of Soils

Soil Mechanics Laboratory

2.6.9 ROCK MECHANICS LABORATORY

Lecturer in Charge : Prof. L. I. N. De Silva

Technical Officer in Charge : Mr. H. A. M. I. T. Hettiarachchi

Equipment	Application
Los Angeles Abrasion Test Apparatus	To perform Los Angeles Abrasion Test
Point Load Test Apparatus	To determine the Point Load Index
Core Drilling Machine	To perform Extrusion of Core Samples
Slake Durability Test Apparatus	To perform Slake Durability Test
Uniaxial Compression Machine	To determine Uniaxial Compression Strength of rock core Samples

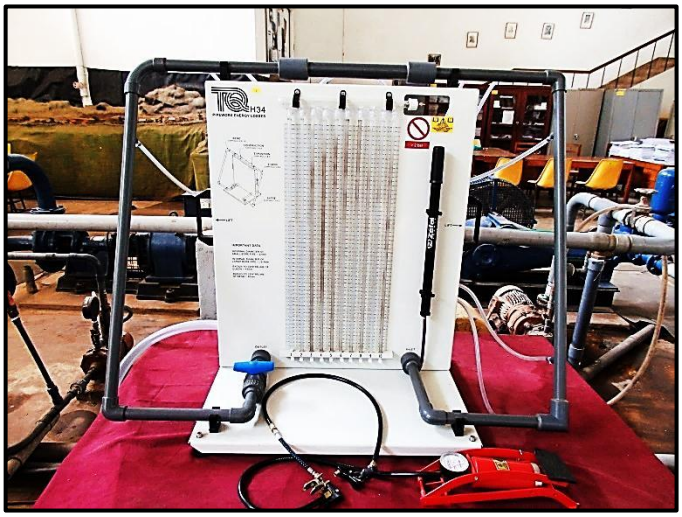
Roch Mechanics Laboratory

2.6.10 HYDRAULIC ENGINEERING LABORATORY

Lecturer in Charge : Dr. T. M. N. Wijayaratna

Technical Officer in Charge : Mr. H.W. Kumarasinghe

Equipment	Application
Circular Orifice Apparatus	To study flow through orifices and determine coefficients of discharge, velocity and contraction for a circular orifice
Pelton Wheel Turbine	To study hydraulic performance and obtain characteristic curves for a Pelton turbine
Centrifugal Water Pump	To establish the head-discharge characteristic for a centrifugal pump
Series & Parallel pumps	To study the effects of having pumps in series or parallel
Flow Measuring Apparatus	To determine the coefficients of discharge and obtain calibration curves for a venturi meter and orifice meter and determine head losses
Pipe Friction Apparatus	To study laminar and turbulent flow in pipes to determine variation of friction factor with Reynolds number
Energy losses in pipe networks	To study the loss of energy in pipe networks due to bends, expansions and contractions
Hydrostatic Pressure Apparatus	To determine the centre of pressure of fully and partially submerged plane surfaces
Pressure Gauge	To calibrate a Bourdon pressure gauge
V-Notch	To study flow through notches and determine the coefficient of discharge for a V-notch
Pontoon Apparatus	To determine the metacentric height and the metacentre of a floating vessel
Forced Vortex Apparatus	To study the characteristics of forced vortex motion
Infiltrometer	To measure in-situ the infiltration rate of soils
Open Channel Flow- tilting Flume	To study the characteristics of open channel flow, behaviour of gates, weirs, spillways etc. and to study the wave propagation in shallow waters
Ground Water Flow Analysis	To determine the distribution of ground water head and flow in aquifers
HEC-RAS	To model and study a river reach and its flood plain
Water CAD Software	To model water distribution
Culvert Master Software	To analyse and design culverts
Hydraulic Ram Pumps	To study the hydraulic transients
Pump/Turbine Apparatus	To study performance characteristics of pump/turbine
MIKE21 HD and Wave models	To model nearshore hydrodynamics and wave transformation



Hydraulic Engineering Laboratory

2.6.11 HIGHWAY ENGINEERING LABORATORY

Lecturer in Charge : Dr. H. R. Pasindu

Technical Officer in Charge : Mrs. G. K. Wijekoon

Equipment	Application
Accelerated Polishing Machine	Conduct polished stone value test to establish friction deterioration levels of aggregates
Concrete Abrasion Resistance Machine	Evaluate the resistance of concrete for abrasion
Vehicle Bump Indicator	To determine the road roughness using a vehicle - mounted roughness measurement unit (Class III type)
Z-250 Reference Profiler	Roughness Calibrating Machine, used to calibrate the bump integrator and pavement profile of small sections
British Pendulum Test Machine	Measure pavement fiction coefficient
CBR Test Machine Dynamic Cone Penetrometer (Field CBR)	Laboratory test of CBR values of soil samples To determine rapid in-situ measurements of the structural properties of road pavements. Penetrometer constructed with unbound materials, TRL (Transportation Research Laboratory) Road Note 31:1993
Sand Equivalent Test	For determining the theoretical maximum specific gravity of uncompacted bituminous paving mixtures & the percent air voids in compacted bituminous mixtures and the amount of bitumen absorbed by aggregates.
Aggregate Impact Value (AIV) Test Equipment	To determine the toughness of aggregates
HDM4	Pavement Management Software for life cycle cost analysis for pavement

Highway Engineering Laboratory

2.6.12 TRAFFIC ENGINEERING LABORATORY

Lecturer in Charge : Dr. G.L.D.I. De Silva

Technical Officer in Charge : Mrs. G. A. N. Gurusinghe

Equipment	Application
Manual Traffic Counters	Traffic Counts, Turning Movement Counts
Radar Guns	Speed Surveys
Global Positioning System	Highway Inventories, Transport Operations, Vehicle Tracking
Precision Odo-Meter	Distance Measurements
Vehicle Installed Back Lighted Distance Measuring Instrument	Distance Measurements
Trazer Automated Traffic Counting Software	Traffic counting
CUBE	Transport planning
Trans Plan V3	Traffic Forecasting, Transport Planning
MTRADA	Cloud Based data mining platform to collect travel time data using Google map
WPTDM	Travel Demand Model for Western Province

Traffic Engineering Laboratory

2.6.13 ROAD SAFETY & INTELLIGENT TRANSPORTATION SYSTEMS LABORATORY

Lecturer in Charge : Dr. G. L. D. I. De Silva

Technical Officer in Charge : Mrs. G. A. N. Gurusinghe

Software Package	Application
Revised MAAP by UoM	Accident data recording and analysis
Blink 2005	Traffic Signal Design
VISSIM	Micros-simulation traffic modelling software

2.5.2 ADVANCED BITUMEN TESTING LABORATORY

Lecturer in Charge : Prof. W. K. Mampearachchi

Technical Officer in Charge : Mr. W.T. Isanka

Equipment	**Application**
Kinematic Viscometer	To determine the Kinematic Viscosity of liquid asphalt (bitumen), road oils and distilled residues of liquid asphalts at 600 C and for asphalt cement at 1350 C
Centrifugal Extractor	To determine bitumen in hot mixed paving mixtures and pavement samples.
Marshall Tester	To design asphalt concrete mixes ASTM D 1559:89
Softening Point Apparatus	To determine the softening point of asphalt ASTM D36:76
Rice Test Apparatus	Density measurement of asphaltic mixtures
Flash Point Tester	To determine the point of the bituminous binder
Saybolt Viscosity Set	For measuring the Saybolt viscosity of bituminous emulsion ASTM D 244-89
Penetration Set	The penetration of bituminous binder ASTM DS: 86
Solubility Set	To determine the purity of asphalt cement.
Ductility Set	To measure ductility on a representative portion of Bitumen = ASTM DI 13: 86
Residue by Distillation Set	Quantitative determination of residue and oil distillate in asphalt emulsion ASTM D 244:89
Asphalt Binder Analyser	To estimate the bitumen content of Asphalt
Rotary evaporator	To recover asphalt from a solvent
Thin film oven	To determine the effects of heat and air on a film of semisolid asphaltic material

Advanced Bitumen Testing Laboratory

2.6.14 SURVEYING LABORATORY

Lecturer in Charge : Mr. T. D. C. Pushpakumara

Technical Officer in Charge : Mr. H. S. Hettiarachchi

Equipment	Testing Facilities	Software Facilities Available
Global Positioning System, Receivers Laser Total Station Total Station Instruments Digital Theodolite Electronic Theodolite Optical Theodolite Vernier Theodolite Cradle Theodolite Micro-optic Theodolite Instructional Theodolite Precise Level Automatic Level Digital Level Engineers Level Dumpy Level Self-Reducing Alidades Self-Reducing Tachometers Sextants Stereoscope Subtense Bar Distance Measuring Wedges Invar Tape Invar Staves Multimedia Photocopy Machine Digital Camera Personal Computers Chain Tapes(linen/ steel) Accessories for basic surveying work	Facilities available for : Chain Surveying Levelling Prismatic Compass Survey Theodolite Traverse Survey Traverse Sheet Calculation Tachometry Surveys Plane Table Surveying Triangulation Surveys Surveying with Total Station Surveying with Global Positioning System Computer generated survey plans Civil engineering setting-out works Survey camp of two weeks duration for Civil Engineering Students.	AutoCAD Pythagoras ArcGIS ERDAS Surfer 8

Surveying

2.7 RESOURCES

2.7.1 COMPUTER UNIT OF THE DEPARTMENT OF CIVIL ENGINEERING

Lecturer in Charge	:	Prof. R. L. H. L. Rajapakse
System Analysts	:	Mr. C. H. Satharasinghe
		Mrs. V. P. Wickramatunga
Technical Officer	:	Mr. K. W. T. Isanka
Data Entry Operator	:	Mrs. A. P. Kandage

Resources and Services Provided

- **Servers:** File Server for Staff and Students
  Two Printer Servers
  DHCP Server
  DNS Server for the Department
  Backup Server
  SSH Server
  WiFi Access points for the Department
- **High speed internet and email connectivity** with a fiber optic backbone Wireless Access Points for Staff and Students
- **Network Printer** for Academic and Non-Academic staff, Research staff, and Research students
- **Student Area for Undergraduates** has 60 computers with internet facilities.
- **Services:** Lab classes for Computer Applications in Civil Engineering - for undergraduate and postgraduate Students
  Distributing Popular Civil Engineering Software/ Software Licences for Staff and Students
  Multimedia communication facilities for undergraduates to enhance their communication skills
  Internet, email, Printing, Scanning, DVD Copy Facilities
  Maintain Computers and the Computer Network of the Department of Civil Engineering
  Maintain Departmental Website
  Moodle Content Development
  E-Learning Website Development for Undergraduates

Computer Resource Unit

2.7.2 CIVIL ENGINEERING WORKSHOP

Lecturer in charge : Dr. K. Baskaran

Technical Officer : Mr. D. M. N. L. Dissanayaka

The following workshop facilities are available for teaching, research and development activities of the department.

- Upright drill machine
- Bench drill machine
- Radial drill
- Milling machine
- Lathe machine
- Bench Grinder
- Shaping Machine
- Surface grinding Machine
- Arc welding plant
- Power Hack saw Machine
- Hand shearing Cutter
- Gas cutter
- Air Compressor

Civil Engineering Workshop

2.8 STUDENT COMMON ROOMS

The Student Common Room of the Department of Civil Engineering has an approximate area of 250 m^2 with furniture, lighting and fans; which provide an area for studying. Students have access to this facility from 8.00 a.m. to 8.00 p.m. on all working days and at weekends.

2.9 WORKING HOURS AND ACCESS TO FACILITIES

All Laboratories are open on all working days. Students can use them during the allocated practical sessions. The facilities can also be used for research and development related activities.

The computer resources unit is open on all working days and on Saturdays.

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3 CIVIL ENGINEERING DEGREE PROGRAMME

3. CIVIL ENGINEERING DEGREE PROGRAMME

3.1 STRUCTURE OF THE DEGREE PROGRAMME

Course Title : Honours Degree of Bachelor of the Science of Engineering

Abbreviated Title : BSc Eng Hons

Field of Specialisation : Civil Engineering

Course Duration : 4 years (8 semesters)

Medium of Instruction : English

Annual Intake : 125 students

Minimum Credit Requirement: Total of 150 credits

136 GPA credits* (out of which 11 credits can be selected from Faculty/Department electives) and 14 Non-GPA credits.

Faculty/Department electives can be opted from Semester 2 and additional Department Electives are offered from Semester 7.

* a credit reflects 14 hrs of lectures or 28 hrs of laboratory, tutorial or field work

The Department of Civil Engineering offers the opportunity for students to specialise in Transportation Engineering by following the compulsory 24 credits specified under the Transportation Engineering Stream.

Further the Department of Civil Engineering allow the students to broaden their knowledge and competencies in a particular area of study outside Civil Engineering by taking faculty approved minors subject to availability in a particular year. The details on minors can be obtained via the Undergraduate Studies Division website of the Faculty of Engineering.

3.1.1 FEATURES

- A degree programme that covers the basics of the entire field of Civil Engineering, while allowing students to specialise in a narrower sub-discipline if they so wish;
- A curriculum that enables students to acquire knowledge, understanding and transferable skills (both intellectual and practical);
- A flexibility in the programme that allows students to make their own choices and become responsible for their customised curricula and also familiar with state-of-the-art tools and practices
- An environment that prepares students for the world of work, self-learning and life-long learning
- Close interaction between students and academic staff

- Assessment schemes that seek to achieve the Programme Outcomes while ensuring the gaining of desirable graduate attributes

3.1.2 VISION OF THE GRADUATE PROFILE

It is expected that Civil Engineers on graduation should have acquired the knowledge, skills and attitudes to carry out a range of activities, required of them in the modern world.

In line with the International Engineering Alliance Graduate Attribute profile required for Washington Accord accreditation, a Civil Engineering graduate of University of Moratuwa is expected to have the following attribute profile:

1. Engineering Knowledge - Be able to apply knowledge of mathematics, science, engineering fundamentals and an engineering specialisation to the solution of complex civil engineering problems
2. Problem Analysis - Identify, formulate, research literature and analyse complex civil engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3. Design and development of solutions - Design solutions for complex civil engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
4. Investigation - Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.
5. Modern Tool Usage - Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modeling, to complex civil engineering activities with an understanding of the limitations.
6. The Engineer in Society - Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
7. Environment and Sustainability - Understand the impact of professional civil engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
8. Ethics - Apply ethical principles and commit to professional ethics and responsibilities and norms of civil engineering practice.
9. Individual and Teamwork - Function effectively as an individual and as a member or leader in diverse teams and in multi-disciplinary settings.
10. Communication - Communicate effectively on complex civil engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations and give and receive clear instructions.

11. Project Management and Finance - Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Lifelong Learning - Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

The Civil Engineering programme at the University of Moratuwa has been developed so that these desired graduate attributes could be achieved through the learning outcomes of the curriculum. The present curriculum has been revised to conform to the accreditation requirements of Civil Engineering Graduates as specified by the Institution of Engineers, Sri Lanka, Washington Accord and the Joint Board of Moderators (including the Institution of Civil Engineers) Engineering Council, United Kingdom.

Thus, recently graduated Civil Engineers must be technically competent and be able to solve problems having first identified and formulated the problem. They must be able to apply the knowledge of mathematics, science and engineering and use systems approaches to design and operational performance. They must be able to work as individuals as well as team members. They should be capable of effective communication. They must understand the social, cultural, global and environmental responsibilities of the professional engineer. They must be aware of the need for sustainable development and also understand the principles of sustainable design and development. They must understand their professional and ethical responsibilities and the commitment to them. They are also expected to continue their professional development by cultivating lifelong learning skills.

3.1.3 PROGRESSION IN CURRICULUM

Pre Academic Term and First Semester – focuses on mathematics and mechanics, and also on acquiring a broad engineering base, inclusive of IT and Computer Science. The importance of communication skills is also stressed.

Modules specific to the field of Civil Engineering such as Structural Mechanics, Fluid Mechanics and Soil Mechanics are included in the next two semesters (2 and 3) while strengthening the mathematics and mechanics base. In addition, you will be introduced to the fundamentals of some modules that will be learnt at greater depth later in the course, like Project Planning, Cost Estimating, Environmental Engineering, Transportation Engineering, and also Surveying and Geology, which are useful for Civil Engineers. These modules form the base for all civil engineering applications. Commencing in Semester 3, you will be learning the design principles in most of the major areas of Civil Engineering, especially in the design courses. Towards the end of your programme, you will take courses in Economics and Management, because all engineers are managers of one sort or another. As part of some of these modules, you will have the opportunity to visit several sites of Civil Engineering interest.

The period of Industrial Training is when you will experience the Civil Engineering world ranging from muddied boots to managers' board rooms (soon after Semester 5). You will

have a taste of your future career. Just prior to the commencement of semester 6, you will participate in a survey camp away from the University environment, where you will carry out projects based on surveying applications using a variety of techniques. You will again experience the 'real world' encountering social, environmental, safety, risk and sustainability issues and economic constraints beyond the familiar learning environment.

Management and design related modules are strengthened further in the final three semesters (6, 7 and 8). A wide variety of specialised applications are also included as elective modules. You can choose electives according to your preference. The electives cover virtually all the areas of Civil Engineering, namely Structural, Construction, Hydraulic, Geotechnical, Environmental and Transportation Engineering.

These three semesters also provide you with an exposure to and simulate real world environments through Research Projects and the Comprehensive Design Projects. These activities are aimed at making you a confident professional, who will be able to take up the challenges of the real world you would face at the end of your undergraduate studies, and contribute to the development of the country that nurtured you and the world that all of us live in.

In the Comprehensive Design Project (CDP), you will be given a brief, and requested to prepare the proposal, carry out pre-feasibility and feasibility studies, and provide the preliminary designs, detailed designs, tender documents and computer based drawings. In this activity, you will be working in teams of about 10, where you will learn the importance of social, environmental and economic aspects of projects, in addition to the technical aspects. The staff will give you minimum guidance in this, and most of the time your team will work independently finding the necessary information from various sources. In CDP, your individual performance and the performance of the group will be assessed.

You must also complete a Research Project on an individual basis under the direct supervision of a senior staff member where you will be trained to tackle unfamiliar problems through creative and systematic work to increase the knowledge gathered.

Details of the curriculum and modules are described under the section-Description of Modules. All taught modules are assessed by continuous assessments and end of semester written examinations. The continuous assessment component ranges from 20% to 100% depending on the module. You will be provided a course outline at the beginning of the semester indicating details pertinent to each module. A minimum requirement must be achieved in both continuous assessment and written examination in order to successfully complete a module.

An innovative feature of the Civil Engineering Programme is the Mentoring Programme that is conducted over a period of about three months. The programme is conducted in two phases. Guest lectures are delivered by specialists on relevant topics during the first phase while in the next phase; a mentor meets with a group of about ten students once a week for seven weeks. Most students meet their mentors away from the University, where they are exposed to a totally different environment, often a private sector office. This opportunity enables you to develop personal confidence and enhance other skills needed

to perform in a modern work environment and you will benefit significantly from the programme. The Department has pioneered this feature and is proud of its success. It greatly values the commitment of the mentors who allocate their time voluntarily amidst busy schedules to inspire the students and be their role models. At the end of each programme the students themselves organise an event in which they demonstrate their appreciation and gratitude to their mentors.

Further to this, the Department allocates small groups of up to 10 students from each batch to the individual staff members. The students are encouraged to meet their staff mentors on a regular basis which will help in their academic as well as personal matters, especially in times of need. This structured program is designed to pair students with experienced staff in their field of study who have expertise and knowledge in the field and are willing to share their experiences and insights with mentees.

3.1.4 COORDINATION OF SPECIFIC ACTIVITIES OF THE B.SC. ENGINEERING DEGREE COURSE

Academic Co-ordinator (Semester 1)	Mr. A. H. R. Rathnasooriya
Academic Co-ordinator (Semester 2)	Dr. H. G. L. N. Gunawardhana
Academic Co-ordinator (Semester 3)	Dr. K. H. S. M. Sampath
Academic Co-ordinator (Semester 4)	Dr. T. M. N. Wijayaratna
Academic Co-ordinator (Semester 5)	Dr. G. L. D. I. de Silva
Academic Co-ordinator (Semester 6)	Dr. K. Baskaran
Academic Co-ordinator (Semester 7)	Prof. J. M. A. Manatunge
Academic Co-ordinator (Semester 8)	Dr. L. L. Ekanayake
Industrial Training (Semester 6)	Dr. K. Baskaran
Research Projects (Semesters 6, 7 & 8)	Dr. H. L. K. Perera
Comprehensive Design Projects (Semesters 7 & 8)	Prof. M. T. R. Jayasinghe Prof. U.P. Nawagamuwa
Survey Camp (Semester 6)	Mr. T. D. C. Pushpakumara

3.2 EXAMINATIONS AND ASSESSMENT STRATEGY

All modules are assessed by continuous assessments based an Outcome Based Education (OBE) philosophy and final examinations. Allocation of marks for final examination and continuous assessment for each module will be different, depending on the module, and this will be given to students in the course outline at the beginning of the semester. Students should have minimum of 80 % attendance to be eligible for the final examination. Students with illness or any other valid reason for their inability to attend lectures should bring a medical certificate from a recognized medical officer or a letter describing the problem they had. All students should also satisfy the minimum

requirement for both continuous assessment and final examination of a particular module in order to pass. All the continuous assessment assignments should be submitted before the specified deadlines. Marks will normally be deducted for late submissions.

3.3 MENTORING PROGRAMME

The primary objective of the mentoring programme is to produce graduates with skills and attitudes that would be sought after by the industry. Accordingly, the focus is broadly on areas such as the development of personality, communication skills, positive attitudes, leadership, teamwork, career search skills and personal grooming.

The mentoring programme is conducted over a period of approximately fourteen weeks. The first half of the programme is carried out in the form of guest lectures delivered by specialists on relevant topics. During the next phase, a mentor meets with a group of about ten students once a week for seven weeks. On most occasions, students meet with their mentors away from the University, where they experience exposure to a totally different environment, often a private sector office. This enables students to further develop their personal confidence and enhance other skills needed to perform in a modern work environment. The programme is personalized and lasts long enough to begin a process of change in the students. It is also anticipated that the close relationship mentors develop with students will help them in their future career search.

Most students benefit significantly from the programme and would recommend it to their juniors. The selected mentors give of their time voluntarily and sacrificially amidst heavy schedules. The commitment of the mentors has been a source of inspiration to students and their contribution is greatly appreciated.

In addition, the departmental mentoring program with senior staff aims to provide students with guidance, support, and advice on various aspects of their academic and future professional lives, such as course selection, internships, career planning, job search strategies, and personal development. The program can help students to gain practical skills, broaden their networks, and enhance their confidence and motivation to succeed in their future academic activities and careers.

3.4 AWARDS

Name of the Award	Awarded to
Gold Medal in Civil Engineering	The Civil Engineering Graduand who obtains the highest overall Grade Point Average of 3.8 or above at the B.Sc. Engineering Degree Examination donated by Deshabandu Dr. A. N. S. Kulasinghe
Special Award for Academic Excellence in Civil Engineering	The Civil Engineering Graduand who obtains the 2nd highest overall Grade Point Average 3.7 and above at the B.Sc. Engineering Degree Examination
Special Award for Academic Excellence in Civil Engineering	The Civil Engineering Graduand who obtains the 3rd highest overall Grade Point Average 3.7 and above at the B.Sc. Engineering Degree Examination
Comprehensive Design Project Award in Civil Engineering	Awards to be made to the 10 best students, based on a marking scheme for performance in the Comprehensive Design Project
Building and Structural Engineering Award*	The Civil Engineering Student who obtains the highest Grade Point Average of 3.7 and above at the first attempt for the specified Building and Structural Engineering modules. The specified modules are: CE1113 Structural Mechanics I CE2014 Structural Mechanics II CE2114 Structural Analysis I CE2023 Design of Steel Structures CE2123 Design of Concrete Structures I CE3113 Structural Analysis II CE3123 Design of Masonry and Timber Structures CE4013 Design of Concrete Structures II and highest marks for any one of the following modules CE4313 Building Engineering CE4443 Computational Mechanics CE4413 Bridge Engineering CE4433 Design of Large Structures
Construction Engineering and Management Award*	The Civil Engineering Student who obtains the highest Grade Point Average of 3.7 and above at the first attempt for the specified Construction Engineering modules. The specified modules are: CE1133 Building Construction and Materials CE2053 Construction Planning and Cost Estimation

Name of the Award	Awarded to
	CE3143 Construction Management CE4113 Management Skills Development CE4124 Engineering Economics CE4343 Construction Technology and highest marks for any one of the following modules CE4493 Project Management CE4523 Sustainable Design and Construction
Environmental Engineering Award*	The Civil Engineering Student who obtains the highest Grade Point Average of 3.7 and above at the first attempt for the specified Environmental Engineering modules. The specified modules are: CE3153 Fundamentals of Environmental Engineering CE4053 Environmental Engineering and highest marks for any one of the following modules CE4553 Water and Wastewater Treatment CE4563 Environmental Impact Assessment CE4650 Environmental Sustainability for Civil Engineering Applications
Geotechnical Engineering Award*	The Civil Engineering Student who obtains the highest Grade Point Average of 3.7 and above at the first attempt for the specified Geotechnical Engineering modules. The specified modules are: CE 2043 Soil Mechanics and Geology I CE 2133 Soil Mechanics and Geology II CE 3133 Geotechnical Engineering CE 4033 Geotechnical Design and highest marks for any one of the following modules CE 4473 Environmental Geotechnics CE 4483 Computational Geotechnical Engineering
Hydraulic Engineering Award*	The Civil Engineering Student who obtains the highest Grade Point average of 3.7 and above at the first attempt for the specified Hydraulic Engineering modules. The specified modules are: CE1023 Fluid Mechanics CE1123 Fluid Dynamics CE2033 Hydraulic Engineering CE3013 Engineering Hydrology CE4023 Hydraulic Design and highest marks for any one of the following modules CE4323 Irrigation Engineering CE4453 Costal and Port Engineering CE4630 Computational Hydraulics and Hydrology

Name of the Award	Awarded to
Transportation Engineering Award*	The Civil Engineering Student who obtains the highest Grade Point Average of 3.7 and above at the first attempt for the specified Transportation Engineering modules. The specified modules are: CE3163 Fundamentals of Transportation Engineering CE4043 Highway Engineering CE4353 Traffic Engineering and Planning and highest marks for any three of the following modules CE4533 Highway Construction and Maintenance Management CE4543 Analysis and Design of Transportation Systems CE4571 Operations Research for Infrastructure Systems CE4581 Intelligent Transportation Systems CE4591 Railway and Airport Engineering CE4333 Remote Sensing and GIS
**** Can be subjected to change as per senate approval***	

4 CURRICULUM AND MODULES

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4. CURRICULUM AND MODULES

4.1 B.SC. ENGINEERING HONOURS DEGREE PROGRAMME

Department of Civil Engineering

Module Code	Module Name	Category	Lectures hrs/week	Lab/ Assignments hrs/week	Credits		Norm		Evaluation	
					GPA	NGPA	GPA	NGPA	CA%	WE%
Semester 1										
MA1014	Mathematics	C	5/2	1	3.0				20	80
CS1033	Programming Fundamentals	C	2	2	3.0				20	80
ME1033	Mechanics	C	2	2/4	2.0				20	80
MT1023	Properties of Materials	C	2	2/4	2.0				20	80
CE1023	Fluid Mechanics	C	2	2/4	2.0				20	80
EE1013	Electrical Fundamentals	C	2	2/4	2.0				20	80
EL1030	Language Skill Enhancement (contd. to Semester 2)	C	-	2	1.0		15.0	0.0	100	0
					Total for Semester 1		**15.0**	**0.0**		
Semester 2										
MA1024	Methods of Mathematics	C	5/2	1	3.0				30	70
CE1113	Structural Mechanics I	C	5/2	2/2	3.0				30	70
CE1123	Fluid Dynamics	C	5/2	2/2	3.0				30	70
CE1133	Building Construction and Materials	C	2	2	3.0				30	70
EL1030	Language Skill Enhancement (contd. from Semester 1)	C	-	2	1.0				0	100
CE1140	Introduction to Conceptual Design (contd. to Semester 3)	C	-	2		1.0	13.0	1.0	100	0
CE1210	Computing for Civil Engineering	E	1	2		2.0			100	0
CE2261	Building Design Process and Applications	E	1	2		2.0	0.0	2.0	30	70
HM-1	Humanities Electives	E	2	-	2.0		2.0	0.0	100	0
					Total for Semester 2		**15.0**	**3.0**		

Module Code	Module Name	Category	Lectures hrs/week	Lab/ Assignments hrs/week	Credits		Norm		Evaluation	
					GPA	NGPA	GPA	NGPA	CA%	WE%
Semester 3										
MA2014	Differential Equations	C	2	-	2.0				30	70
MA2024	Calculus	C	2	-	2.0				30	70
CE2014	Structural Mechanics II	C	5/2	2/2	3.0				30	70
CE2023	Design of Steel Structures	C	2	2	3.0				30	70
CE2033	Hydraulic Engineering	C	5/2	2/2	3.0				30	70
CE2043	Soil Mechanics and Geology I	C	2	2	3.0				30	70
CE2053	Construction Planning and Cost Estimating	C	2	2	3.0				30	70
CE2063	Surveying I	C	2	2	3.0				30	70
CE1140	Introduction to Conceptual Design (contd. from Semester 2)	C		2		1.0	22.0	1.0	100	0
					Total for Semester 3		**22.0**	**1.0**		
Semester 4										
MA2034	Linear Algebra	C	2	-	2.0				30	70
CE2114	Structural Analysis I	C	5/2	2/2	3.0				30	70
CE2123	Design of Concrete Structures I	C	2	2	3.0				40	60
CE3013	Engineering Hydrology	C	5/2	2/2	3.0				30	70
CE2133	Soil Mechanics and Geology II	C	2	2	3.0				30	70
CE2143	Surveying II	C	2	2	3.0				30	70
CE3153	Fundamentals of Environmental Engineering	C	3/2	2/2	2.0				30	70
CE3163	Fundamentals of Transportation Engineering	C	3/2	2/2	2.0		21.0	0.0	40	60
					Total for Semester 4		**21.0**	**0.0**		

Module Code	Module Name	Category	Lectures hrs/week	Lab/ Assignments hrs/week	Credits		Norm		Evaluation	
					GPA	NGPA	GPA	GPA	CA%	WE%
Semester 5										
MA3014	Applied Statistics	C	2	-	2.0				30	70
CE3113	Structural Analysis II	C	5/2	2/2	3.0				50	50
CE3123	Design of Masonry and Timber Structures	C	2	2	3.0				40	60
CE3133	Geotechnical Engineering	C	5/2	2/2	3.0				30	70
CE3143	Construction Management	C	5/2	2/2	3.0				30	70
CE4023	Hydraulic Design	C	5/2	2/2	3.0				30	70
CE4343	Construction Technology	C	2	2	3.0		20.0	0.0	40	60
					Total for Semester 5		**20.0**	**0.0**		
Industrial Training & Survey Camp										
CE3993	Industrial Training	C	-	-		6.0			100	0
CE3914	Survey Camp	C	-	-		2.0	0.0	8.0	100	0
					Total for Industrial Training & Survey Camp		**0.0**	**8.0**		
Semester 6										
CE4903	Communication Skills and Research Methodology	C	1	2		2.0			100	0
CE4923	Research Project (contd. to Semester 6)	C	-	2	1.0				100	0
CE3880	Engineer and Society	C	2	2	3.0				100	0
					Total for Semester 6		**4.0**	**2.0**		

Module Code	Module Name	Category	Lectures hrs/week	Lab/ Assignments hrs/week	Credits		Norm		Evaluation	
					GPA	NGPA	GPA	NGPA	CA%	WE%
Semester 7										
CE4033	Geotechnical Design	C	5/2	2/2	3.0				30	70
CE4043	Highway Engineering	C	5/2	2/2	3.0				40	60
CE4053	Environmental Engineering	C	5/2	2/2	3.0				40	60
CE4913	Comprehensive Design Project (contd. to Semester 7)	C	-	4	2.0				100	0
CE4013	Design of Concrete Structures II	C	2	2/2	3.0				40	60
CE4923	Research Project (contd. to Semester 6)	C	-	4	2.0		16.0	0.0	100	0
CE4313	Building Engineering	E	2	2	3.0				40	60
CE4323	Irrigation Engineering	E	5/2	2/2	3.0				30	70
CE4333	Remote Sensing and GIS	E	5/2	2/2	3.0				50	50
CE4353	Traffic Engineering and Planning	E	5/2	2/2	3.0				40	60
CE4571	Operations Research for Infrastructure Systems	E	2	2	3.0				50	50
CE4581	Intelligent Transportation Systems	E	2	2	3.0				40	60
CE4611	Sustainable design and whole lifecycle	E	3	-	3.0				100	0
CE4640	Disaster Risk Management	E	2	2	3.0		0.0	0.0	80	20
				Total for Semester 7			**16.0**	**0.0**		
Semester 8										
CE4923	Research Project (contd. from Semester 7)	C	-	2	1.0				100	0
CE4913	Comprehensive Design Project (contd. from Semester 7)	C		6	3.0				100	0
CE4113	Management Skill Development	C	2		2.0				30	70
CE4124	Engineering Economics and Financial Accounting	C	2	2	3.0		9.0	0.0	30	70

Module Code	Module Name	Category	Lectures hrs/week	Lab/ Assignments hrs/week	Credits		Norm		Evaluation	
					GPA	NGPA	GPA	NGPA	CA%	WE%
CE4413	Bridge Engineering	E	2	2	3.0				40	60
CE4433	Design of Large Structures	E	5/2	2/2	3.0				40	60
CE4443	Computational Mechanics	E	5/2	2/2	3.0				40	60
CE4453	Coastal & Port Engineering	E	5/2	2/2	3.0				30	70
CE4473	Environmental Geotechnics	E	2	2	3.0				30	70
CE4483	Computational Geotechnical Engineering	E	2	2	3.0				50	50
CE4493	Project Management	E	2	2	3.0				30	70
CE4523	Sustainable Design and Construction	E	2	2	3.0				40	60
CE4533	Highway Construction and Maintenance Management	E	5/2	2/2	3.0				40	60
CE4543	Analysis and Design of Transportation Systems	E	5/2	2/2	3.0				40	60
CE4553	Water & Wastewater Treatment	E	5/2	2/2	3.0				40	60
CE4563	Environmental Impact Assessment	E	2	2	3.0				40	60
CE4591	Railway and Airport Engineering	E	2	2	3.0				40	60
CE4621	Engineering Response to Climate Change	E	3	-	3.0				100	0
CE4630	Computational Hydraulics and Hydrology	E	2	2	3.0				50	50
CE4650	Environmental Sustainability for Civil Engineering Applications	E	5/2	2/2	3.0		3.0	0.0	40	60
						Total for Semester 8	**12.0**	**0.0**		
Total for the Civil Engineering specialization							**125.0**	**14.0**		
Faculty/specialization electives beyond the specialization requirements							11.0			
Total minimum credit requirement for graduation							**150.0**			

Category: C – Core/Compulsory Module E – Elective Module

Modules Offered to Other Fields of Specialisation

Module Code	Module Name	Lectures hrs/week	Lab/ Assignments hrs/week	Credits		Evaluation	
				GPA	NGPA	CA%	WE%
Semester 3							
CE1813	Mechanics of Materials	2.0	-	2.0		30	70
CE1823	Aspects of Civil Engineering	2.0	-	2.0		30	70
CE2063	Surveying I	2.0	2	3.0		30	70
Semester 5							
CE2143	Surveying II	2.0	2	3.0		30	70
CE2812	Soil Mechanics	2.5	3/2	3.0		30	70

Please refer to Undergraduate Studies Division of the Faculty of Engineering for details on Faculty Elective and Humanities Elective modules.

4.2 TRANSPORTATION ENGINEERING STREAM

Students in the Transportation Engineering stream will be following the same number of core modules as the other students, the specialised modules for the stream are defined from the elective basket, hence they would need to take 15 credits from elective modules offered in Semester 7 and 8 as per the prescribed elective baskets. In addition to this, the students would need to do their Final Year Research Project as well as Industrial Training in a transportation engineering related area.

The Transportation Engineering Stream will be introduced from Semester 5 onwards.

Selection to the stream will be as follows: students can opt for the Stream at the end of Semester 4, selection criteria will be based on the Cumulative Grade Point Average (CGPA) at the end of Semester 4 if the number of applicants exceeds 20.

Module Code	Module Name	Category	Lectures	Lab/ Assignments	Credits		Evaluation		Offering Semester	Required Minimum		
			hrs/week	hrs/week	GPA	NGPA	CA%	WE%				
CE4343	Construction Technology	C	2	2	3.0	-	30	70	Semester 5	3.0		
CE4043	Highway Engineering	C	2.5	1	3.0	-	40	60	Semester 7	3.0		
CE4353	Traffic Engineering and Planning	C	2.5	1	3.0	-	40	60	Semester 7	3.0		
CE4533	Highway Construction and Maintenance Management	E	2.5	2/2	3.0	-	40	60	Semester 8	3.0	**Basket 1**	12.0
CE4543	Analysis and Design of Transportation Systems	E	2.5	2/2	3.0	-	40	60	Semester 8			
CE4571	Operations Research for Infrastructure Systems	E	2.0	2/1	3.0	-	50	50	Semester 7	6.0	**Basket 2**	
CE4581	Intelligent Transportation Systems	E	2.0	2/1	3.0	-	40	60	Semester 7			
CE4591	Railway and Airport Engineering	E	2.0	2/1	3.0	-	40	60	Semester 8			
CE4333	Remote Sensing and GIS	E	2.0	2/1	3.0	-	50	50	Semester 7	0.0	**Basket 3**	
CE4413	Bridge Engineering	E	2.0	2/1	3.0	-	40	60	Semester 8			
CE4563	Environmental Impact Assessment	E	2.0	2/1	3.0	-	40	60	Semester 8	3.0	**Basket 4**	
CE4650	Environmental Sustainability for Civil Engineering Applications	E	2.5	2/2	3.0	-	40	60	Semester 8			
	Total Credits Required									**24.0**		

Possible combinations (to satisfy the minimum credit requirement) from modules that the students in the stream may opt for is as follows,

	Basket 1	**Basket 2**	**Basket 3**	**Basket 4**	**Total from Electives**	**Total from Core**	**Total Credits**
Option 1	3.0	6.0	3.0	3.0	15.0	9.0	24.0
Option 2	6.0	6.0	0.0	3.0	15.0	9.0	24.0
Option 3	3.0	9.0	0.0	3.0	15.0	9.0	24.0
Minimum from Basket	3.0	6.0	0.0	3.0			
Minimum from Baskets 1+2+3	12.0						

4.3 DESCRIPTION OF MODULES – CIVIL ENGINEERING

Module Code	CE1023	**Module Title**	Fluid Mechanics			
Credits	2.0	**Hours/Week**	**Lectures**	2.0	**Pre/Co- requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	2/4		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *describe* the significance of properties of fluids in engineering applications,
LO-2: *identify* hydrostatic forces on submerged surfaces/ bodies and *analyse* the conditions for equilibrium and stability of such surfaces/bodies in engineering application,
LO-3: apply the concepts of conservation of mass, momentum, and energy of fluids and calculate the velocities, pressures, flow rates, forces, etc., in engineering applications, and
LO-4: classify the different types of hydraulic machinery and estimate the operating conditions of pumps in engineering applications.

Module Outline	**LOs Covered**
Introduction [1 h] *Applications of fluid mechanics in engineering practice, historical development of fluid mechanics*	LO-1
Characteristics/ Properties of Fluids [1 h] *Characteristic behaviour of fluids, continuum concept, properties of fluids: density, specific weight, relative density, viscosity, compressibility, surface tension, vapor pressure*	LO-1
Fluid Statics [12 h] *Hydrostatic pressure: governing equation, variation of pressure, piezometric pressure, absolute and gauge pressures, pressure head, measurement of pressure, pressure rating of pipes; Hydrostatic thrust: hydrostatic thrust on plane and curved surfaces, pressure diagram; Buoyancy: upthrust on submerged bodies, Archimedes principle, equilibrium and stability of fully submerged and floating bodies, effect of liquid cargo; Relative equilibrium: relative equilibrium of fluids under linear acceleration, forced vortex motion*	LO-2
Fluids in Motion [10 h] *Introduction to fluid flow: characteristics of fluid flow, flow classification, flow visualization; Conservation of mass: continuity equation for incompressible flow, applications; Conservation of energy: Bernoulli's equation, steady flow energy equation, applications; Conservation of momentum: steady flow force-momentum equation, applications*	LO-3
Introduction to Hydraulic machinery [4 h] *Introduction to hydraulic machinery: classification of hydraulic machinery, pumps and turbines, operating conditions of pumps*	LO-3
Practical Work	
1. Stability of a rectangular pontoon	LO-2
2. Forced vortex motion (demonstration)	LO-2

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Coursework on laboratory practical: Stability of a rectangular pontoon	LO-2	20%
	WE	End Semester Examination	All	80%

Recommended Textbooks	1. Subramanya, K. (2001). Theory and Applications of Fluid Mechanics – Revised edition (SI Units). McGraw-Hill Publishing Co. 2. Hamill, L. (2001). Understanding Hydraulics, (3rd ed.), Palgrave Macmillan Publishers. 3. Douglas, J. F., Gasiorek, J. M., and Swaffield, J. A. (2000). Fluid Mechanics (4th ed.). Prentice Hall Publishers. 4. Massey, B. S. (1998). Mechanics of Fluids (7th ed.). Chapman & Hall.
Names of Lecturers	Mr. A. H. R. Rathnasooriya, Dr. P. K. C. De Silva, Dr. R. L. H. L. Rajapakse

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	L											
LO-2	L	L										
LO-3	M	L	L	L								L
Module	**M**	**L**	**L**	**L**								**L**

Scale: H – High M – Medium L – Low

Module Code	CE1112	**Module Title**	Structural Mechanics I			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	ME1032
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: examine different types of structural and material behaviour under different types of actions,
LO-2: compute various types of stresses and deformations in determinate structures,
LO-3: apply their knowledge to solve practical problems involving structural behaviour, and
LO-4: design, fabricate (and subsequently test) within a group, a simple structure that optimizes load carrying capacity and material usage, based on their understanding of structural behaviour.

Module Outline	**LOs Covered**
Bending stresses [8 h] *Theory of bending, applications in uni-axial and biaxial conditions, composite sections and moment of resistance, derivation of bending formula*	LO-1, LO-2 LO-3
Transverse shear stresses [6 h] *Horizontal and vertical shear stress distribution, location of shear centre, design of rivets*	LO-1, LO-2 LO-3
Torsion [4 h] *Torsion of circular sections, hollow cylinders and tapering shafts*	LO-1, LO-2 LO-3
Deflection of beams [8 h] *Differential equation of flexure, Macaulay's method and moment-area method, introduction to simple statically indeterminate beams*	LO-1, LO-2 LO-3
Theory of columns and struts [9 h] *Core of a short column section, buckling of struts in long columns, design for imperfections*	LO-1, LO-2 LO-3
Practical Work	
1. Buckling of struts	LO-1
2. Torsion and biaxial bending tests	LO-1
3. Build and test a truss	LO-4
Assignments	
1. Tutorials on all 5 topics	LO-2, LO-3

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Complete labsheets on torsion and biaxial bending tests [2%]	LO-1	30%
		Coursework on buckling of struts [3%]	LO-1	
		Performance of truss [10%]	LO-4	
		In-class quizzes (Best 3 out of 4) [15%]	LO-1, LO-2 LO-3	
	WE	End Semester Examination	LO-1, LO-2 LO-3	70%

Recommended Textbooks

1. Case, J. and Chilver, A. H. (1971). Strength of Materials and Structures (2nd ed.). London: Edward Arnold.
2. Ryder, G. H. (1969). Strength of Materials (3rd ed.). Houndmills: Macmillan.

Names of Lecturers: Prof. I. R. A. Weerasekera

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	H											L
LO-2	M											
LO-3	M											
LO-4	L		M						M			L
Module	**M**		**L**						**L**			**L**

Scale: H – High M – Medium L – Low

Module Code	CE1122	**Module Title**	Fluid Mechanics II			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE1022
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *compute* the flow rates in pipes/ channels and their sizes required under different conditions,

LO-2: *compute* the flow rates and hydraulic heads in pipe networks by iterative methods,

LO-3: *identify* flow measuring devices suitable for various applications and *determine* the flow rates using such devices,

LO-4: *apply* theories of ideal fluid flow to simulate real flow conditions, and

LO-5: *articulate* the general laws governing real fluid flow.

Module Outline	**LOs Covered**
Pipe flow [12 h] *Laminar and turbulent flow in pipes, head losses, flow rate and pipe sizes required, power transmission by pipes*	LO-1
Pipe networks [4 h] *Analysis of pipe networks by iterative methods, computer based analysis*	LO-2
Flow measurement [6 h] *Flow measuring devices for pipe flow, channel/stream flow, flow from tanks/reservoirs*	LO-3
Steady, uniform flow in open channels [6 h] *Velocity formulae, optimum sections*	LO-1
Ideal fluid flow [5 h] *Mathematical concepts, basic flow patterns and combinations, applications*	LO-4
Flow of real fluids [2 h] *Navier-Stokes equation, applications*	LO-5
Practical Work	
1. Head losses in pipe flow	LO-1
2. Flow measurements	LO-3
Assignments	
1. Computer aided pipe network analysis	LO-2
2. Tutorials on all 6 sections	All

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Coursework on head losses in pipe flow [7.5 %]	LO-1	30%
		Coursework on flow measurements [7.5 %]	LO-3	
		Coursework on computer aided pipe network analysis [10 %]	LO-2	
		Attendance for tutorials [5 %]	All	
	WE	End Semester Examination	All	70%

Recommended Textbooks	1. Chadwick, A., Morfett, J., Borthwick, M. (2004). Hydraulics in Civil and Environmental Engineering, (4th ed.), Abingdon 2. Hamill, L. (2002). Understanding Hydraulics, (3rd ed.), Palgrave Macmillan Limited 3. Kumar, D. S. (1987). Fluid Mechanics and Fluid Power Engineering, (9th ed.), S. K. Kataria & Sons
Names of Lecturers	Dr. T. M. N. Wijayaratna, Mr. A. H. R. Ratnasooriya

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M	L										
LO-2	M	L	L	L								
LO-3	L	L										
LO-4	M	L	L	L								
LO-5	L											
Module	**M**	**L**	**L**	**L**								

Scale: H – High M – Medium L – Low

Module Code	CE1132	**Module Title**	Building Construction and Materials			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *identify* appropriate building materials for use in low and medium rise buildings considering their advantages and limitations with regard to sustainability, availability and economic viability,

LO-2: *recognize* the role of different elements in a building; foundations, walls, doors, windows, roofs, finishes, their construction methods and their compliance with relevant standards,

LO-3: *specify* and *adopt* manufacturing processes, properties and test methods including that of quality control and quality assurance for cement, concrete, masonry, timber and steel, and

LO-4: *select* building materials and method that conform to relevant standards.

Module Outline	**LOs Covered**
Introduction to building construction and building elements [4 h] *Identification of building elements, theory and practice and its use in the construction of buildings*	LO-1, LO-2
Building materials and construction methods [8 h] *Identification and use of suitable building materials and construction methods which satisfy relevant structural, health, safety, serviceability specifications and standards for foundations, walls, doors and windows, roofs, floors and finishes*	LO-1, LO-2, LO-4
Alternative construction materials and methods [8 h] *New construction materials and methods with an introduction to sustainable construction*	LO-1, LO-2, LO-3
Properties and specifications of construction materials [8 h] *Manufacturing processes, properties, specifications and test methods for main construction materials including cement, steel, bricks, timber, concrete aggregates, sand, roof covering materials*	LO-1, LO-3, LO-4
Practical Work	
1. Tests on aggregates	LO-1, LO-3, LO-4
2. Concrete Mix Design	LO-1, LO-3, LO-4
3. Tests on Ordinary Portland Cement	LO-1, LO-3, LO-4
4. Properties of Timber	LO-1, LO-3, LO-4
Assignments	
1. Tutorials on all 4 topics	LO-1, LO-2, LO-3, LO-4
2. Take home assignments	LO-1, LO-2

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	In-class quizzes [5%]	LO-1, LO-2, LO-3	30%
		Coursework on aggregate testing [5 %]	LO-1, LO-3, LO-4	
		Coursework on Concrete Mix design [5%]	LO-1, LO-3, LO-4	
		Coursework on Ordinary Portland Cement [5%]	LO-1, LO-3, LO-4	
		Properties of timber [5%]	LO-1, LO-3, LO-4	
		Take-home assignment [3%]	LO-1, LO-2	
		Active participation and interaction in tutorial sessions [2%]	LO-1, LO-2, LO-3, LO-4	
	WE	End Semester Examination	ALL	70%

Recommended Textbooks	1. Seeley, I. H. (1995). Building Technology (Building and Surveying Series) (5th ed.). Red Globe Press. 2. Barry, R. (1999). The Construction of Buildings (7th ed.). Wiley-Blackwell. 3. Hendry, A. W. (1981). Structural Brickwork (2nd ed.). London: Macmillan Publishers Limited.
Names of Lecturers	Prof. (Mrs.) C. Jayasinghe, Prof. S. M. A. Nanayakkara

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M						M				L	L
LO-2	M		L	L		M	L			M		L
LO-3	H		M			L			M			L
LO-4							H					M
Module	**M**		**L**	**L**		**L**	**M**		**L**	**L**	**L**	**M**

Scale: H – High M – Medium L – Low

Module Code	CE2013	**Module Title**	Structural Mechanics II			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	ME1032
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *compute* elastic stress and strain at a point and check for failure mechanisms in a material,

LO-2: *examine* the effects of moving loads on determinate structures,

LO-3: c*ompute* forces and displacements in determinate and indeterminate structures, and

LO-4: *perform* two-dimensional (2D) computer modelling of simple structures.

Module Outline	**LOs Covered**
Analysis of elastic stress and strain at a point; Mohr Circles; Generalized Hook's Law [8.5 h] *Introduction to stress and strain analysis, analysis of stress, analysis of strain, Mohr's circle, stress - strain relationships*	LO-1
Theories of elastic failure [4 h] *Study different theories of elastic failures, failure mechanisms for ductile and brittle materials*	LO-1
Influence lines for determinate structures [7.5 h] *Influence lines for determinate structures and basic concepts, effect of moving loads, distributed loads and series of point loads*	LO-2
Moment distribution methods [7.5 h] *Introduction to moment distribution method (MDM), analysis of continuous beams and frames using MDM*	LO-3
Energy theorems [7.5 h] *Introduction to energy theorems, calculations of strain energy due to axial, shear, bending and torsional actions, theorem of minimum potential energy, Castigliano's theorems, principle of virtual work, etc, analysis of trusses, beams and frames using energy theorems*	LO-3
Computer modelling of two-dimensional structures (Practicals) [9 h] *Introduction to a commercial finite element package (SAP2000), degrees of freedoms and different 1D element formulations, analysis of a trusses, frames and shell structures*	LO-4
Practical Work	
1. Computer laboratory classes	LO-4
Assignments	
1. Computer modelling of a 2D truss (individual submission)	LO-4
2. Computer modelling of a 2D beam/ frame (individual submission)	LO-4

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Reports on 2 computer assignments (individual submissions) [20 %]	LO-4	30%
		Two in class quizzes (best 2 out of 3 quizzes will be selected based on the maximum marks) [10 %]	LO-1, LO-2, LO-3	
	WE	End Semester Examination	LO-1, LO-2, LO-3	70%

Recommended Textbooks	1. Hearn, E. J. (1977). Mechanics of Materials Vol. 1 (3rd ed.). Oxford: Pergamon. 2. Case, J. and Chilver, A. H. (1971). Strength of Materials and Structures (2nd ed.). London: Edward Arnold. 3. Marshall, W. T. and Nelson, H. M. (1969). Structures. London: Isaac Pitman. 4. Gere, J. M. and Goodno, B. J. (2009). Mechanics of Materials (7th ed.). Toronto: Cengage Learning. 5. Hibbeler, R. C. (2006). Structural Analysis (6th ed.). Lafayette: Pearson.
Names of Lecturers	Dr. H. G. H. Damruwan

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	H		L									L
LO-2	H											L
LO-3	H											L
LO-4					M					L		M
Module	**H**		**L**		**M**					**L**		**L**

Scale: H – High M – Medium L – Low

Module Code	CE2022	**Module Title**	Design of Steel Structures			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	CE1112
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *convince* a client on the merits of structural steel construction,

LO-2: *propose* alternative solutions for a client's brief and *justify* the selection of a particular solution,

LO-3: *assess* the magnitude of loads and *identify* load paths in a structure,

LO-4: *prepare* structural calculations adopting relevant design standards, and

LO-5: *articulate* lessons learnt from historical failures of structures.

Module Outline	**LOs Covered**
Introduction to the process of design [2 h] *Explain what is meant by design of a structure, the features of a well designed structure and the philosophy of design*	LO-2
Types of loads, their effects and load paths [2 h] *Permanent and variable loads including imposed and wind loads, the static and dynamic nature, their effect on the structure and how they are traced to the ground with examples.*	LO-2,LO-3
Properties of steel in relation to design [2 h] *Manufacture of steel, its advantages and disadvantages, its properties relevant to structural design and how it should be selected according to standards/specifications*	LO-1, LO-2, LO-4
Design of steel members subject to tension, compression and bending [12 h] *Elements of a structure and how they perform, different failure modes and how safety is ensured using Eurocode 3 as an example code*	LO-4
Design of steel connections [6 h] The *behaviour of bolts and welds in different types of simple connections and how to determine either the size/number of bolts and or length of weld required in a simple connection*	LO-4
Design failures [4 h] *Introduce the concept of learning from failures highlighting some classic examples in history and the lessons learnt.*	LO-5
Assignments	
1. Report to convince a client on the merits/demerits of steel for a proposed structure	LO-1
2. Report proposing alternatives for a roof structure	LO-2
3. Load evaluation and structural calculations	LO-3,LO-4
4. Presentation on lessons learnt from failure of structures	LO-5

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	In class un-announced quizzes [10%]	LO-4	30%
		Individual and Group Assignments (in class and take home) [15%]	LO-1,LO-2, LO-3,LO-4	
		Report on Design failures [5%]	LO-5	
	WE	End Semester Examination	All	70%

Recommended Textbooks	1. Narayanan, R.S. and Beeby, A.W. (2001). Introduction to Design for Civil Engineers. London: Spon Press. 2. Hettiarachchi, M.T.P. and Nanayakkara, K.I.U. (2019). An Introduction to the Design of Steel Structures to Eurocode 3. 3. Arya, C. (2009). Design of Structural Elements: Concrete, steelwork, masonry and timber designs to British Standards and Eurocodes(3rd ed.). London: Spon Press. 4. Brettle, M.E. and Brown, D.G. (2009). Steel Building Design: Concise Eurocodes. Ascot: Steel Construction Institute. 5. Davison, B. and Owens, G.W. (2011). The Steel Designer's Manual(7th ed.). Ascot: Steel Construction Institute and Oxford: Blackwell. 6. Draycott, T. and Bullman, P. (2009). Structural Elements Design Manual: Working with Eurocodes (2nd ed.). Butterworth-Heinemann.
Names of Lecturers	Dr. (Mrs.) M.T.P. Hettiarachchi

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	L		L			L	L			L		
LO-2			M			L	L			M		
LO-3	M				M				M			
LO-4	H		M		M							L
LO-5								L	M	H		H
Module	**M**		**M**		**M**	**L**	**L**	**L**	**M**	**M**		**M**

Scale: H – High M – Medium L – Low

Module Code	CE2032	**Module Title**	Hydraulic Engineering I			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE1122
GPA/NGPA	**GPA**		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *explain* the influence of boundary layer on the flow over solid surfaces,

LO-2: *apply* the techniques in dimensional analysis and physical modelling in solving engineering problems,

LO-3: *compute* the surge pressures developed in pipes and *devise* impact mitigation measures, and

LO-4: *articulate* various types of hydraulic machines used in engineering practice and *analyse* the performance of centrifugal pumps, impulse and reaction type turbines.

Module Outline	**LOs Covered**
Boundary layer theories [7.5 h] *Flow over solid surfaces, boundary layer concepts, drag force and other applications*	LO-1
Dimensional analysis and physical modelling [10 h] *Dimensional homogeneity, Buckingham's pi theorem, significance of non-dimensional groups, criteria governing physical modelling*	LO-2
Pressure transients [7.5 h] *Unsteady flow in pipes, water hammer, surge tanks*	LO-3
Hydraulic machinery [10 h] *Different types of hydraulic machines, rotodynamic machines, characteristics of pumps and turbines, pumps in pipeline systems, turbines and their efficiencies*	LO-4
Practical Work	
1. Physical modelling of hydraulic structures	LO-2
2. Testing the performance of a centrifugal pump	LO-4
3. Series and parallel use of centrifugal pumps	LO-4
Assignments	
1. Tutorial 1 on boundary layer theory and dimensional analysis	LO-1, LO-2
2. Tutorial 2 on pressure transients and hydraulic machinery	LO-3, LO-4

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Mid-Term Test [0%]	LO-1, LO-2	30%
		Assignment 1 [0%]	LO-1, LO-3	
		Assignment 2 [0%]	LO-1, LO-2	
		Assignment 3 [0%]	LO-3, LO-4	
		Report on Lab Class 1 [10%]	LO-2	
		Report on Lab Class 2 [10%]	LO-4	
		Report on Lab Class 3 [10%]	LO-4	
	WE	End Semester Examination	All	70%

Recommended Texts Books

1. Chadwick, A., Morfett, J. and Borthwick, M. (2004). Hydraulics in Civil and Environmental Engineering (4th ed.). Abingdon: CRC Press.
2. Hamill, L. (2002). Understanding Hydraulics (3rd ed.). Palgrave Macmillan Limited.
3. Cengel, Y. S. and Cimbala, J. M. (2006). Fluid Mechanics – Fundamentals and Applications (3rd ed.). McGraw-Hill

Names of Lecturers: Dr. T. M. N. Wijayaratna

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	L											
LO-2	M	M	M	L								L
LO-3	M	M	M	L								L
LO-4	M	M	M	L								L
Module	**M**	**M**	**M**	**L**								**L**

Scale: H – High M – Medium L – Low

Module Code	CE2042	**Module Title**	Soil Mechanics and Geology I			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *explain* the formation of rocks and soils,

LO-2: *demonstrate* the fundamental concepts of geological mapping,

LO-3: *identify* the fundamental properties of soils and rocks and *determine* the basic engineering properties using appropriate laboratory testing, and

LO-4: *classify* soils and *assess* the suitability of the soil for different civil engineering constructions

Module Outline	**LOs Covered**
Geology [10 h] *Geological history and Internal structure of the Earth* *Crust of the Earth: composition, strata, minor and major intrusions; tectonic plates, earthquakes, volcanoes, ridges, trenches, subduction;* *Internal and surface processes: weathering, erosion, transportation, deposition, lithification, uplift, volcanism, plutonism, metamorphism, melting, mountains;* *Igneous, sedimentary and metamorphic rocks: environments of rock formation, rock forms, rock types, and characteristic;* *Rock forming minerals: silicate and non-silicate minerals.*	LO-1, LO-2
Soil Mechanics [18 h] *Basic Properties of Soils: formation of soils, mass volume relationships;* *Particle Size Analysis: sieve analysis, hydrometer analysis;* *Plasticity: clay minerals, Atterberg limits, Plasticity chart;* *Classification of soils according to unified classification system;* *Compaction of Soils: effects of soil type water content and compaction effort, standard and modified Proctor compaction tests, air voids lines, methods of compaction in the field and quality control*	LO-3, LO-4
Practical Work	
1. Particle size distribution analysis	LO-3
2. Plasticity characteristics of soils	LO-3
3. Proctor compaction test	LO-3
4. In-situ density tests	LO-3
Assignments	
1. Selection of suitable materials for the construction of an earth dam	LO-4
2. Geology mapping	LO-1, LO-2

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Un-announced quiz [10%]	LO-3, LO-4	30%
		Selection of suitable materials for the construction of an earth dam [5%]	LO-4	
		Report(s) on Lab classes [10%]	LO-3	
		Report(s) on Geology mapping [5%]	LO-1, LO-2	
	WE	End Semester Examination	All	70%

Recommended Textbooks

1. Das, B. M. (1998). Principles of Geotechnical Engineering (4th ed.). Boston: PWS.
2. Craig, R. F. (1997). Soil Mechanics (6th ed.). E & FN Spon.
3. Coduto, D. P. (1998). Geotechnical Engineering. Prentice Hall.

4. Holtz, R. D. and Kovacs, W. D. (1981). An Introduction to Geotechnical Engineering. Prentice Hall.
5. Blyth, F. G. H. and de Freitas, M. (1984). A Geology for Engineers (7th ed.). CRC Press.

Names of Lecturers	Prof. U. G. A. Puswewala, Prof. S. A. S. Kulathilaka, Dr. U. P. Nawagamuwa

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	L											
LO-2	L									M		
LO-3	L	L			L				L	L		L
LO-4	H	L	L		L					L		L
Module	**M**	**L**	**L**		**L**				**L**	**L**		**L**

Scale: H – High M – Medium L – Low

Module Code	CE2052	**Module Title**	Construction Planning and Cost Estimating			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *extract* information from construction drawings for cost estimates and interim valuations,

LO-2: *prepare* Bills of Quantities and interim valuations of a construction project complying to standards and specifications,

LO-3: *produce* construction plans using project management and IT tools, and

LO-4: *check* for the compliance of Building regulations of a building.

Module Outline	**LOs Covered**
Preparation of construction drawings [8 h] *Preparation of drawings using computer tools such as AutoCAD, extracting information from drawings for the preparation of bills of quantities and interim valuations, special emphasis to be made on detail drawings*	LO-1
Preparation of Bills of Quantities [8 h] *Centre line method, taking off methods and calculations of quantities, preparation of Bills of Quantities for the requirements given in SLS 573 and similar standards, pricing methods and calculation of unit rates of construction work*	LO-2, LO-3
Construction planning [8 h] *Planning methods such as Activity on Node (AON) and Activity on Arrow (AOA), critical path methods, extracting estimating data for planning work and applications of MS Project computer tool*	LO-2, LO-3
Building regulations [4 h] *Introduction to building regulations*	LO-2, LO-4
Practical Work	
1. Preparation of AutoCAD drawings	LO-1
2. Application of MS Project computer tool	LO-3
Assignments	
1. Class assignment on Network analysis	LO-1, LO-2, LO-3
2. Taking off and preparation of BOQ and tender documents	LO-2, LO-3
3. End semester assignment	LO-2, LO-3, LO-4

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on Assignment 1 on Network analysis [6%]	LO-1, LO-2, LO-3	30%
		Report on Assignment 2 on BOQ and Tender [15%]	LO-2, LO-3	
		Report on End semester assignment [9%]	LO-2, LO-3, LO-4	
	WE	End Semester Examination	All	70%

Recommended Textbooks	1. SLS 573, Method of measurement of building works. Sri Lanka Standards Institution.
Names of Lecturers	Prof. A. A. D. A. J. Perera, Prof. R. U. Halwatura

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M				L					M		M
LO-2	L									H	H	M
LO-3	L	M	M		H				L	H	H	M
LO-4	L	L						H				M
Module	**M**	**L**	**L**		**M**			**M**	**L**	**H**	**H**	**M**

Scale: H – High M – Medium L – Low

Module Code	CE2062	**Module Title**	Surveying I				
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	None	
GPA/NGPA	GPA		**Lab/Assignments**	3/1			
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐		

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *demonstrate* an understanding of the use of survey measurements in civil engineering,

LO-2: *use* survey instruments to make measurements in the vertical and horizontal planes, and

LO-3: *produce* hand-drawn survey plans and longitudinal section/cross-section drawings.

Module Outline	**LOs Covered**
Introduction to Land Surveying [8 h] *Classification of surveying, principles of surveying, method of surveying, true bearing and magnetic bearing, linear and angular measurements, scale and maps, errors in measurements, coordinates on earth's surface*	LO-1
Linear measurements and Chain Surveying [6 h] *Chain, tape and accessory instruments, survey stations and lines, offsets, field procedure, booking procedure, plotting errors and corrections*	LO-2
Levelling and Contouring [8 h] *Levels, levelling staff, reduced level and level differences, rise and fall, height of collimation, booking procedures, fly-back, longitudinal and cross-sections, errors and corrections, curvature and refraction, contours and contouring*	LO-2, LO-3
Theodolite Surveying [6 h] *Vernier and glass–circle theodolite: measurement of horizontal and vertical angles, bearing, methods of traversing, angular and linear error, correction of coordinates*	LO-2, LO-3
Practical Work	
1. Chain Surveying	LO-1, LO-2
2. Levelling	LO-1, LO-2
3. Theodolite Surveying	LO-1, LO-2
Assignments	
1. Detail drawing using linear measurements	LO-3
2. Cross-section and longitudinal section drawings	LO-2, LO-3
3. Traverse adjustment, computation and detail drawing	LO-2, LO-3

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Competency in Chain surveying fieldwork [5%]	LO-1, LO-2	30%
		Detail drawing using linear measurements [5%]	LO-3	
		Competency in Levelling fieldwork [5%]	LO-1, LO-2	
		Cross-section and longitudinal section drawing [5%]	LO-3	
		Competency in Theodolite surveying [5%]	LO-1, LO-2	
		Traverse adjustment, computation and detail drawing [5%]	LO-2, LO-3	
	WE	End Semester Examination	All	70%

Recommended Textbooks	1. Bannister, A., Raymond, S. and Baker, R. (1998). Surveying (7th ed.). Harlow: Addison Wesley Longman. 2. Duggal, S. K. (2004). Surveying (Volume 1). Tata Mc-Graw Hill.
Names of Lecturers	Prof. U. G. A. Puswewala, Mr. T. D. C. Pushpakumara

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	H											
LO-2	M				M				M			L
LO-3	M									H		L
Module	**M**				**L**				**M**	**H**		**L**

Scale: H – High M – Medium L – Low

Module Code	CE2113	**Module Title**	Structural Analysis I			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE1112
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *demonstrate* the knowledge of different types of structural analysis methods and *identify* the most suitable methods for hand calculation and computer application respectively,

LO-2: *describe* the generalized nature of structural analysis methods and their related basic concepts for indeterminate structures,

LO-3: *solve* problems with matrix force method of analysis and *apply* it to trusses and continuous beams and *observe* their limitations,

LO-4*: solve* problems with matrix displacement method of analysis related to trusses, continuous beams, frames and grids, and

LO-5: *apply* plastic methods of analysis to continuous beams, frames and slabs.

Module Outline	**LOs Covered**
Introduction to analysis of statically indeterminate structures [3 h] *Introduction to matrix methods and analysis of statically indeterminate structures*	LO-2
Analyse statically indeterminate structures with matrix force method of analysis [8 h] *Solve problems with matrix force methods of analysis, applications to trusses and continuous beams, limitations of force method*	LO-3
Analyse statically indeterminate structures with matrix displacement method of analysis [6 h] *Solve problems with matrix displacement method of analysis, demonstrate the applications of it to trusses, continuous beams, frames and grid structures*	LO-4
Plastic analysis of beams, framed structures and slabs [18 h] *Plastic zone, plastic behaviour of beams, basic conditions of plastic collapse, statical and kinematical approaches, analysis of framed structures, yield line method and their application*	LO-5
Introduction to 2D and 3D modelling with computer software (Practicals) [14 h] *Introduction to SAP2000 finite element analysis software, modelling different types of truss and framed structures and verifying with simple manual calculations*	LO-1
Practical Work	
1. Computer laboratory classes	LO-1
2. Tutorial classes	LO-2, LO-3, LO-4, LO-5
Assignments	
1. Computer modelling of curved frames (individual submission)	LO-1, LO-2
2. Computer modelling of 3D truss structure (group submission)	LO-1, LO-3

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	In-class computer quiz [5%]	LO-1	30%
		Individual computer assignment on modelling of curved frames [5%]	LO-1, LO-2	
		Computer assignment (group) on modelling of 3D truss structure [10%]	LO-1, LO-3	
		Un-announced quizzes (best 2 out of 3 quizzes) [10%]	LO-2, LO-3, LO-4, LO-5	
	WE	End Semester Examination	All	70%

Recommended Textbooks	1. Ghali, A., Neville, A. M. and Brown, T. G. (2009). Structural Analysis: Unified Classical and Matrix Approach (6th ed.). London: Tayler & Francis. [624.04:519.6] 2. Megson, T. H. G. (2014). Structural and Stress Analysis (2nd ed.). Butterworth-Heinemann. [624.04 M4]
Names of Lecturers	Dr. H. M. Y. C. Mallikarachchi, Dr. H. G. H. Damruwan

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M				H							L
LO-2	M				M							L
LO-3	H	M			M							
LO-4	H	M										
LO-5	H	M										
Module	**H**	**M**			**H**							**L**

Scale: H – High M – Medium L – Low

Module Code	CE2122	**Module Title**	Design of Concrete Structures I			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	CE1112
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *recognize* the need to appreciate the construction aspects during the structural design process,

LO-2: *formulate* alternative solutions for a proposed building so that preliminary designs could be conducted for the selection of optimum solutions,

LO-3: *relate* structural modelling and analysis for low rise buildings while verifying the results of analysis to complete the structural designs,

LO-4: *execute* detailed design calculations for different components of reinforced concrete low-rise buildings using appropriate design standards, and

LO-5: *prepare* detailed drawings according to standard methods of detailing to communicate the final outcome of structural design.

Module Outline	**LOs Covered**
Introduction to reinforced concrete and the construction aspects [1 h] *Introduction, material properties, member types and connectivity, load paths, important aspects in design and construction*	LO-1
Preliminary design concepts and selection of member sizes [2 h] *Initial member sizes according to the architectural drawings, approximate reinforcement amounts and other structural details required for the tendering process*	LO-2
Methods for performing structural idealization and modelling for analysis [3 h] *Slab analysis and approximation to beams depending on the type, support and loading, columns and beams approximations into braced or unbraced frames, approximate method of frame analysis, validation methods, etc.*	LO-3
Behaviour in flexure and shear [4 h] *The behaviour of beams, slabs, footings (pad and strip) under flexure and shear, failure mechanisms, introduction to reinforcement detailing*	LO-3, LO-4
Design of structural elements [16 h] *Detailed design of beams (continuous/simply supported/cantilever), slabs (one way spanning/two way spanning/cantilever/flat slabs), columns (short and slender), bases (pad footing subjected to vertical load only, load + uni axial bending, load+biaxial bending), staircases (spanning between landings, landing and floor, foundation and landing, staircases with cantilevered steps)*	LO-4
Standard method of detailing for reinforced concrete members [2 h] *Reinforcement detailing of beams, slabs, columns, footings and staircases*	LO-5
Practical Work	
1. Casting and testing of two reinforced concrete beams	LO-4
Assignments	
2. Assignment on design and detailing of a four/five-storey building	All

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	In-class quiz [10 %]	LO-2, LO-4	40%
		Report on laboratory experiment [5%]	LO-1, LO-3	
		Report on design and detailing of structural elements for a given four/five-story building [25%]	All	
	WE	End Semester Examination	All	60%

Recommended Textbooks	1. Reynolds, C. E. and Steedman, J. C. (2007). Reinforced concrete designer's Handbook (11th ed.). London: E &F N Spon, Taylor & Francis Group. 2. The Institution of Structural Engineers (2000). Manual for the design of reinforced concrete building structures to EC2. Published for the Institution of Structural Engineers UK. 4. Mosely, B., Bungey, J. and Hulse, R., (2007). Reinforced concrete design to Eurocode 2 (6th ed.). Palgrave Macmillan. 5. Dias, W. P. S. Graded examples in Reinforced concrete design to Eurocode. 6. Bhatt, P., MacGinley,T. J. and Choo, B. S. (2013). Reinforced concrete design to Eurocodes Design Theory and Examples (4th ed.). CRC Press, Taylor and Francis Group.
Names of Lecturers	Prof. M.T.R. Jayasinghe, Dr. (Mrs.) J. C. P. H. Gamage

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1			L			L	M					
LO-2			M			L				L		
LO-3	H	L	H		M					M		M
LO-4	H	L	H		L					H		H
LO-5					L							
Module	**M**	**L**	**M**		**L**	**L**	**L**			**M**		**M**

Scale: H – High M – Medium L – Low

Module Code	CE2132	**Module Title**	Soil Mechanics and Geology II			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	CE2042
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *classify* rocks and *explain* groundwater hydrogeology,

LO-2: *interpret* geological maps with geological structures,

LO-3: *evaluate* the vertical stresses and pore water pressure in soils under static water conditions,

LO-4: *estimate* the rate of flow and pore water pressure in commonly encountered civil engineering structures such as earth dams, weirs and during dewatering, and

LO-5: *estimate* settlements due to consolidation because of construction and/or dewatering and design improvements in soft clay through pre-consolidation.

Module Outline	**LOs Covered**
Classify rocks and explain hydrogeology [4 h] *Soils on the Earth's surface: Glacial, Aeolian, Alluvial, and Residual soils; Hydrogeology: hydrological cycle, aquifers and aquicludes, infiltration, percolation, groundwater flow, rivers, springs, wells*	LO-1
Interpret geological maps with structures [6 h] *Geological structures: dip, strike, strata, lava flows, minor and major intrusive forms, faults, folds, unconformities, surface features*	LO-2
Vertical stresses and pore water pressures in soils under static water conditions [1 h] *Concept of total stress and effective stress*	LO-3
Rate of flow and pore water pressures in commonly encountered civil engineering structures [8 h] *Flow of water through soils: concept of head, energy equation, one dimensional flow, coefficient of permeability, determination of the coefficient of permeability in the lab and in-situ, equivalent permeability, two dimensional flow, equation of continuity and Laplace equations, analysis of two dimensional flow with flow nets, seepage force, quick condition*	LO-4
Consolidation settlements due to constructions and/or dewatering [9 h] *Consolidation: concept of consolidation, Terzaghi's theory for one dimensional consolidation, determination of consolidation characteristics in the laboratory, stress distributions in the soils, estimation of amount and rate of settlement due to loading, consolidation due to dewatering, secondary consolidation, improvement of soft clays by preloading*	LO-5
Practical Work	
1. Permeability test	LO-4
2. Consolidation test	LO-5
Assignments	
1. Estimation of seepage and pore water pressure distribution through an earth dam using flow nets	LO-4
2. Geology mapping	LO-1, LO-2

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report(s) on Lab classes 1 and 2 [10%]	LO-4, LO-5	30%
		Estimation of seepage and pore water pressure distribution through an earth dam using flow nets [10%]	LO-4	
		Report(s) on Geology mapping [10%]	LO-1, LO-2	
	WE	End Semester Examination	All	70%

Recommended Textbooks	1. Das, B. M. (1998). Principles of Geotechnical Engineering (4th ed.). Boston: PWS. 2. Craig, R. F. (1997). Soil Mechanics (6th ed.). E & FN Spon. 3. Coduto, D. P. (1998). Geotechnical Engineering. Prentice Hall. 4. Holtz, R. D. and Kovacs, W. D. (1981). An Introduction to Geotechnical Engineering. Prentice Hall. Blyth,F.G.H. and de Freitas, M. (1984). A Geology for Engineers (7th ed.). CRC Press.
Names of Lecturers	Prof. U. G. A. Puswewala,Dr. U. P. Nawagamuwa, Dr. L. I. N. de Silva

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	L	L								L		
LO-2	L	L								L		
LO-3	L	L										
LO-4	H	L	L		L					M		
LO-5	H	L	L	L						L		L
Module	**M**	**L**	**L**	**L**	**L**					**L**		**L**

Scale: H – High M – Medium L – Low

Module Code	CE2142	**Module Title**	Surveying II			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	CE2062
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *use* modern instruments for survey measurements in civil engineering,

LO-2: *perform* computations and prepare drawings for civil engineering works based on survey measurements using manual methods and software,

LO-3: *setout* civil engineering works, and

LO-4: *use* field astronomy for location and time measurements.

Module Outline	**LOs Covered**
Modern surveying techniques and instruments [4 h] *Electronic distance measurement (EDM): maximum non ambiguous distance, principles of modulation and simulation; Total Station (TS) to measure inclined distances, tie distances, coordinates, levels and angles*	LO-1
Global Position Systems (GPS) [2 h] *Satellite systems, principles of measurement, errors, uses, differential GPS*	LO-1
Areas, volumes and earth work calculations [4 h] *Area using geometrical figures and formulae, areas using planimeter, volume /earthwork by end-areas and trapezoidal formulae, by spot level and by contours*	LO-2
Introduction to surveying software [4 h] *Use of AutoCAD for survey plans and Pythagoras software for terrain data processing*	LO-2
Tacheometry [3 h] *Contour map, reduced level calculation, distance measurement*	LO-2
Setting out [4 h] *Curve ranging (using chain/tape, theodolite, and TS), Setting out of buildings, curves, horizontal and vertical alignments*	LO-3
Field Astronomy and time [7 h] *Movement of earth in space: celestial sphere, constellations, apparent motion of stars, determination of true north and coordinates; Axial tilt of the Earth, seasons, apparent motion of sun in the celestial sphere; Solar time, sidereal time, standard time*	LO-4
Practical Work	
1. Use of GPS	LO-1
2. Use of Total Station	LO-1
3. Building Setting out	LO-3
Assignments	
1. Detail drawing using GPS	LO-2
2. Calculation of setting out coordinates	LO-2
3. Traverse adjustment and computation and detail drawing using software	LO-2

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on group fieldwork using GPS [5%]	LO-1	30 %
		Detail drawing using GPS measurements [5%]	LO-2	
		Report on group fieldwork on building setting out [5%]	LO-3	
		Report on calculation of setting out coordinates [5%]	LO-2	
		Competency in Total Station fieldwork [5%]	LO-1	
		Report on traverse adjustment, computation and detail drawing using CAD software [5%]	LO-2	
	WE	End Semester Examination	All	70%

Recommended Textbooks	1. Bannister, A., Raymond, S. and Baker, R. (1998). Surveying (7th ed.). Harlow: Addison Wesley Longman. 2. Schofield, W. and Breach, M. (2007). Engineering Surveying (6th ed.). CRC Press.
Names of Lecturers	Prof. U. G. A. Puswewala, Mr. T. D. C. Pushpakumara

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M				H				M			M
LO-2	M	L			H				M	H		L
LO-3	L				L				M			L
LO-4	H											L
Module	**M**	**L**			**H**				**H**	**M**		**M**

Scale: H – High M – Medium L – Low

Module Code	CE2260	**Module Title**	Building Design Process and Applications			
Credits	2.0	**Hours/Week**	**Lectures**	1.0	**Pre-requisites**	None
GPA/NGPA	NGPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO 1: *discuss* the basic drawing equipment and the function of them,

LO 2: *transform* 2D and 3D elements and convert 2D to 3D and 3D to 2D for civil engineering elements and drawings,

LO 3: *discuss* the basic building elements and their behavior in a typical building design process, and

LO 4: *adopt* building regulations for the building design process.

Module Outline	**LOs Covered**
Introduction to Engineering drawing equipment [2 h] *Engineering drawing equipment and their use*	LO-1
Types of Engineering drawings [5 h] *First angle projection, Third angle projection, Oblique projection, Isometric projection, Single point perspective, Two point perspective, Three point perspective*	LO-2
Adopt Building design process [5 h] *Foundations, Walls, Roof, Sustainable concepts, Building regulations, Finishes and stair cases*	LO-3, LO-4
Introduction to computer aided drafting [2 h] *Computer aided drafting and its applications*	LO-3, LO-4
Assignment	
1. Student as a teacher – group presentation on building design process	All
2. Preparation of council drawings and 3D physical models	All

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Student as a teacher – group presentation on building design process [10%]	All	30
		Manual drawings [10%]	LO-1 to LO-3	
		Report on assignment based on building project [10%]	All	
	WE	End Semester Examination	All	70

Recommended Textbooks	Planning and Building Regulations, Urban Development Authority, Sri Lanka
Names of Lecturers	Prof. R. U. Halwatura

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (POs)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1					L				L	L	L	M
LO-2					M				L	M	L	M
LO-3						M	M	H	L	L	L	H
LO-4					M	M	M	H	L	L	L	H
Module					**M**	**M**	**M**	**H**	**L**	**L**	**L**	**H**

Scale: H – High M – Medium L – Low

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Module Code	CE3012	**Module Title**	Hydraulic Engineering II

Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE2032
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *demonstrate* an understanding of non-uniform flow in open channels and solve related engineering problems,

LO-2: *articulate* and *apply* the theories and concept of water balance of a river basin to compute variables and parameters related to surface water hydrology,

LO-3: *identify* the differences between types of aquifers, *apply* the relevant theories to determine aquifer characteristics and *analyse* pumping test data, and

LO-4: *apply* basic theories of coastal hydraulics to recognise problems related to wave induced processes.

Module Outline	**LOs Covered**
Non-uniform flow in open channels [10 h] *Types of flow, flow characteristics, specific energy, sub-critical/ critical/ super-critical flows, surface profiles and hydraulic jump*	LO-1
Surface water hydrology [10 h] *Water balance, precipitation analysis, stream-flow measurement, rational method of flood estimation and analysis of hydrological extremes*	LO-2
Groundwater hydrology [7.5 h] *Types of aquifers, aquifer characteristics, Darcy's Law, groundwater flow governing equations and analysis of pumping test data*	LO-3
Coastal hydraulics [7.5 h] *Wave theory and wave induced processes*	LO-4
Practical Work	
1. Backwater curve and hydraulic jump measurements using flume	LO-1
2. Developing a hydrodynamic model using HEC-RAS (Steady/Unsteady flow)	LO-1, LO-2
Assignments	
1. Field visit to the Meteorological Department	LO-2
2. Assignment on computer aided analysis/design of open channel flow (OCF)	LO-1
3. Tutorials on all 4 topics	LO-1, LO-2, LO-3, LO-4

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on field visit [5%]	LO-2	30%
		Report on OCF modelling [5%]	LO-1, LO-2, LO-3	
		Lab Class 1 (Lab sheets and CW) [10%]	LO-1	
		Lab Class 2 (Lab sheets and CW) [10%]	LO-1, LO-2	
	WE	End Semester Examination	All	70%

Recommended Textbooks

1. Chow, V. T. (2009). Open-channel Hydraulics. McGraw Hill/ Blackburn Press.
2. Chadwick, A., Morfett, J. and Borthwick, M. (2004). Hydraulics in Civil and Environmental Engineering (4th ed.). CRC Press.
3. Subramanya, K. (1994). Engineering Hydrology (2nd ed.). Tata McGraw Hill.
4. Sorensen, R. M. (1997). Basic Coastal Engineering (2nd ed.). Springer Publication.

Names of Lecturers: Dr. R. L. H. L. Rajapakse, Dr. T. M. N. Wijayaratna

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M	M	L		M		L					L
LO-2	M	M	L	L	M	L	L					L
LO-3	M	M	L	L			M					L
LO-4	M	M	L	L								
Module	**M**	**M**	**L**	**L**	**M**	**L**	**L**					**L**

Scale: H – High M – Medium L – Low

Module Code	CE3112	**Module Title**	Structural Analysis II			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE2113
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes

After completing this module, students should be able to:

LO-1: *utilize* fundamentals of structural dynamics in analysing buildings and bridges,

LO-2: *differentiate* between different finite element formulations and *select* most suitable elements in modelling statically indeterminate structures,

LO-3: *perform* structural idealization, modelling and analysis of civil engineering structures while verifying the results with basic manual calculations, and

LO-4: *idealise* and *analyse* structures made of surfaces.

Module Outline	**LOs Covered**
Introduction to structural dynamics [8 h] *Introduction to modelling of structural dynamic problems, free vibration analysis – SDOFS/MDOFS, calculations of modal frequencies mode shapes with lumped mass modelling, force vibration analysis – SDOFS*	LO-1
Theory of finite element analysis [10 h] *Introduction to finite element modelling (FEM), displacement interpolation and shape functions, Pascal triangle, formation of stiffness matrix and consistent load vector, different types of finite element formulations*	LO-2
Application of finite element modelling [7 h] *Structural idealization and modelling of bridges and buildings, use of 1D, 2D and 3D finite elements, linear and non-linear geometric analysis using FEM software, modal analysis and element connectivity*	LO-3
Plates and shells [10 h] *Introduction to analysis of surfaces, curvature and twist, analysis of plates, axis-symmetric shells, membrane hypothesis*	LO-4
Assignments	
1. Group assignment on design, analysis and testing of a structure made with non-conventional material (Design Challenge)	LO-2, LO-3, LO-4
2. Computer based assignment on analysis of a liquid storage tank (Modelling shells)	LO-3, LO-4

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Two quizzes [20%]	LO-1, LO-2	50%
		Design Challenge [25%]	LO-2, LO-3, LO-4	
		Modelling shells [5%]	LO-3, LO-4	
	WE	End Semester Examination	All	50%

Recommended Textbooks

1. Hosur, V. (2013). Earthquake-Resistant Design of Building Structures. Wiley.
2. Jaeger, L. G. (1964). Elementary Theory of Elastic Plates. Pergmon press. [624.073.2 J3]
3. Timoshenko, S. P. and Woinowsky-Krieger, S. (1959). Theory of Plates and Shells (2nd ed.). New York: McGraw-Hill. [624.073.1 T5]
4. Calladine, C. R. (2007). Theory of Shell Structures. Cambridge University Press. [624.074.4 C3]
5. Ghali, A., Neville, A. M. and Brown, T. G. (2009). Structural Analysis: Unified Classical and Matrix Approach (6th ed.). London: Tayler & Francis. [624.04:519.6]
6. Zienkiewics, O. C. and Taylor, R. L. (2000). The Finite Element Method: The Basis (5th ed.). Oxford: Butterworth Heinemann. [624.04Z5]

Names of Lecturers	Prof. I. R. A. Weerasekera, Dr. C. S. Lewangamage, Dr. H. M. Y. C. Malliakrachchi

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M	L			L							L
LO-2	H	L			H							L
LO-3	L	H	M	M	H				M	M		H
LO-4	H	M			H							L
Module	**H**	**M**	**L**	**L**	**H**				**L**	**L**		**M**

Scale: H – High M – Medium L – Low

Module Code	CE3122	**Module Title**	Design of Masonry and Timber Structures			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	CE2113
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *convince* a client on the merits of masonry and timber in construction,

LO-2: *propose* alternative solutions for a client's brief and *justify* the selection of a particular solution,

LO-3: *assess* the magnitude of loads and *identify* load paths in a structure, and

LO-4: *prepare* structural calculations adopting relevant design standards.

Module Outline	**LOs Covered**
Use of timber as a structural material [2 h] *The structure of timber, a natural material, the effects of moisture, growth characteristics, limitations to size and aspects of durability and treatability*	LO-1, LO-2
Design of timber members subject to tension compression and bending [6 h] *Strength properties of timber, elements of a structure and how they perform, different failure modes and how safety is ensured using Eurocode 5 as an example code*	LO-3, LO-4
Design of nailed and bolted timber connections [4 h] *The behaviour of nails and bolts in timber connections and how to determine either the size/number of nails/bolts*	LO-4
Use of Masonry as a structural material [4 h] *Introduction to different types of masonry and the strengths*	LO-1, LO-2
Design of load bearing masonry for vertical, lateral and in-plane loads [6 h] *The behaviour of masonry when subjected to distributed and concentrated loads and the way structural design can be performed using Eurocode 6 as an example code*	LO-2, LO-4
Design of infill masonry panels [4 h] *The design of masonry walls subjected to lateral loads when behaving as wall panels, resisting loads using arching action and also behaving as free standing walls using Eurocode 6 as an example code*	LO-2, LO-4
Assignments	
1. Design of Timber structures	All
2. Design of Masonry structures - Quiz 1 - vertically loaded walls	LO-2, LO-3, LO-4
3. Design of Masonry structures - Quiz 2 - laterally loaded walls	LO-3, LO-4

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	In class un-announced quizzes [20%]	LO-3, LO-4	40%
		Individual and Group Assignments (in class and take home) [20%]	All	
	WE	End Semester Examination	All	60%

Recommended Textbooks	1. McKenzie, W.M.C. (2013). Design of Structural Elements to Eurocodes (2nd ed.). Red Globe Press. 2. Draycott, T. and Bullman, P.(2009). Structural Elements Design Manual (1st ed.). Butterworth-Heinemann. 3. Manual for the design of timber building structures to Eurocode 5 (2007). Institution of Structural Engineers. TRADA. 4. Larsen, H. and Enjily, V. (2009). Practical design of timber structures to Eurocode 5. Thomas Telford. 5. Porteus, J. and Kermani A. (2007). Structural Timber Design to Eurocode 5. Blackwell Publishing. 6. EN 1996-1-1 2004: Eurocode 6: Design of masonry structures - Part 1-1: General rules for reinforced and unreinforced masonry structures. 7. McKenzie, W.M.C. (2015). Design of Structural Elements to Eurocodes. Palgrave. 8. Arya, C. (2009). Design of Structural elements: Concrete, Steelwork, Masonry and Timber Designs to British Standards and Eurocodes (3rd ed.). London: Taylor and Francis. 9. Designers' Guide to Eurocode 6:Design of Masonry Structures En 1996-1-1: Institution of Civil Engineers (ICE). 10. Manual for the design of plain masonry in building structures to Eurocode 6 (2008).IStructE.
Names of Lecturers	Prof. M.T.R. Jayasinghe, Dr. (Mrs.) M. T. P. Hettiarachchi

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	L		L			L	L					L
LO-2	L		M			L	L			M		
LO-3	M								M			
LO-4	H		H							M		L
Module	**M**		**M**			**L**	**L**		**L**	**M**		**L**

Scale: H – High M – Medium L – Low

Module Code	CE3132	**Module Title**	Geotechnical Engineering			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE2132
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *propose* an appropriate geotechnical investigation for a civil engineering project,

LO-2: *apply* the shear strength concept in geotechnical problems,

LO-3: *assess* the stability of existing slopes, *design* new cut or fill slopes and *propose* methods for rectification of failed slopes,

LO-4: *explain* the basic mechanical and physical behaviour of rock masses, and

LO-5: *design* rock slopes.

Module Outline	**LOs Covered**
Geotechnical investigations [3 h] *Methods of geotechnical investigation, methods of advancing a borehole in soil, methods of coring in rock, in situ tests, methods of obtaining undisturbed samples, borehole logging, idealization of a soil profile with borehole data*	LO-1
Shear strength of soils [10 h] *Relevance of shear strength of soils, Mohr - Coulomb failure criterion, drained and undrained conditions, determination of shear strength in the laboratory by direct shear test and triaxial tests, applicability of different types of triaxial tests, pore water pressure development and Skempton's law, stress invariants and stress paths, Vane shear test, shear strength of unsaturated soils*	LO-2
Stability of soil slopes [10 h] *Different modes of slope instability, drained and undrained behaviour, shallow translational slides, analysis of rotational slides by friction circle method, Taylor's charts, Bishop and Morgenstern charts, ordinary slices method, Bishop's method of slices, concept of probability of failure, stabilization of slopes*	LO-3
Rock mechanics [12 h] *Rock mass and rock material, discontinuities, rock mass classification, investigation in rock, orientation of discontinuities, stereo-plots, stability of rock slopes: plane failure and wedge failure; stabilization of rock slopes*	LO-4, LO-5
Practical Work	
1. Direct shear test	LO-2
2. Triaixial shear test	LO-2
3. Tests on rocks	LO-4
Assignments	
1. Design of an earth fill on soft clay	LO-5 of CE2132
2. Computer aided slope stability analysis	LO-3

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Unannounced quiz [10%]	LO-1, LO-2, LO-3	30%
		Report on design of an earth fill on soft clay [5%]	LO-5 of CE2132	
		Report on computer aided assignment on slope stability analysis [5%]	LO-3	
		Report(s) on Lab Classes [10%]	LO-2, LO-4	
	WE	End Semester Examination	All	70%

Recommended Textbooks	1. Das, B. M. (1998). Principles of Geotechnical Engineering (4th ed.). Boston: PWS. 2. Craig, R. F. (1997). Soil Mechanics (6th ed.). E & FN Spon. 3. Coduto, D. P. (1998). Geotechnical Engineering. Prentice Hall. 4. Holtz, R. D. and Kovacs, W. D. (1981). An Introduction to Geotechnical Engineering. Prentice Hall. 5. Hoek, E. and Bray, J. (1981). Rock Slope Engineering (3rd ed.). London: Inst. of Minning and Metallurgy. 6. Clayton, C. R. I., Matthews, M. C. and Simons, N.E. (1995). Site Investigations (2nd ed.). Oxford: Blackwell Science.
Names of Lecturers	Prof. U.G.A. Puswewala, Prof. S. A. S. Kulathilaka, Dr. L. I. N. De Silva

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	L	H	L			L						
LO-2	H	H			M				L	L		
LO-3	H	H	H		H					M		
LO-4	L											
LO-5	H	L	H		M							
Module	**H**	**M**	**M**		**M**	**L**			**L**	**L**		

Scale: H – High M – Medium L – Low

Module Code	CE3142	**Module Title**	Construction Management			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE1132 CE2052
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *demonstrate* an understanding of the legal aspects of construction contracts and *use* various forms of contract including CIDA standard bidding documents for procurement of construction works,

LO-2: *apply* quality management, work study, materials management, good housekeeping, and lean construction at construction site level in order to improve project performance,

LO-3: *manage* construction equipment including selection, acquisition, maintenance, and replacement at both project and company levels,

LO-4: *perform* cash flow analysis based on schedule and cost estimate and *examine* its influence on the financial health of a project, and

LO-5: *evaluate* health and safety risks at construction sites and recommend preventive actions.

Module Outline	**LOs Covered**
Law of Contract and Contract administration [10 h] *Introduction to Law of contract, Contract administration*	LO-1
Construction quality and site Management [10 h] *Quality management in construction, introduction to work study, site management*	LO-2
Construction equipment [5 h] *Construction equipment management*	LO-3
Cash flow management [5 h] *Cash flow forecasting and management*	LO-4
Construction Health and Safety [5 h] *Health and safety in construction*	LO-5
Assignments	
Report on contract administration, work study and cash flow forecasting	LO-1, LO-2, LO-4

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	In-class quiz on equipment and site management [5%]	LO-3, LO-2	30%
		In-class quiz on construction safety [5%]	LO-5	
		Report on contract administration, work study and cash flow forecasting [20%]	LO-1, LO-2, LO-4	
	WE	End Semester Examination	All	70%

Recommended Textbooks	1. Harris, F. and McCaffer, R. (2013). Modern Construction Management (7th ed.). West Sussex: John Wiley & Sons, Ltd. 2. Griffith, A. and Watson, P. (2004).Construction Management: Principles and Practice. New York: Palgrave Macmillan.
Names of Lecturers	Prof. A.A.D.A.J. Perera, Dr. C.S.A. Siriwardana

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M	M				H		H	L	L	M	L
LO-2	L	M		L	M	M				L	H	M
LO-3		L				L	L				H	M
LO-4		M			M					L	H	M
LO-5			L	L		H		M	L	L		M
Module	**L**	**M**	**L**	**L**	**M**	**H**	**L**	**M**	**L**	**L**	**H**	**M**

Scale: H – High M – Medium L – Low

Module Code	CE3152	**Module Title**	Fundamentals of Environmental Engineering			
Credits	2.0	**Hours/Week**	**Lectures**	1.5	**Pre-requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *convince* a client about the need for conservation of resources in a project to be undertaken,

LO-2: *analyse* a given scenario based on key environmental concepts and *propose* solutions to environment-related problems such as water, air and soil pollution, and

LO-3: *assess* the magnitude of environmental consequences related to human activities and *propose* mitigatory actions.

Module Outline	**LOs Covered**
Introduction [1.5 h] *Introduction to Environmental Engineering*	LO-1
Principles of Ecology [3 h] *Introduction to Ecology and ecological impact assessments of development projects*	LO-1, LO-2
Sustainability and development [3 h] *Sustainable Development Goals (SDG), resource constraints and Earth's life support system, global environmental issues*	LO-1, LO-2
Concepts of Environmental Management [1.5 h] *Environmental quality management, risk assessment*	LO-1, LO-3
Noise and vibration and its control [3 h] *Pollution due to noise and vibration and its control*	LO-2, LO-3
Air pollution and its control [1.5 h] *Air pollution due to construction projects and its control*	LO-2, LO-3
Surface and groundwater pollution and its control [3 h] *Introduction to surface and groundwater, water quality, objectives, and measurements, water pollutants, sources of pollution, indicators of pollution, water quality issues, water pollution control*	LO-2, LO-3
Solid and hazardous waste management [3 h] *Introduction to solid and hazardous waste, generation of waste, hierarchy of waste management, detailed steps and approach of an integrated waste management plan*	LO-2, LO-3
Environmental Impact Assessment [1.5 h] *Introduction to EIA, National Environmental Act and other Environmental regulations, nature of projects, identification of impacts, mitigation of negative impacts*	LO-1, LO-2 LO-3
Practical Work	
1. Field sampling and in situ measurement of water quality parameters	LO-2
2. Laboratory experiment on measurement of water quality parameters	LO-2
3. Noise and vibration measurements for a piling exercise	LO-2, LO-3
Assignments	
1. Identification of ecological impacts of a development project	LO-1, LO-2
2. Identification of environmental legislation/ regulations for a development project	LO-1, LO-2
3. Tutorial (Discussion sessions)	LO-1, LO-2 LO-3

	Category	Type	Assessed LOs	Weightage
Assessments	CA	Report based on Practical 1 and 2 [10%]	LO-2	30%
		In-class assignment on identification of ecological impacts of a development project [5%]	LO-1, LO-2	
		Report based on measurement and control of noise and vibration [10%]	LO-2, LO-3	
		In-class assignment on identification of environmental legislation/ regulations for a development project [5%]	LO-1, LO-2	
	WE	End Semester Examination	All	70%
Recommended Textbooks		1. Davis, M. L. and Corwnwell, D. A. (2012). Introduction to Environmental Engineering (5th ed.). Science Engineering & Math. 2. Miller, G. T. and Spoolman, S. (2019). Living in the Environment (20th ed. or latest version). Cengage Learning, Inc.		
Names of Lecturers		Prof. M. W. Jayaweera, Prof. J. M. A. Manatunge, Dr. (Ms.) W. B. Gunawardana		

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1						M	H	M	L	L		L
LO-2	L	L		M	H	H	M	M		L		L
LO-3	L	L	M			M	M	M		L		L
Module	**L**	**L**	**L**	**M**	**M**	**H**	**H**	**M**	**L**	**L**		**L**

Scale: H – High M – Medium L – Low

Module Code	CE3162	**Module Title**	Fundamentals of Transportation Engineering			
Credits	2.0	**Hours/Week**	**Lectures**	1.5	**Pre-requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *express* basic traffic flow theory to *describe* traffic flow conditions and *recognize* the appropriateness of traffic management measures that are in use,

LO-2: *identify* basic elements in highway planning, *describe* transport planning process, *identify* its importance and *calculate* traffic demand based on given information,

LO-3: *discuss* the importance of transportation systems management for various modes of transport, and

LO-4: *discuss* the importance of safety, socio-economic, environmental considerations and sustainable developments in transportation systems.

Module Outline	**LOs Covered**
Introduction [1.5 h] *Fundamentals of transport systems, impacts, desired features, role of transport professionals*	LO-3
Transport Function and Transportation System Management [3 h] *Need for transport, accessibility and mobility, different transport modes and transportation systems management*	LO-2, LO-3
Traffic Flow theory [1.5 h] *Speed, flow & density measurements, data handling, analysis and interpretation*	LO-1
Fundamentals of Transport Planning [6 h] *Planning processes, trip generation & attraction, trip distribution, model split, trip assignment*	LO-2
Transport Safety [3 h] *Concept of safety and risk, safety management, driver behaviour and human factors, human error, overview of road safety in Sri Lanka, risk mitigation*	LO-3, LO-4
Sustainable development and environmental considerations [3 h] *Sustainable development of transport infrastructures, transport related activities that affect the environment, identification of possible impacts and countermeasures*	LO-3, LO-4
Transport Infrastructure [3 h] *Process of development, basic elements of highway planning, airport and rail transport infrastructure, new transport infrastructure developments*	LO-2
Practical Work	
1. Debates on transport related topics	LO-1 to LO-3
2. Field visit to transport development project(s)	LO-2 to LO-4
Assignments	
1. Assignment on traffic data analysis	LO-1
2. Assignment on Transport Systems	LO-3
3. Assignment on Safety/Environment	LO-4

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on Assignment 1 [6%]	LO-1	40%
		Report on Assignment 2 [6%]	LO-3	
		Report on Assignment 3 [6%]	LO-3	
		Debates [10%]	LO-2 to LO-4	
		Quiz [6%]	LO-1 to LO-3	
		Field visit report [6%]	LO-2 to LO-4	
	WE	End Semester Examination	All	60%

Recommended Textbooks	1. Kadiyali, R. L. (2007). Traffic Engineering and Transport Planning (7th ed.). Delhi: Khanna Publishers.
Names of Lecturers	Prof. J. M. S. J. Bandara, Dr. H. L. K. Perera, Dr. H. R. Pasindu, Dr. G. L. D. I. De Silva

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M	L	M									
LO-2		M			L	L	M					
LO-3						M	M	L	H	H		M
LO-4						M	H	L	L	M		
Module	**L**	**M**	**L**		**L**	**M**	**M**	**L**	**M**	**H**		**L**

Scale: H – High M – Medium L – Low

Module Code	CE3912	**Module Title**	Survey Camp			
Credits	2.0	**Hours/Week**	**Lectures**	-	**Pre-requisites**	None
GPA/NGPA	NGPA		**Lab/Assignments**	2 weeks		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *use* of appropriate surveying instruments and surveying software,

LO-2: *organize* and *execute* surveying for a civil engineering project,

LO-3: *demonstrate* teamwork and nurture leadership qualities,

LO-4: *apply* appropriate surveying principles and solve engineering problems, and

LO-5: *demonstrate* written and oral communication skills.

Module Outline Work schedule for each day: 7.00 am – 5.00 pm fieldwork, 6.00 pm – 11.00 pm office work	**LOs Covered**
Design of a Road Profile [1 day] *Preliminary site inspection, level traverse (using Level instrument), Existing level data collection: cross section (CS) and longitudinal section (LS), booking of data, error correction and distribution, office work (design of vertical alignment, formation level, cut and fill volume estimation, LS and CS drawings, report preparation)*	LO-1, LO-2, LO-3, LO-4
Establishment of a Terrain [1 day] *Site reconnaissance survey, traverse station identification, traverse survey, error correction and distribution, tacheometric constant validation, tacheometric survey (using Theodolite instrument), office work (determination of drawing scale, plotting topographic contour map)*	LO-1, LO-2, LO-3, LO-4
Establishment of a Benchmark [1 day] *Introduction to Precise Level, introduction to precise levelling procedure, establishment of level of a benchmark using Precise Level, office work (reduced level calculation)*	LO-1,LO-4
Differential Global Positioning System (DGPS) and Drone surveying [0.5 days] *Introduction to DGPS and Real Time Kinematic (RTK) surveying, demonstration of DGPS, RTK surveying procedure; Introduction to drone surveying, demonstration of aerial mapping procedure using Unmanned Aerial Vehicle (UAV)/ Drone*	LO-1, LO-4
Group Project [6.5 days] *Reconnaissance survey, locating topographic features, project formulation,establishment of benchmarks, control traverse survey (using Total Station (TS) instrument and Level instrument), terrain data collection, establishing the contour map, setting-out design plan (using TS instrument), office work (project discussion, alternative analysis, preliminary feasibility studies (technical, environmental, economic), traverse adjustment computation, calculation of station coordinates, field data compilation, contour map development using computer aided design (CAD) software, design drawings, report preparation, presentation preparation), final presentation and viva*	LO-1, LO-2, LO-3, LO-4, LO-5
Computer Aided Design (CAD) software [1.5 days] *Application of CAD software: Autodesk Civil3D, Pythagoras, Surfer*	LO-1
Field Astronomy [0.5 days] *Discussion on field astronomy, use of software to observe celestial bodies, determination of true north, identification of constellations*	LO-1, LO-4
Practical Work	
1. Design of a Road profile	LO-1, LO-2, LO-3, LO-4
2. Establishment of a Terrain	LO-1, LO-2, LO-3, LO-4
3. Establishment of a Benchmark	LO-1, LO-4
4. Group Project	LO-1, LO-2, LO-3, LO-4, LO-5

	Category	Type	Assessed LOs	Weightage
Assessments	CA	Design report and LS and CS drawings on design of a road profile [10%]	LO-1, LO-2, LO-3, LO-4	100%
		Topographic contour map from establishment of a terrain [10%]	LO-1, LO-2, LO-3, LO-4	
		Computation of reduced level of a benchmarkusing Precise Level [5%]	LO-1, LO-3, LO-4	
		Setting up of surveying instruments – Individual [5%]	LO-1	
		Establishment of reduced levels – Individual [5%]	LO-1, LO-4	
		Application of Total Station – Individual [5%]	LO-1, LO-4	
		Measuring angles using Theodolite – Individual [5%]	LO-1, LO-4	
		Carry outa given task usingappropriate surveying principles and surveying instruments – Individual [5%]	LO-1, LO-2, LO-4	
		Group project report, presentation and viva [50%]	LO-1, LO-2, LO-3, LO-4, LO-5	
	WE	End Semester Examination	-	-

Recommended Textbooks	1. Bannister, A., Raymond, S. and Baker, R. (1998). Surveying (7th ed.). Harlow: Addison Wesley Longman. 2. Schofield, W. and Breach, M. (2007). Engineering Surveying (6th ed.). CRC Press. 3. Grant, S. (2019). Setting Out for Construction: A Practical Guide to Site Surveying. Costello House Publishing.
Names of Lecturers	Prof. U. G. A. Puswewala, Dr. U. P. Nawagamuwa, Mr. T. D. C. Pushpakumara

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	H		L		M							M
LO-2	L	H	M	L	M	M	M	M	M		M	H
LO-3									H			H
LO-4	H	M	M	M	H		M	L				M
LO-5		M		M					M	H		M
Module	**H**	**H**	**M**	**M**	**H**	**L**	**M**	**L**	**H**	**M**	**M**	**H**

Scale: H – High M – Medium L – Low

Module Code	CE3992	**Module Title**	Industrial Training		
Credits	6.0	**Duration**	Minimum of 16 weeks (extendable up to 20 weeks)	**Pre-requisites**	None
GPA/NGPA	NGPA				
Module Type:	Core Module/Compulsory ☑		Elective ☐	Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: study organization in which trainee is undergoing training with respect to the work carried out, organizational structure, stakeholders, past/ future changes, strategic planning, its business practices and financial management, economic viability and sustainability,

LO-2: recognise the health, safety and environmental (HSE) polices adapted, HSE issues at the training place, risk management/ emergency response and best practices adopted at the training place,

LO-3: demonstrate the technical, teamwork, and managerial skills developed through the training at the worksite or design office, and

LO-4: reflect and report on the economic, environmental, social, and cultural impacts of the projects and project environment exposed to during the training.

Module Outline

Areas of Exposure	**(Weeks)**		**LOs Covered**
	Min	Max	
A. Study the details of the Organization (SWOT Analysis/Annual reports)/ Financial management procedure/Economical viability and Sustainability/ Project brief/Health and Safety policy and practices/Safety plan/Discussion with safety officer about safety at work	2	3	LO-1, LO-2, LO-4
B. Study of Contract/Tender documents, preparation of technical documentation; tender procedures and evaluation/Preparation of method statement/Evaluation of method statement/Preparation of BOQ/Study project progress monitoring method	2	3	LO-3
C. Study of work site procedures/Site planning /Safety practices	1	2	LO-2, LO-3
D. Surveying, levelling, and setting out /Design office practices	1	2	LO-3, LO4
E. Study of construction materials/Study of construction equipment/Study of building services/Finishes/Familiarization of design software and/or design manuals	2	3	LO-3, LO-4
F. Design office practices/Assist design engineers/Discussion with a senior design engineer	2	3	LO-3, LO-4
G. Assist in construction supervision, Assist in interim valuations: assist in sub-contractors payments, assist in claims for variations	3	4	LO-3, LO-4
H. Construction /Design of structures or any civil engineering infrastructure	5	7	LO-2, LO-3, LO-4

	Category	Type	Assessed LOs	Weightage
Assessments	CA	Daily Diary and Four-weekly Continuous Assessment [30%]	LO 1, LO-2, LO-3	30%
	Final Assessment	Presentation and Oral examination [40%]	All	70%
		Report on Industrial Training [30%]	All	

Recommended Textbooks	1 Neville, A.M. and Brooks, J.J. (2010). Concrete Technology (2nded.). Pearson Education. 2. Roy, C. (2006). Advanced Construction Technology (4thed.). Prentice Hall. 3. Charles, J. K. (2016). Sustainable Construction: green building design and delivery (4thed.).Wiley. 4. Mannering, F. L. and Washburn, S.S. (2013). Principles of Highway Engineering and Traffic Analysis (5thed.). 5. Davis, M. L. and Cornwell, D. A. (2012). Introduction to Environmental Engineering (5thed.).Science Engineering & Math. 6. Thilakasiri, H. S. Construction and Testing of Piles. 7. CIDA Publications. 8. ICE. Civil Engineering Procedure (6thed.). Thomas Telford.
Names of Lecturers	Dr. K. Baskaran, Eng. T. A. Gamage

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1		L				M				L	L	M
LO-2	L					H	H	M	L	L		M
LO-3	L	L	L		L	M	M	L		M	L	H
LO-4							M	L	H	L	L	H
Module	**L**	**L**	**L**			**H**	**H**	**M**	**H**	**H**	**M**	**H**

Scale: H – High M – Medium L – Low

Module Code	CE4012	**Module Title**	Design of Concrete Structures II			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	CE2122
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *analyse* a reinforced concrete water tank by modelling and *evaluate* internal forces/moments in different structural elements,

LO-2: *design* structural elements of a water retaining structure for serviceability limit state of crack control and ultimate limit state in accordance with BS and Euro Codes,

LO-3: *specify* suitable materials and appropriate construction methods for construction of water retaining structures to achieve the expected performance and durability during the lifespan of the structure,

LO-4: *reflect* on basic design principles in designing pre-stressed concrete elements, and

LO-5: *apply* theories to design statically determinate pre-stressed concrete beam elements.

Module Outline	**LOs Covered**
Introduction to design of water retaining structures [2 h] *Types of water retaining structures, available design codes, analyse different structural elements in a water tank*	LO-1, LO-2
Cracking of concrete [2 h] *Types of cracks, principles of crack formation, significance of crack width on water tightness, controlling of cracking*	LO-2, LO-3
Calculation of crack widths due to structural effects [4 h] *Calculation of crack widths due to flexure, tensile forces and combined tension and bending, limitation of steel stress*	LO-2, LO-3
Calculation of crack widths in relation to thermal and moisture movements [4 h] *Cracking due to heat of hydration and drying shrinkage in immature concrete, crack distribution, critical steel ratio, crack spacing, crack width, restraint factors*	LO-2, LO-3
Joints in water retaining structures [2 h] *Expansion, contraction, hinged, sliding and construction joints, design of movement joints*	LO-1, LO-3
Basic principles and methods of pre-stressing, materials for pre-stressing [4 h] *Introduction, historical development, basic concepts, types of prestressing, construction methods, materials and equipment, applications*	LO-4
Design of flexural members for serviceability and ultimate limit states [8 h] *Design of prestress considering service and transfer conditions, checks for ultimate limit state requirements (flexural strength and shear resistance)*	LO-5
Pre-stress losses [2 h] *Estimation of prestress losses (short term and long term)*	LO-5
Practical Work	
1. Tutorial classes	All
Assignments	
1. Design of a water retaining structure (A group assignment, where students have to model a tank using a computer software, analyse and then design structural elements)	LO-1, LO-2, LO-3
2. Design of a pre-stressed concrete beam (A group assignment, where students have to design a prestressed concrete beam)	LO-4, LO-5

	Category	Type	Assessed LOs	Weightage
Assessments	CA	1. Report on design of a water retaining structure [15%]	LO-1, LO-3	40 %
		2. Report on design of a pre-stressed concrete beam [15%]	LO-4, LO-5	
		3. Best 2 out of 4 in class quizzes (each from water retaining and pre-stressed) [10%]	All	
	WE	End Semester Examination	All	60%
Recommended Textbooks		1. Anchor, R. D. (1992). Design of Liquid Retaining Concrete Structures (2nd ed.). McGraw-Hill Inc. 2. Mosley, B., Bungey, J. and Hulse, R. (2012). Reinforced Concrete Design for Euro Code 2 (7th ed.). Red Globe Press. 3. Forth, J. P. and Martin A. J. (2014). Design of liquid retaining concrete structures (3rd ed.). Caithness: Whittles Publishing. 4. Kong, F. K. and Evans, R. H. (1987). Reinforced and Pre-stressed Concrete (3rd ed.). Cambridge: E & FN Spon. 5. Hurst, H. K. (1998). Prestressed Concrete Design (2nd ed.). London: CRC Press. 6. Bhatt, P. (2011). Prestressed Concrete Design to Eurocodes (1st ed.). London: E & FN Spon.		
Names of Lecturers		Dr. K. Baskaran, Dr H. G. H. Damruwan		

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	H	M			M							M
LO-2	H	M	M		L				L			M
LO-3	M	L										M
LO-4	M	M										L
LO-5	H	M	M		L				L			M
Module	**H**	**M**	**M**		**L**				**L**			**M**

Scale: H – High M – Medium L – Low

Module Code	CE4022	**Module Title**	Hydraulic Design			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre – requisites**	CE3012
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *identify* hydraulic structures and *describe* their components according to purpose,

LO-2: *demonstrate* how to delineate a watershed and *develop* the design hydrograph of the watershed,

LO-3: *compute* the design capacity, yield and spillway capacity of a reservoir, and

LO-4: *design* the inlet(s), outlet(s) and the energy dissipater of a hydraulic structure, considering hydrologic, hydraulic, economic and environmental factors.

Module Outline	**LOs Covered**
Introduction to Hydraulic Structures [5 h] *Different types of hydraulic structures, their components and purposes, and environmental considerations related to hydraulic structures and their design*	LO-1
Computation of Design Hydrograph [10 h] *Catchment delineation, concepts and theories of Unit Hydrograph, and computation of design hydrograph using Synthetic Unit Hydrograph*	LO-2
Flood Frequency Studies [10 h] *Application of probability and statistics in precipitation and flood frequency analysis, Reservoir capacity and yield, and spillway capacity estimation*	LO-3
Design of Hydraulic Structures [10 h] *Design considerations, steps and guidelines, design of transitions and Energy Dissipaters*	LO-4
Practical Work (Design Class)	
1. Development of Synthetic Unit Hydrograph	LO-1, LO-2
2. Estimation of Reservoir Capacity and Yield	LO-2, LO-3
3. Design of an Energy Dissipater	LO-3, LO-4
Assignments	
1. Field visit to a reservoir/ hydraulic structure identified by individual students	LO-1
2. In-class assignment on Frequency studies/ Yield studies	LO-2, LO-3
3. In-class assignment on Design of hydraulic structures	LO-3, LO-4

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on individual field visit [10%]	LO-1	30%
		Report on Assignment 2 on Frequency studies/ Yield studies [2.5%]	LO-2, LO-3	
		Report on Assignment 3 on Design of hydraulic structures [2.5%]	LO-3, LO-4	
		Design Class 1 (Coursework) [5%]	LO-1, LO-2	
		Design Class 2 (Coursework) [5%]	LO-2, LO-3	
		Design Class 3 (Coursework) [5%]	LO-3, LO-4	
	WE	End Semester Examination	All	70%

Recommended Textbooks

1. Chadwick, A., Morfett, J. and Borthwick, M. (2004). Hydraulics in Civil and Environmental Engineering (4th ed.). CRC Press.
2. Subramanya, K. (1994). Engineering Hydrology (2nd ed.). Tata McGraw Hill.
3. Novak, P., Moffat, A. I. B., Nalluri, C. and Narayanan R. (2007). Hydraulic Structures (4th ed.). London: CRC Press.
4. United States Department of Interior, Bureau of Reclamation (1978). Design of Small Canal Structures, Revised reprint. Denver, Colarado: United States Government Print Office.

Names of Lecturers	Prof. N. T. S. Wijesekera, Dr. R. L. H. L. Rajapakse

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M	M	M	L								
LO-2	M	M	M									
LO-3	H	H	H	H	H	L	M				M	M
LO-4	H	M	H	H	H	L	M				M	L
Module	**H**	**M**	**H**	**H**	**H**	**L**	**M**				**M**	**M**

Scale: H – High M – Medium L – Low

Module Code	CE4032	**Module Title**	Geotechnical Design			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre – requisites**	CE3132
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *propose* alternative solutions for earth retaining structures and foundations so that preliminary designs could be conducted for the selection of optimum solutions with a greater degree of sustainability,

LO-2: *comprehend* the importance of construction quality control and quality assurance measures and ability to propose such measures for practical applications,

LO-3: *apply* classical earth pressure theories to evaluate the lateral earth pressure behind earth retaining structures,

LO-4: *design* gravity type and embedded type retaining walls in accordance with standard design codes used in Sri Lanka, and

LO-5: *perform* idealization of the subsurface conditions and design shallow and deep foundation systems under various loading and subsurface conditions.

Module Outline	**LOs Covered**
Earth Retaining Structures [12 h] *Introduction to different options of earth retaining systems, evaluation of earth pressures by Rankine's theory and by Coulomb's trial wedge approach considering the effects of wall roughness, pore water pressure and seepage, introduction to British code for the design of earth retaining structures, design of gravity retaining walls and embedded retaining walls to resist different failure modes*	LO-1, LO-3, LO-4
Shallow Foundations [12 h] *Introduction to the concepts of foundation design and alternative foundation options, understanding of the safety and environmental concerns related to construction of different foundation options, evaluation of material properties from in-situ test results and idealization of the subsurface conditions, design of centrally and eccentrically loaded shallow foundations subjected to vertical and inclined loads, introduction of model testing of shallow foundations and extrapolation techniques for prototype foundations and their limitations, modulus of subgrade reaction and beams on elastic foundations*	LO-1, LO-2, LO-5
Deep Foundations [11 h] *Introduction to construction quality controlling and quality assurance of deep foundations, axial carrying capacity of single pile and pile groups subjected to vertical loads, settlement of piles and pile groups, negative skin friction, testing of piles*	LO-2, LO-5
Assignments	
1. Design of an earth retaining wall	LO-1, LO-3, LO-4
2. Design of a shallow foundation	LO-1, LO-5
3. Design of a deep foundation	LO-1, LO-5

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on design of an earth retaining wall [10%]	LO-1, LO-3, LO-4	30%
		Report on design of a shallow foundation [10%]	LO-1, LO-5	
		Report on design of a deep foundation [10%]	LO-1, LO-5	
	WE	End Semester Examination	All	70%

Recommended Textbooks	1. Bowles, J. E. (1996). Foundation analysis and design (5th ed.). New York: McGraw-Hill. 2. Das, B. M. (1998). Principles of Geotechnical Engineering (4th ed.). Boston: PWS. 3. Poulos, H. G. and Davis, E. H. (1980). Pile foundation analysis and design. New York: John Wiley and Sons. 4. Tomlinson, M. J. (1994). Pile design and construction practice (4th ed.). London and New York: Taylor & Francis.
Names of Lecturers	Prof. S. A. S. Kulathilaka, Dr. U. P. Nawagamuwa, Dr. L. I. N. de Silva

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	L						L			L		L
LO-2	L									L		L
LO-3	M											
LO-4	H	L	H							H		M
LO-5	H	L	H	M						H		L
Module	**H**	**L**	**H**	**M**			**L**			**H**		**M**

Scale: H – High M – Medium L – Low

Module Code	CE4042	**Module Title**	Highway Engineering			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE3162
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *discuss* the highway planning process and the basic principles of highway design,

LO-2: *design* the geometrical elements of a highway in accordance with design standards,

LO-3: *apply* an appropriate methodology to design the capacity of a highway,

LO-4: *analyse* and *design* pavements (following an appropriate design code), and

LO-5: *demonstrate* an understanding of the properties of soil, aggregate and bitumen, standard specifications and test methods related to highway material design.

Module Outline	**LOs Covered**
Highway Planning [3 h] *Functional classification, principle of highway location, factors influencing highway design*	LO-1
Geometric Design [10 h] *Sight distance, design of alignment, horizontal and vertical curves, cross sections, super elevation, pedestrian and bicycle facilities, use of Geometric design codes and guidelines*	LO-2
Capacity Design [6 h] *Highway capacity, design of two-lane roads, service flow rate, volume/capacity ratio, level of service*	LO-3
Pavement Analysis and Mechanistic Design [10 h] *Types of pavements, structural components of flexible pavements, estimation of design loads, Stresses and strains in pavements, introduction of design guidelines, asphalt pavement design, concepts of mechanistic design*	LO-4
Highway Materials [6 h] *Properties of soils, aggregate, and bitumen used in highway construction, Standard specifications and test methods for road construction materials, quality control and acceptance criteria*	LO-5
Practical Work	
1. California Bearing Ratio (CBR) and Dynamic Cone Penetrometer (DCP) Tests	LO-5
Assignments	
1. Highway design project – Carry out a highway design on selected trace considering the forecasted traffic flow, prevailing road safety issues and alignment	LO-1, LO-2, LO-3, LO-4
2. Class Quiz	LO-1, LO-2, LO-3

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on CBR/DCP Tests [2%]	LO-5	40%
		Report on Highway Design Project [33%]	LO-1, LO-2, LO-3, LO-4	
		In-class Quiz [5%]	LO-1, LO-2, LO-3	
	WE	End Semester Examination	All	60%

Recommended Textbooks	1. Wright, P. H. and Dixon, K. (2003). Highway Engineering (7th ed.). John Wiley & Sons, Inc.
Names of Lecturers	Prof. W. K. Mampearachchci, Dr. H. R. Pasindu

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	L		L			L	M		L		L	
LO-2	L	M	H		H				L			
LO-3	L	M	H						L			
LO-4	L	M	H		L				L			
LO-5	L		L									
Module	**L**	**M**	**H**		**M**	**L**	**L**		**M**		**L**	

Scale: H – High M – Medium L – Low

Module Code	CE4052	**Module Title**	Environmental Engineering			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE3152
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *demonstrate* his/her ability to plan a water supply scheme for a given community based on sound engineering principles and *determine* the operating levels and sizes of all components,

LO-2: *select* suitable unit operations for treatment of the source water to achieve the required quality to meet drinking water standards and *provide* a conceptual design for a water treatment plant,

LO-3: *assess* the requirement and *provide* detailed designs for wastewater collection systems for urban communities, and

LO-4: *explain* the processes taking place in biological and physicochemical wastewater treatment systems and *design* a septic tank system according to the Sri Lanka Standards.

Module Outline	**LOs Covered**
Water Supply [10 h] *Achieving SDGs related to water and sanitation, engineering decisions in planning of a water supply scheme, design principles for water supply schemes – Intake, Pumps, Transmission mains, Service reservoirs, Distribution systems*	LO-1
Water Treatment Principles [10 h] *Introduction to conventional water treatment processes- Aeration, Plain sedimentation, Coagulation, Flocculation, Sedimentation, Filtration, Disinfection, Stabilization*	LO-2
Wastewater Collection [7 h] *Sewerage systems, Layouts, Sewer appurtenances and design concepts, Sewer hydraulics, Estimation of wastewater and Stormwater flows, Design of sewerage*	LO-3
Wastewater Treatment Principles [8 h] *Introduction to biological treatment and physicochemical treatment of wastewater, Design of a septic tank according to Sri Lanka Standards*	LO-4
Practical Work	
1. Field sampling and in-situ measurement of water quality parameters [e.g. pH, Dissolved Oxygen (DO), Turbidity]	LO-1, LO-2
2. Laboratory experiments on measurement of water quality parameters using different methods [Gravimetric analysis - Total Suspended Solids, Colorimetric methods - Colour, High-end instruments (Ion Chromatography)- Anions such as Fluoride, Chloride, Nitrate, Phosphate, Sulphate]	LO-1, LO-2
3. Determination of microbiological contamination in water (Total and Faecal coliform levels in water using Multiple Tubes Fermentation technique)	LO-1, LO-2
4. Jar test for removal of Turbidity (Water treatment)	LO-1, LO-2
5. Break-point Chlorination for disinfection (Water treatment)	LO-1, LO-2
Assignments	
1. Suitability of a water source for water supply with simple treatment	LO-1, LO-2
2. Design of a water supply scheme with the incorporation of a suitable water treatment plant	LO-1, LO-2
3. Design of a septic tank and its associated effluent disposal system	LO-4
4. Take-home tutorial	LO-1, LO-3

	Category	Type	Assessed LOs	Weightage
Assessments	CA	Assignment 1- [10%] Report on selecting a suitable water source for water supply with simple treatment based on ambient water quality (Practicals 1–3)	LO-1, LO-2	40%
		Assignment 2- [20%] Report on design of a water supply scheme and application of concepts of unit processes for water treatment	LO-1, LO-2	
		Assignment 3- [10%] Report based on design of a septic tank and its associated effluent disposal system	LO-4	
		Assignment 4- [0%] Take-home assignments	LO-1, LO-3	
	WE	End Semester Examination	All	60%

Recommended Textbooks	1. Davis, M. L. (2015). Water and Wastewater Engineering: Design principles and Practice (2nd ed.). New York: McGraw-Hill Education. 2. Hammer, M. J. and Hammer, M. J., Jr. (2001). Water and Wastewater Technology (5th ed.). Upper Saddle River: Prentice Hall. 3. Metcalf & Eddy Inc., Tchobanoglous, G., Burton, F. L. and Stensel, H. D. (2002). Wastewater Engineering: Treatment and Reuse (4th ed.). New York: McGraw Hill Higher Education. 4. WHO (2011). Guidelines for Drinking Water Quality (4th ed.).
Names of Lecturers	Prof. M. W. Jayaweera, Prof. J. M. A. Manatunge, Dr. (Ms.) W. B. Gunawardana

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	L	L	H	H		L	H			L		
LO-2		M	M	M		M		L				L
LO-3	L	M	H			M						
LO-4	L	L	M			L	M	L				L
Module	**L**	**M**	**H**	**H**		**M**	**H**	**L**		**L**		**L**

Scale: H – High M – Medium L – Low

Module Code	CE4112	**Module Title**	Management Skill Development			
Credits	2.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	-		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *discuss* essential personal, interpersonal and group skills necessary for engineers,

LO-2: *identify* the skills necessary to manage the human resource that they will be interacting and dealing with as young engineers.

Module Outline	**LOs Covered**
Personal skills [8 h] *Developing self-awareness – values, cognitive style, attitude towards change, interpersonal orientation; Managing Stress – major elements of stress, managing stress, eliminating stress, temporary stress reduction techniques*	LO-1, LO-2
Interpersonal skills [10 h] *Supportive communication – definition, principles of supportive communication, principles of supportive listening; Motivating employees – performance, diagnosing work performance problems, enhancing ability, creating a motivating environment; Managing conflicts – interpersonal conflict management, conflict response alternatives, collaborative approach for conflict resolution*	LO-1, LO-2
Group skills [10 h] *Leadership – characteristics, styles of leadership, contingency approach and its variables; Delegation – advantages of delegation, when and whom to delegate, how to delegate effectively; Teamwork – developing teams and teamwork, advantages of teams, stages of team development*	LO-1, LO-2

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Quiz on end of 6th, 7th, 8th and 9th weeks [20%]	All	30%
		Attendance and active participation at class discussions [10%]	All	
	WE	End Semester Examination	All	70%

Recommended Textbooks	1. Whetten, D. A. and Cameroon, K. S. (2003). Developing Management Skills (5thInt. ed.). New Jersey: Prentice-Hall International
Names of Lecturers	Prof. K.A.M.K. Ranasinghe, Dr. L.L. Ekanayake

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1								M	H		M	M
LO-2								L	L	L	M	M
Module								**M**	**M**	**L**	**M**	**M**

Scale: H – High M – Medium L – Low

Module Code	CE4123	**Module Title**	Engineering Economics			
Credits	2.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	-		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *explain* fundamental concepts of engineering economics,

LO-2: *select* the best course of action for an engineering problem, by comparing a range of alternative actions based on their costs, benefits and returns, and

LO-3: *apply* risk response strategies to manage the selected alternatives.

Module Outline	**LOs Covered**
Fundamentals and discounted cash flow [8 h] *Fundamentals: time value equivalence of money, cash flow diagrams; Discounted cash flow: time value equivalence of money, single payment and annuity factors, numerical examples, cash flows and compounding*	LO-1
Comparison methods [10 h] *Comparison methods: assumptions, net present value, annual worth, equivalent annual cost with/without salvage value, equivalent annual worth of fixed asset lives and perpetual lives, internal rate of return (IRR), minimum acceptable rate of return, benefit cost (B/C) analysis, IRR and B/C irregularities, numerical examples; Analysis of alternatives: classification, mutually exclusive alternatives, incremental analysis, preferred method for decision-making*	LO-1, LO-2
Risk response strategies to manage selected alternatives [10 h] *Economic analysis: market price and economic price, shadow pricing, performance measures, total economic value, extended benefit cost analysis, interpretation of sensitivity analysis, risk identification, risk analysis, risk response, risk control*	LO-1, LO-2, LO-3

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Quiz on end of 6th, 8th, 9th and 10th weeks [20%]	LO-1, LO-2	30%
		Attendance and active participation at class discussions [10%]	All	
	WE	End Semester Examination	All	70%

Recommended Textbooks	1. Riggs, J. L., Bedworth, D. D. and Randhawa, S. U. (1998). Engineering Economics (4th ed,). New York: McGraw-Hill.
Names of Lecturers	Prof. K.A.M.K. Ranasinghe, Dr. L.L. Ekanayake

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	L						L	L			M	L
LO-2	L	L		L			M	M		L	H	L
LO-3		L		L			M	M		L	H	M
Module	**L**	**L**		**L**			**M**	**M**		**L**	**H**	**L**

Scale: H – High M – Medium L – Low

Module Code	CE4312	**Module Title**	Building Engineering			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	CE1112
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *recognize* the different types of services that have to be included in a building,

LO-2: *analyse* and design the building services needed for effective functioning,

LO-3: *implement* passive and green concepts for houses and buildings,

LO-4: *recognize* the way the services can be integrated within a building, and

LO-5: *design* formwork and facade systems needed for construction of buildings.

Module Outline	**LOs Covered**
Introduction to building services [2 h] *Highlight different types of building services and the need for proper integration in buildings*	LO-1
Design of different types of building services [12 h] *Design of building services based on data pertaining to a particular building incorporating various peculiarities and then the integration*	LO-1, LO-2, LO-4
Passive concepts applicable to buildings [6 h] *Passive concepts for better thermal performance and energy efficiency*	LO-2, LO-3
Design of formwork systems [4 h] *Formwork systems and the design aspects*	LO-5
Design of facades of buildings [4 h] *Façade systems and the design aspects*	LO-5
Assignments	
1. Individual Design Assignment 1 - Design of building services for a three-storey house	LO-1, LO-2, LO-3
2. Individual Design Assignment 2 - Design of building services for a 20 to 30-storey building	LO-1, LO-2, LO-3, LO-4

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on Individual Design Assignment 1 [15%]	LO-1, LO-2, LO-3	40%
		Report on Individual Design Assignment 2 [10%]	LO-1, LO-2, LO-3, LO-4	
	WE	End Semester Examination	All	60%

Recommended Textbooks	1. Hall, F. and Green, R. (2009). Building services handbook (5th ed.). Burlington: Elsevier. 2. David, V. C. (2007). Building Services Engineering (5th ed.). New York: Taylor & Francis Group. 3. Roger, G. (1997). Building Services Technology and Design (1st ed.). Longman
Names of Lecturers	Prof. M. T. R. Jayasinghe, Dr. (Mrs) J. C. P. H. Gamage, Dr. H. G. H. Damruwan

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1			M				L					
LO-2	M	L	H				M			H		L
LO-3	M		M				H			M		L
LO-4	M	L	M									
LO-5	L	L	M									
Module	**M**	**L**	**M**				**M**			**M**		**L**

Scale: H – High M – Medium L – Low

Module Code	CE4322	**Module Title**	Irrigation Engineering			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE3012
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *plan* and *design* an irrigation canal layout and *select* associated structure locations,

LO-2: *optimize* irrigation reservoir operation and water management scheduling to plan alternatives for reservoir rehabilitation and construction, and

LO-3: *demonstrate* an understanding of the hydro-economic concepts (e.g. time value of money, rate of return) and *perform* an economic feasibility study.

Module Outline	**LOs Covered**
Irrigation Principles [4 h] *Soil-plant-water relationship, soil moisture storage, reservoir analogy, evaluation of water available to the plant, field capacity, permanent wilting point, root zone, infiltration – introduction and measurements*	LO-2
Evaluation of Irrigation Requirement [4 h] *Evapotranspiration, reference crop evapotranspiration, crop growth stages, crop coefficient, crop evapotranspiration, effective rainfall, efficiency concepts in water use, field irrigation requirement*	LO-2
Irrigation Practices [4 h] *Common irrigation practices, surface irrigation, wetting pattern, basin, border and furrow irrigation, sub-irrigation, Overhead irrigation, Drip irrigation, Lift irrigation*	LO-1
Planning and Design of Irrigation Systems [4 h] *Availability of land and water resources, soil surveys, climatologic surveys related to crop water use, site investigations, command area, canal layout considerations and major irrigation structures for planning and design*	LO-1
Irrigation System Management [6 h] *Reservoir operation, reservoir operation schedules, reservoir operation and management options, estimation of reservoir yield*	LO-2
Irrigation in Sri Lanka [3 h] *Types of irrigation systems, types of water sources, tank irrigation, rice cultivation, environmental considerations in the design and rehabilitation of irrigation systems*	LO-1
Irrigation Water Management [4 h] *Objectives of water management, methods of distributing irrigation water, preparation of irrigation schedules, advantages and disadvantages of each method, water management design guidelines*	LO-1, LO-2
Feasibility Analysis [6 h] *Financial, economic and environmental feasibility of irrigation projects, interest calculations, cash-flow diagrams, discount factors and discounting techniques*	LO-3
Assignments	
1. Determination of the Irrigation Demand	LO-1
2. Planning and Designing of Irrigation Systems	LO-1, LO-3
3. Irrigation Reservoir Operation	LO-2

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on Determination of the Irrigation Demand [10%]	LO-1	30%
		Report on Planning and Designing of Irrigation Systems [10%]	LO-1, LO-3	
		Report on Irrigation reservoir operation [10%]	LO-2	
	WE	End Semester Examination	All	70%

Recommended Textbooks	1. Withers, B. and Vipond, S. (1974). Irrigation: Design and Practice. London: Batsford Academic and Educational Limited. 2. Garg, S. K. and Garg, R. (2010). Elementary Irrigation Engineering (3rd ed.). Delhi: Khanna Publishers. 3. Ponrajah, A. J. P. (1988). Technical Guidelines for Irrigation Works. Colombo: Department of Irrigation of Sri Lanka.
Names of Lecturers	Prof. N. T. S. Wijesekera, Dr. P. K. C. De Silva

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M	M	H			L	M			L		L
LO-2	M	M	M	M	L		M			L		L
LO-3	M	M	M	L						L	H	L
Module	**M**	**M**	**M**	**L**	**L**	**L**	**M**			**L**	**L**	**L**

Scale: H – High M – Medium L – Low

Module Code	CE4332	**Module Title**	Remote Sensing and GIS			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	CE2142
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *articulate* the fundamentals of Remote Sensing (RS) and Geographic Information Systems (GIS),

LO-2: *interpret* aerial photographs and estimate heights,

LO-3: *analyse* remote sensing data visually and digitally,

LO-4: *use* GIS for data analysis and presentation for engineering applications, and

LO-5: *apply* drone technology in engineering applications.

Module Outline	**LOs Covered**
Aerial Photogrammetry and its applications [8 h] *Introduction to aerial photogrammetry, flight planning, geometry of photographs and distortions, stereo-photogrammetry, heightening, analogue and analytical methods of plotting from aerial photographs; Air photo interpretation*	LO-1, LO-2
Introduction to Remote Sensing [6 h] *Spectral reflectance curve of earth objects; Electromagnetic energy transfer through atmosphere and digital data acquisition; Earth observation satellite systems and energy bands; analysis of digital data; Effective combination of energy bands for different purposes; production of colour composites; Interpretation of satellite images*	LO-1, LO-2, LO-3
GIS techniques [10 h] *Introduction to GIS, vector and raster features, relationship between features and attribute data, introduction to development of feature maps; Use of GIS software in data analysis and presentation*	LO-1, LO-4
Introduction to Drone technology [4 h] *Introduction to the use of drone technology in engineering applications and surveying*	LO-5
Practical Work	
1. Aerial photograph interpretation	LO-2
2. Image analysis using RS images	LO-2, LO-3
3. Data analysis using GIS software	LO-1, LO-4
Assignments	
1. Assignment on Aerial photogrammetry	LO-1, LO-2, LO-3
2. Assignment on GIS software	LO-1, LO-4
3. Assignment on use of RS images in surveying	LO-1, LO-2, LO-3

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	In class practical work using GIS software [10%]	LO-1, LO-4	50%
		Report on Aerial photogrammetry assignment [10%]	LO-1, LO-2, LO-3	
		Presentation on use of GIS software [20%]	LO-1, LO-4	
		Report on the use of RS images in Surveying [10%]	LO-1, LO-2, LO-3	
	WE	End Semester Examination	All	50%

Recommended Textbooks

1. Mesev, V. (2007). Integration of GIS and Remote Sensing. Wiley.
2. Harder, C. (2015). The ArcGIS Book: 10 Big Ideas about Applying Geography to Your World (1st ed.). California: Esri Press.

Names of Lecturers	Mr. T. D. C. Pushpakumara

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1										M		
LO-2	L	L			L					L		
LO-3	L	L			H	L			L	L		
LO-4	L	L	H		H	M	L		M	H	L	L
LO-5			L		H	L	L		M	L		L
Module	**L**	**L**	**M**		**H**	**M**	**L**		**M**	**M**		**L**

Scale: H – High M – Medium L – Low

Module Code	CE4342	**Module Title**	Construction Technology			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *evaluate* fundamentals of planning civil engineering construction with the knowledge of current technology, construction equipment, new engineering products and methods, and

LO-2: *identify* range of skills including ability to organize, teamwork, problem solving and communication.

Module Outline	**LOs Covered**
Construction equipment, ground water pumping and cofferdams [8 h] *Classification of construction equipment, Excavation and ground water control, Pipe – laying and drainage work, cofferdams*	LO-1, LO-2
Construction of tunnels, roads, bridges, and high-rise buildings [10 h] *Tunnelling, drilling equipment and rock blasting, Road and bridge construction, High – rise building construction*	LO-1, LO-2
Formwork, concreting, waterproofing and crack repair [6 h] *Mixing, transporting and placing concrete, Formwork and falsework, Waterproofing and crack repair*	LO-1, LO-2
Productivity and safety [4 h] *Health and safety, Construction productivity*	LO-1, LO-2
Assignments	
1. Class assignment on method statement for a given civil engineering problem	LO-1, LO-2
2. Field visits to selected construction sites	LO-1, LO-2

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on Assignment on Method Statement [10%]	LO-1, LO-2	40%
		Report and presentation on field visits [30%]	LO-1, LO-2	
	WE	End Semester Examination	LO-1, LO-2	60%

Recommended Textbooks	1. Robert Peurifoy, Clifford Schexnayder, Aviad Shapira Robert, Schmitt (2010). "Construction planning, equipment and methods", McGraw- Hill Education; (8th ed.)
Names of Lecturers	Prof. A. A. D. A. J. Perera, Dr. L. L. Ekanayake, Dr. C. S.A. Siriwardene

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1			M		M	H	L		M	L	H	L
LO-2					M	H	L	M	M	L	H	L
Module			**L**		**M**	**H**	**L**	**L**	**M**	**L**	**H**	**L**

Scale: H – High M – Medium L – Low

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Module Code	CE4352	**Module Title**	Traffic Engineering and Planning			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE3162
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *solve* problems related to traffic engineering and planning,

LO-2: *choose* and *design* an appropriate intersection control mechanism based on traffic flow and geometric conditions,

LO-3: *conduct* a basic Traffic Impact Assessment (TIA), and

LO-4: *identify* accident risk and *propose* suitable remedial measures.

Module Outline	**LOs Covered**
Traffic Flow Models and Flow Analysis [6 h] *Basic car following models, different traffic flow models, use of traffic flow models, one-way roads, lane reversal, bus only lanes*	LO-1
Traffic Impact Assessments (TIA) [3 h] *Methodology of conducting TIAs*	LO-1, LO-3
Road safety and Accident Analysis [3 h] *Accident data collection and analysis, accident investigations, conflict studies, road safety audits*	LO-1, LO-4
Transport Planning: **Trip Assignments and Traffic Calming [5 h]** *Advanced trip assignment models and traffic calming measures*	LO-1
Un-signalized Intersections and Interchanges [**3 h]** *Types of control and selection criteria, overpasses vs. underpasses, different ramp arrangements, basic interchange types*	LO-1, LO-2
Design of Roundabouts and Traffic Circles [3 h] *Design of roundabouts, capacity, weaving sections*	LO-1, LO-2
Traffic Signals [6 h] *Signal technology, warrants for traffic signals, phasing arrangements, signal timing calculations, pedestrian signals*	LO-1, LO-2
Traffic Microsimulation [6 h] *Traffic microsimulation techniques and introduction to simulation software (VISSIM)*	LO-1, LO-2
Practical Work	
1. Traffic Survey	LO-1
2. Introduction to VISSIM Software	LO-1, LO-2
Assignments	
1. Assignment on Traffic Flow Theory	LO-1
2. Assignment on TIA	LO-3
3. Assignment on Signal Design	LO-1, LO-2
4. Assignment on Traffic Simulation using VISSIM	LO-1, LO-2

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on Traffic Flow Theory [5%]	LO-1	40%
		Report on TIA [5%]	LO-3	
		Signal Design Report [15%]	LO-1, LO-2	
		Traffic Simulation using VISSIM results output and report [15%]	LO-1, LO-2	
	WE	End Semester Examination	All	60%

Recommended Textbooks	1. Kadiyali, R. L. (2007). Traffic Engineering and Transport Planning (7th ed.). Delhi: Khanna Publishers.
Names of Lecturers	Prof. J. M. S. J. Bandara, Dr. H. L. K. Perera, Dr. H. R. Pasindu, Dr. G. L. D. I. De Silva

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	H	H	M	M	H							L
LO-2	M		H	L	H							
LO-3	L	L		M		L						
LO-4	M				M	M						
Module	**H**	**M**	**H**	**M**	**H**	**L**						**L**

Scale: H – High M – Medium L – Low

Module Code	CE4412	**Module Title**	Bridge Engineering			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	CE3112
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☐		Elective ☐		Optional ☑	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *identify* a suitable bridge considering the need and resources,

LO-2: *idealise*, *analyse* and *design* bridges made of various materials, and

LO-3: *apply* theories to assess the load carrying capacity of reinforced concrete bridge decks.

Module Outline	**LOs Covered**
Classification of bridges [2 h] *Introduction, classification of bridges, Three moments theorem*	LO-1
Bridge loading [4 h] *Bridge loading, Macaulay's method (revision), reciprocal theorem and influence lines (revision)*	LO-1, LO-2
Investigation for bridges [2 h] *Investigate the need, location, future traffic, cost and other engineering aspects for bridges*	LO-1
Steel bridges [4 h] *Steel bridges (including thin walled structures like box girders)*	LO-2
Reinforced concrete bridges and prestressed concrete bridges [6 h] *Reinforced concrete bridges, analysis and design of prestressed concrete bridges, composite bridges*	LO-2
Analysis of arches, design of masonry arch bridges [2 h] *Elastic and plastic analysis of arches, preliminary aspects involved in masonry arch bridge design*	LO-1, LO-2
Suspension bridges [1 h] *Introduction to suspension bridges*	LO-1, LO-2
Maintenance of bridges [4 h] *Maintenance aspects of bridges, strength assessment of bridge decks using yield line theory*	LO-3
Design of substructures and foundations [1 h] *Fundamentals of bridge substructures*	LO-2
Construction techniques of bridges [2 h] *Details of construction techniques of bridges*	LO-1
Practical Work	
1. Testing the physical model in laboratory	LO-2
Assignments	
1. Group assignment (numerical modelling, physical modelling, testing and interpretation)	LO-2

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Quiz 1 on sections covered up to week 5 [10%]	LO-1, LO-2	40%
		Quiz 2 on materials covered between weeks 5 to 10 [10%]	LO-2, LO-3	
		Group assignment [20%]	LO-2	
	WE	End Semester Examination	All	60%

Recommended Textbooks

1. BS 5400: (1988). Steel, concrete and composite bridges.
2. Euro codes relevant to bridge design.
3. Leonhordt, F. (1984). Bridges: Aesthetics and Design. MIT Press.
4. Beckett, D. (1969). Bridges. London: The Hamlyn Publishing Group Limited.

Recommended Textbooks	5. Sir Pugley, A. (1968). The theory of Suspension Bridges (2nd ed.). Edward Arnold. 6. Victor, D. J. (2017). Essentials of Bridge Engineering (6th ed.). CBS Publishers. 7. Zhao, J. and Tonias, D. E. (2017). Bridge Engineering: Design, rehabilitation, and maintenance of modern highway bridges (4th ed.). McGraw-Hill Education. 8. Waddell, J. A. L. (1916). Bridge Engineering. New York: Wiley. 9. Ryall, M.J., Nigel Hewson, Parke, G.A.R. and Harding, J.E. (2000). The Manual of bridge engineering. Thomas Telford. 10. O'Connor, C. and Shaw, P. (2000). Bridge loads: an international perspective (1st ed.). CRC Press.
Names of Lecturers	Dr. K. Baskaran

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M	L	H		L							M
LO-2	H	M	H		M							M
LO-3	M	M	L									M
Module	**H**	**M**	**H**		**M**							**M**

Scale: H – High M – Medium L – Low

Module Code	CE4432	**Module Title**	Design of Large Structures			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE3112
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *analyse* and *design* large structures such as buildings, large span bridges, towers, space trusses,

LO-2: *perform* dynamic analysis and *design* for medium rise buildings, and

LO-3: *prepare* structural detailing for reinforced concrete, steel and pre-stressed concrete elements with disaster resistant features.

Module Outline	**LOs Covered**
Analysis and design of tall buildings [7.5 h] *Structural idealization, use of strong elements, coupled shear walls, transfer plates, dealing with pile foundations, 3D modelling techniques, interpretation of results*	LO-1
Analysis and design of large span brides and culverts [5 h] *Structural idealizations, dealing with highway loads, 2D and 3D modelling and interpretation of results*	LO-1
Analysis and design of towers [2.5 h] *Structural idealization, interpretation and checking of results*	LO-1
Analysis and design of space trusses [2.5 h] *Structural idealization, 3D modelling, interpretation of results*	LO-1
Earthquake and wind analysis of structures [15 h] *Modelling of dynamic systems, vibration isolation, analysis and design using codes*	LO-2
Structural detailing [2.5 h] *Special detailing for enhanced earthquake resistance*	LO-3
Assignments	
1. Analysis and design of a tall building	LO-1
2. Analysis and design of a tower/ bridge/ shell structure	LO-1
3. Earthquake analysis, vibration control and detailing of a reinforced concrete medium rise building	LO-2, LO-3

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on Assignment 1 on a tall building [15%]	LO-1	40%
		Report on Assignment 2 on a bridge/ tower/ space truss structure [5%]	LO-1	
		Report on Earthquake analysis of a building [20%]	LO-2, LO-3	
	WE	End Semester Examination	All	60%

Recommended Textbooks

1. Hosur, V. (2012). Earthquake resistant design of building structures. Wiley India (Pvt) Ltd.
2. Smith, B. S. and Coull, A. (1991). Tall building structures: Analysis and Design (1st ed., 552 p.). Wiley.
3. Hambly, E. C. and Hambly E. A. (1992). Bridge deck behaviour. E & F N Spon.
4. Standards Australia (1989). AS 1170.2: Minimum design loads on structures-Part 2: Wind loads, New South Wales.
5. Standards Australia (2007). AS 1170.4: Minimum design loads on structures-Part 4: earthquake loads, New South Wales.
6. BS EN codes/ Design guidelines.

Names of Lecturers Prof. M. T. R. Jayasinghe, Dr. C. S. Lewangamage

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M	M	H		H					M		M
LO-2	H	H	H		H					M		M
LO-3	M		M			M				M		L
Module	**M**	**M**	**H**		**M**	**L**				**M**		**M**

Scale: H – High M – Medium L – Low

Module Code	CE4442	**Module Title**	Computational Mechanics			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE3112
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *discretise* 2D, 3D, and curved structures,

LO-2: *identify* suitable finite element(s) for structural idealization,

LO-3: *model* geometrical and material variations and inconsistencies,

LO-4: *select* suitable numerical techniques such as finite elements, finite difference and boundary element methods, and

LO-5: *use* advanced finite element modelling software to model complex structures.

Module Outline	**LOs Covered**
Introduction to computational mechanics [2 h] *Introduction to different computational techniques, basics of idealization and discretization*	LO-1
Finite element formulation [8 h] *Introduction to displacement-based shape functions, assemblage of global stiffness matrix and consistent load vector*	LO-2
Geometrical modelling and material variations [10 h] *Geometric idealization, modelling material behaviour, numerical integration schemes, convergence, compatibility and completeness*	LO-3
Different numerical techniques and idealizations [15 h] *Method of finite difference, introduction to boundary element method, introduction to fracture mechanics and nano-mechanics*	LO-4
Application of computational techniques (Practical) [20 h] *Introduction to advanced finite element with Abaqus FEA package, thermo-mechanical modelling, mesh sensitivity and discretization; Programme basic finite elements with MATLAB*	LO-5
Assignments	
1. Assignment on advanced modelling with FEA	LO-5
2. Assignment on formulating basic finite element using MATLAB	LO-2, LO-5

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on Assignment 1 on Advanced modelling with FEA [10%]	LO-5	40%
		Report on Assignment 2 on Formulating basic FEA [10%]	LO-2, LO-5	
		Quiz 1 on finite element formulation [10%]	LO-2	
		Quiz 2 on geometrical modelling and material behaviour [10%]	LO-3	
	WE	End Semester Examination	All	60%

Recommended Textbooks

1. Ghali, A., Neville, A. M. and Brown, T. G. (2009). Structural Analysis: Unified Classical and Matrix Approach (6th ed.). Tayler & Francis. [624.04:519.6]
2. Zienkiewicz, O. C. and Taylor, R. L. (1989). The Finite Element Method: Volume 1 (4th ed.). New York: McGraw-Hill. [624.04:Z5]

Names of Lecturers: Prof. I. R. A. Weerasekera, Dr. H. M. Y. C. Mallikarachchi

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M											
LO-2	H				M							M
LO-3	H				M							
LO-4	H	M		M	H							
LO-5	H	H		M	H					L		H
Module	**H**	**M**		**M**	**H**					**L**		**M**

Scale: H – High M – Medium L – Low

Module Code	CE4452	**Module Title**	Costal and Port Engineering			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE3012
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *articulate* the importance of coast conservation and protection methods within an integrated coastal zone management framework,

LO-2: *apply* the principles of coastal and estuary hydraulics in analysing the impacts of coastal processes,

LO-3: *articulate* and *apply* the theories to assess various coastal processes to identify alternative coast protection methods leading to the preferred option, and

LO-4: *identify* appropriate layouts for small craft harbours and design breakwaters and supporting structures as necessary.

Module Outline	**LOs Covered**
Coastal environment and Coastal Zone Management in Sri Lanka [5 h] *Shoreline of Sri Lanka: Regulatory mechanism and management framework of the coastal zone*	LO-1
Coastal and Estuary hydraulics [12.5 h] *Waves and nearshore hydrodynamics, estuary hydrodynamics*	LO-2
Coastal processes and Coastal protection [7.5 h] *Coastal sediment transport, coastal cell concept, coast protection systems*	LO-3
Port and Harbour engineering [10 h] *Harbour planning, design of breakwaters and other harbour structures*	LO-4

Assignments	
1. Assignment on integrated coastal zone development	LO-1
2. Assignment on nearshore hydrodynamics and coast protection systems	LO-2, LO-3
3. Assignment on design of breakwaters	LO-4

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on Assignment 1 [10%]	LO-1	30%
		Report on Assignment 2 [10%]	LO-2, LO-3	
		Report on Assignment 3 [10%]	LO-4	
	WE	End Semester Examination	All	70%

Recommended Textbooks	1. Sorensen, R.M. (1978). Basic Coastal Engineering. New York: John Wiley & Sons. 2. Burcharth, H. F. and Hughes S. A. (2002). Coastal Engineering Manual, Part VI, Fundamentals of Design, Chapter VI-5, Engineer Manual 1110-2-1100, U.S. Army Corps of Engineers. Washington DC: CEM 3. Dean, R. G. and Dalrymple R. A. (1991). Water Wave Mechanics for Engineers and Scientists. Singapore: Advanced Series on Ocean Engineering Vol. 2, World Scientific.
Names of Lecturers	Mr. A. H. R. Ratnasooriya, Dr. T. M. N. Wijayaratna

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M	M	L	L			L					
LO-2	M	M	M	L					M	M		L
LO-3	M	M	H	L	L				M	M		M
LO-4	H	M	L	L								
Module	**M**	**M**	**M**	**L**					**M**	**M**		**L**

Scale: H – High M – Medium L – Low

Module Code	CE4472	**Module Title**	Environmental Geotechnics			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	CE3132
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *appraise* the role of geotechnics in the design of sanitary landfills and the current design methods and technologies,

LO-2: *predict* the likely interactions between waste and soil and *estimate* the pollutant movement in the ground,

LO-3: *determine* the mechanical aspects and stability of waste containment facilities,

LO-4: *evaluate* strategies for the containment of different types of wastes in sanitary landfills, and

LO-5: *design* natural and geosynthetic base barriers, drainage, and cover systems.

Module Outline	**LOs Covered**
Soils and wastes [4 h] *Clay mineralogy, waste composition, effects of minerology and chemicals on soil permeability*	LO-1, LO-2
Landfill design [8 h] *Introduction to the concepts of landfill design and understanding of the safety and environmental design of liners, stability of clay liners on slopes, design of covers*	LO-1, LO-2, LO-3, LO-5
Pollutant movement through soils and membranes [6 h] *Flow rates through membranes, effect of punctures, composite liners, mechanisms of mass transport, diffusion, dispersion, advective transport, sorption, predicting transport time, solutions to advection-dispersion equation, infiltration rates*	LO-2, LO-5
Establishment of waste disposal systems [6 h] *Sri Lankan/ International guidelines for the establishment of waste disposal systems including site selection*	LO-4
Study of success stories [4 h] *Case studies on waste containment systems under different environment conditions*	LO-1, LO-4
Practical Work	
1. Air permeability test	LO-1, LO-2
2. Composition of Municipal Solid Waste (MSW)	LO-2
Assignments	
1. Presentation on case studies	LO-1, LO-4
2. Design of a natural attenuation landfill	LO-1, LO-2
3. Design of an engineered landfill	LO-1, LO-2, LO-3, LO-5

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on Practical work [10%]	LO-1, LO-2	30%
		Presentation on case studies [10%]	LO-1, LO-4	
		Report on Design of landfills [10%]	LO-1, LO-2, LO-3, LO-5	
	WE	End Semester Examination	All	70%

Recommended Textbooks	1. Davis, M. L. (2015). Water and Wastewater Engineering: Design principles and Practice (2nd ed.). New York: McGraw-Hill Education. 2. Chen, Y., Zhan, L. and Tang, X. (2009). Advances in Environmental Geotechnics. Springer. 3. Sharma, H. D. and Reddy, K. R. (2004). Geoenvironmental Engineering: Site Remediation, Waste Containment, and Emerging Waste Management Technologies. Wiley. 4. Reddy, K. R. (2013). Evolution of Geoenvironmental engineering. ICE publishing. 5. Sarsby, R. W. (2019). Environmental Geotechnics in Practice: Introduction and case studies. ICE publishing.
Names of Lecturers	Dr. U. P. Nawagamuwa

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	L	H				H	H			L		M
LO-2	H											
LO-3	H						H			L		
LO-4	L	M	M	L		H				L		H
LO-5	M		H			M	H		L	L		
Module	**M**	**L**	**M**	**L**		**H**	**H**		**L**	**L**		**M**

Scale: H – High M – Medium L – Low

Module Code	CE4482	**Module Title**	Computational Geotechnical Engineering			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	CE3132
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *apply* the finite element formulation, stress and strain analysis, and constitutive relations to solve complex engineering problems,

LO-2: *simulate* earth slope stability problems, seepage in soils, earth retaining structures and foundations in soil numerically using computer software,

LO-3: *interpret* computer generated results in the proper context of geotechnical engineering, and

LO-4: *interpret* high strain load testing and low strain integrity testing of piles.

Module Outline	**LOs Covered**
Finite element formulation [20 h] *Boundary value problems and Indicial notation, the finite element method under small displacement and infinitesimal strain theory, stress and strain analysis in a continuum, constitutive relations for geo-materials*	LO-1
Analysis of dynamic test results of piles [8 h] *High strain dynamic load testing, and low strain integrity testing of pile foundations*	LO-4
Practical Work	
1. A site visit to observe an application of geotechnical design	LO-2, LO-3
2. Modelling of geotechnical problems (seepage, earth retaining systems, slopes and embankments, foundations)	LO-2, LO-3
Assignments	
1. Finite element (FE) analysis of a propped excavation	LO-1, LO-2, LO-3
2. FE analysis of a raft foundation	LO-1, LO-2, LO-3
3. FE analysis of the stability of a cut slope	LO-1, LO-2, LO-3

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Design report on FE analysis of propped excavation [20%]	LO-1, LO-2, LO-3	50%
		Design report on FE analysis of a raft foundation [15%]	LO-1, LO-2, LO-3	
		Design report on FE analysis of the stability of a cut slope [15%]	LO-1, LO-2, LO-3	
	WE	End Semester Examination	All	50%

Recommended Textbooks	1. V Zienkiewicz, O. C., Taylor, R. L. and Zhu, J.Z. (2005). The Finite Element Method: Its Basis and Fundamentals (6th ed.). Butterworth-Heinemann. 2. Huebner, K. H., Dewhirst, D. L., Smith, D. E. and Byrom, T. G. (2001). The Finite Element Method for Engineers (4th ed.).Wiley-Interscience.
Names of Lecturers	Dr. L. I. N. De Silva

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	H				H							
LO-2	H		H		H	H				H		M
LO-3	M		H		H	H	L	L		H		H
LO-4	H				H	L						M
Module	**H**		**H**		**H**	**H**	**L**	**L**		**H**		**M**

Scale: H – High M – Medium L – Low

Module Code	CE4492	**Module Title**	Project Management			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	CE3142
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1 *plan* and *execute* a project using project management tools and technique,

LO-2 produce project progress reports, and

LO-3 use of leading project management software MS Project, MS Project Sever and Primavera and ERP systems.

Module Outline	**LOs Covered**
Section 1 Project Management Framework [9 h] *Project Initiation – Introduction to project management, Project management framework and project management framework*	LO-1
Section 2 Project Management Body of Knowledge [10 h] *Project Management knowledge areas – Integration management, Project scope, Time management, Cost management, Quality management, Human resource management, Communication management, Risk management, Procurement management and Code of Professional conduct*	LO-1, LO-2
Section 3 IT Tools and Modern Project Management Methods [9 h] *Project Management computerbased tools and techniques – MS Project, MS Project Sever and Primavera. New project management techniques such as Agile Project Management*	LO-2, LO-3
Practical Work	
1. Project plan of construction project using MS Project and Primavera	LO-3
2. Setting up a project	LO-1
Assignments	
1. Assignment on Earned Value Method	LO-2
2. Assignment on Project Cost Monitoring	LO-2
3. Assignment on Project Risk and Quality Management	LO-2
4. Assignment on Project Modern ICT methods for Project Management	LO-3

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on Assignment 1 [5 %]	LO-2	30%
		Report on Assignment 2 [5 %]	LO-2	
		Report on Assignment 3 [10 %]	LO-2	
		Report on Assignment 4 [5 %]	LO-2	
		Coursework on Lab Class 1 [3%]	LO-3	
		Coursework on Lab Class 2 [2%]	LO-1	
	WE	End Semester Examination	All	50%

Recommended Textbooks	1. Project Management Institute USA, Project Management Body of Knowledge, Version 6 2. Andrew Stellman, Head First PMP, O'Reilly, New York.
Names of Lecturers	Prof. A. A. D. A. J. Perera, Dr. C. S. A. Siriwardena

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	L			M	M	M		H	H	M	M	M
LO-2					M	H		M	H	H	M	
LO-3				M	H				M	H	M	H
Module	**L**			**M**	**H**	**M**		**M**	**H**	**H**	**M**	**H**

Scale: H – High M – Medium L – Low

Module Code	CE4522	**Module Title**	Sustainable Design and Construction			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	CE1132
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *demonstrate* skills required to incorporate sustainable design concepts into engineering projects,

LO-2: *select* materials for civil engineering projects using a life cycle approach,

LO-3: *apply* sustainable concepts to evaluate building performance, and

LO-4: *perform* evaluations and *rate* civil engineering projects using Green building certification protocols

Module Outline	**LOs Covered**
Concepts of sustainable design [2 h] *Environmental degradation associated with development projects and corrective actions*	LO-1
Life cycle approach to select building materials [4 h] *Efficient use of building materials in development projects, energy consumption in material manufacturing, transporting and during operational cycle of the buildings, embodied and life cycle energy*	LO-2
Sustainable construction techniques [4 h] *Efficient structural and architectural systems for building construction with optimization techniques*	LO-1, LO-2
Thermal comfort and Indoor air quality [4 h] *Indoor environmental quality of buildings including thermal comfort and indoor air quality*	LO-3
Natural and artificial ventilation designs of buildings [2 h] *Building ventilation systems and occupant comfort levels*	LO-1, LO-3
Energy efficiency and the built environment [4 h] *Energy consumption in the operational phase of buildings, energy modelling using standard software by varying building materials and ventilation systems*	LO-3
The current trends in renewable energy sources and applications [2 h] *Renewable energy sources used in the built environment*	LO-3
Sustainable site selection, heat island effect, utilization of daylight [2 h] *Sustainable aspects related to the building site including heat island effect*	LO-1
Rainwater Harvesting [2 h] *Water efficiency of development projects giving emphasis to the rainwater harvesting*	LO-1, LO-3
Green building certification protocols [2 h] *Reputed green building certification protocols (e.g. SLGBC, LEED, BREAM) and their application to Sri Lanka*	LO-4
Practical Work	
1. A field visit to green-rated projects	LO-3, LO-4
Assignments	
1. A review on Green certification systems (LEED /BREEAM/SLGBC)	LO-1, LO-2, LO-3, LO-4
2. Assessment of sustainable features of the projects visited	LO-1, LO-2, LO-3
3. Building energy modelling using the latest software	LO-2, LO-3

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on a Green building certified by LEED / BREEAM/ SLGBC [20%]	LO-1, LO-2 LO-3, LO-4	40%
		A report on the green projects visited with a detailed analysis of sustainable concepts incorporated [10%]	LO-1, LO-2 LO-3	

Assignments	CA	A report on embodied energy of different building materials and selecting materials based on the green score [10%]	LO-2, LO-3	
	WE	End Semester Examination	All	60 %
Recommended Textbooks		1. Yudelson, J. (2008). The Green Building Revolution. Washington: Island Press. 2. Kibert, C. J. (2016). Sustainable Construction: Green Building design and delivery (4th ed.). John Wiley. 3. Sarte, S. B. (2010). Sustainable Infrastructure: the guide to green engineering and design (1st ed.). John Wiley. 4. Malina, M. (2013). Delivering sustainable buildings: an industry insider's view. Wiley-Blackwell.		
Names of Lecturers		Prof. (Mrs.) C. Jayasinghe, Prof. M. T. R. Jayasinghe, Visiting Lecturers		

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1		M	M	L		M	H			M	M	M
LO-2	M	H	M	L	M		H			M		
LO-3	H	H	M		H		H			M		
LO-4		H	M	L	M	M	H		M	M		M
Module	**M**	**H**	**M**	**L**	**M**	**M**	**H**		**M**	**M**	**L**	**M**

Scale: H – High M – Medium L – Low

Module Code	CE4532	**Module Title**	Highway Construction and Maintenance Management			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE3162
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *select* suitable materials for subgrade, subbase and base construction,

LO-2: *design* hot mix asphalt for a given design specification,

LO-3: *identify* suitable road construction methodology for a given design and site conditions,

LO-4: *demonstrate* an understanding of road maintenance management, surfacing and repair methods, and

LO-5: *examine* a road construction environment and review the road construction methods.

Module Outline	**LOs Covered**
Pavement structure [2.5 h] *Function of subgrade, subbase, base and surface layer*	LO-1, LO-2
Pavement materials – Soil and Aggregate [2.5 h] *Material selection for pavement layers, compaction of soil layers, quality control and assurance tests for soil, gravel and aggregate layers*	LO-1, LO-3
Asphalt Mix Design [7.5 h] *Types and uses of asphalt mixes, bitumen specification, bitumen tests, aggregate tests, volumetric design, Marshal mix design*	LO-2
Road construction [12.5 h] *Asphalt surfacing – production, transportation, laying and compaction of asphalt concrete, concrete pavement construction, low cost construction methods, tests for quality assurance of construction*	LO-3
Highway maintenance [10 h] *Pavement distresses, periodic and routine maintenance of roads - single and multiple surface dressing for periodic maintenance, sand seals, fog seals, and slurry seals, pothole repair and sealing cracks, maintenance of road markings and road signs, asphalt concrete overlay, maintenance of structures*	LO-4, LO-5
Practical Work	
1. Bitumen and Aggregate Tests relevant for Asphalt Mix Design	LO-1
2. Marshall Mix Design	LO-2
3. Field visit to road construction project, Distress survey	LO-4, LO-5
Assignments	
1. Preparation of Method Statement for a Road Construction Activity	LO-1, LO-2, LO-3, LO-4

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Method Statement for a Road Construction Activity [5%]	LO-4, LO-5	40%
		Report on Asphalt Mix Design [20%]	LO-2	
		Report(s) on Road construction method / Distress survey [15%]	LO-4, LO-5	
	WE	End Semester Examination	All	60%

Recommended Textbooks	1. Wright, P. H. and Dixon, K. (2003). Highway Engineering (7th ed.). John Wiley & Sons, Inc.
Names of Lecturers	Prof. W. K. Mampearachchci, Dr. H. R. Pasindu

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1		L		M								
LO-2	L		M									
LO-3			L	L	H	L		L	L	L		L
LO-4				L	L	L						
LO-5				M	M	L						
Module	**L**	**L**	**M**	**M**	**H**	**L**		**L**	**L**	**L**		**L**

Scale: H – High M – Medium L – Low

Module Code	CE4542	**Module Title**	Analysis and Design of Transportation Systems			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE3162
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *identify* and *formulate* problems related to transportation systems planning and design,

LO-2: *identify* appropriate tools for solving formulated problems mathematically,

LO-3: *design* a transportation system based on user requirements, and

LO-4: *analyse* a given transportation system using various tools.

Module Outline	**LOs Covered**
Introduction to transportation systems [3 h] *Context, concepts and characterization*	LO-1
Highway networks [3 h] *Connectivity and accessibility, inventory data collection and routine, optimal paths, link independent/node independent alternate paths, traffic assignment models*	LO-2, LO-3, LO-4
Urban transport systems [3 h] *Queuing models and delay analysis, traffic flow synchronization and coordination*	LO-1, LO-2, LO-3, LO-4
Feasibility studies for transport infrastructure [3 h] *Selection of alternatives, pre- feasibility assessment, comparison of alternatives, project evaluations, concepts of disaster resilience*	LO-1, LO-2, LO-3, LO-4
Facility location problem [3 h] *E.g. fire and police stations, emergency medical services, emergency repair services, etc., optimum routing mechanisms, transport hubs, reliability analysis*	LO-3
Mass transit systems [**6 h]** *Optimum network, terminal location and route arrangement, feeder systems*	LO-3
Logit Choice Modelling and Model estimations [9 h] *Mode choice behaviour and stochastic choice modelling techniques*	LO-2
Integrated Land use - Transport Modelling [5 h] *Use of integrated land use - transport modelling techniques for transport planning*	LO-2, LO-4
Practical Work	
1. Traffic Modelling with CUBE Voyager Software	LO-1, LO-2, LO-3, LO-4
Assignments	
1. Assignment on Transport networks	LO-1, LO-2
2. Assignment on Feasibility studies	LO-3, LO-4
3. Assignment on Logit estimations	LO-1, LO-2, LO-4

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Report on Assignment 1 [10%]	LO-1, LO-2	40%
		Report on Assignment 2 [15%]	LO-3, LO-4	
		Report on Assignment 3 [15%]	LO-1, LO-2, LO-4	
	WE	End Semester Examination	All	60%

Recommended Textbooks	1. Banks, J. H. (2001). Introduction to Transportation Engineering (2nd ed.). McGraw-Hill. 2. Haefner, L. E. (1986). Introduction to Transportation Systems. CBS College publishing.
Names of Lecturers	Prof. J. M. S. J. Bandara, Dr. H. L. K. Perera, Dr. H. R. Pasindu, Dr. G. L. D. I. De Silva

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1		H	M	M	H							L
LO-2	H				H							
LO-3		L	M	L		L						
LO-4	H				H							
Module	**H**	**M**	**M**	**M**	**H**	**L**						**L**

Scale: H – High M – Medium L – Low

Module Code	CE4552	**Module Title**	Water and Wastewater Treatment			
Credits	3.0	**Hours/Week**	**Lectures**	2.5	**Pre-requisites**	CE3152 CE4052
GPA/NGPA	GPA		**Lab/Assignments**	3/2		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *apply* the basic scientific principles underlying environmental systems used in water and wastewater treatment unit operations and processes, including mass balances, reactor hydraulics, mass transfer, water chemistry, and wastewater microbiology in conceptual and detailed designs,

LO-2: *analyse* a given scenario and *evaluate* the situation, *select* unit operations and *describe* underlying mechanisms of basic design principles of common water and wastewater treatment processes,

LO-3: *apply* these principles to select conventional and advanced treatment options and *produce* creative, cost-effective conceptual designs of water and wastewater treatment engineering systems, and

LO-4: *perform* detailed calculations for each unit operation/ process and *devise* solutions and *stipulate* technical specifications and cost calculations.

Module Outline	**LOs Covered**
Water treatment design [15 h] *Importance of good quality water, Water quality guidelines and standards, Selection of water sources and intake structures, Design of conventional treatment processes: screening, aeration, coagulation, flocculation, sedimentation, filtration, disinfection, plant sizing and layout; Examining the feasibility of site locations, provision for expansion, connection to the water distribution system; Residuals handling system*	LO-1, LO-2, LO-3, LO-4
Wastewater treatment design [15 h] *Preliminary treatment (screening, grit removal, odour control, flow equalization); Primary treatment; Biological processes (attached growth and suspended growth processes, anaerobic processes, sludge handling, treatment, disposal; Land-based and on-site treatment facilities*	LO-1, LO-2, LO-3, LO-4
Introduction to advanced water and wastewater treatment [5 h] *Suspended solids removal (granular media filtration, filtration and chlorination for virus removal, adsorption); Nutrient removal (biological and chemical phosphorous removal, biological nitrification, denitrification and ammonia stripping); Reduction of dissolved salts (distillation, reverse osmosis, electrodialysis); Use of nanotechnology*	LO-2, LO-3
Assignments	
1. Design of a water treatment system for a selected location/ project	LO-1, LO-2, LO-3, LO-4
2. Design of a wastewater treatment system for a selected location/ project	LO-1, LO-2, LO-3, LO-4

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Assignment 1- [20%] Report on design of a water treatment system for a selected location/project	LO-1, LO-2, LO-3, LO-4	40%
		Assignment 2- [20%] Report on design of a wastewater treatment system for a selected location/ project	LO-1, LO-2, LO-3, LO-4	
	WE	End Semester Examination	All	60%

Recommended Texts Books	1. Davis, M. L. (2015). Water and Wastewater Engineering: Design principles and Practice (2nd ed.). New York: McGraw-Hill Education. 2. Metcalf & Eddy Inc., Tchobanoglous, G., Burton, F. L. and Stensel, H. D. (2002). Wastewater Engineering: Treatment and Reuse (4th ed.). New York: McGraw Hill Higher Education. 3. Ambient water quality standards, Guidelines/ Standards for Drinking Water Quality: WHO; SLS; EPA standards. 4. Wastewater discharge standards (CEA).
Names of Lecturers	Prof. M. W. Jayaweera, Prof. J. M. A. Manatunge, Dr. (Ms.) W. B. Gunawardana

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	H	M	M		L	L		M	L	M		L
LO-2	H		M	M	M	M	M		L			
LO-3	H	M	M		L	L	L				L	
LO-4	H	H	H		M	L	M	M	L	M		L
Module	**H**	**M**	**H**	**M**	**M**	**L**	**M**	**M**	**L**	**M**	**L**	**L**

Scale: H – High M – Medium L – Low

Module Code	CE4562	**Module Title**	Environmental Impact Assessment			
Credits	3.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	CE3152
GPA/NGPA	GPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *participate* in discussions on and express opinions about global environmental issues, global trends and Sri Lanka's commitment to sustainable development, international treaties and conventions on environment,

LO-2: *explain* the purpose and role of Environmental Impact Assessment (EIA) in the decision-making process,

LO-3: *serve* as a member of a team of consultants who undertake an Environmental Impact Assessment study,

LO-4: *prepare* the Terms of Reference and to evaluate an EIA report submitted by a client as an officer in a Project Approving Agency, and

LO-5: *quantify* the impacts and *recommend* measures to avoid or minimise social and environmental concerns in engineering projects.

Module Outline	**LOs Covered**
Development and the environment [8 h] *Environmental issues related to development projects, global environmental issues*	LO-1, LO-2
The EIA process [10 h] *EIA regulations, the EIA process in Sri Lanka, project EIA and strategic environmental assessment (SEA) – EIA as a planning and management tool, incorporation of remedial measures into project documentation, EIA process adopted by multilateral/ bilateral organizations*	LO-2, LO-3
Conducting an EIA [8 h] *Terms of Reference (TOR) preparation, baseline studies, impact identification and quantification, EIA techniques and methodologies, evaluation of alternatives, impact mitigation*	LO-3, LO-4, LO-5
Introduction to environmental cost – benefit analysis [4 h] *Concept of valuation of environmental costs, discounting rates, internalization of environmental costs*	LO-1, LO-2, LO-4
Environmental Management and Environmental Monitoring Plans [4 h] *Preparation of Environmental Management Plan (EMP) and Environmental Monitoring Plan (EMoP) for development projects*	LO-3, LO-5
Assignments	
1. Case Study – Initial Environmental Examination or Environmental Impact Assessment of a proposed development project in Sri Lanka, using the project details provided by the proponent and Terms of Reference provided by the relevant Project Approving Agency	LO-2, LO-3, LO-4, LO-5
2. Field Visit – Reconnaissance visit to the Project Site, interviews with local residents and officials of the project proponent.	LO-3, LO-5

	Category	**Type**	**Assessed LOs**	**Weightage (%)**
Assessments	CA	Assignment 1- [40%] Report based on an EIA carried out for a given case study, including the important steps involved in an EIA (role-play exercise for scoping, TOR preparation, Impact Matrix Preparation and Assessment, Quantification and mitigation of Impacts, preparation of EMP and EMoP)	LO-1, LO-2, LO-3, LO-4, LO-5	40%
	WE	End Semester Examination	All	60%

Recommended Textbooks	1. Canter, L. W. (1995). Environmental Impact Assessment (2nd ed.). McGraw- Hill Series in Water Resources & Environmental Engineering. 2. Principles of Environmental Impact Assessment (1998). USEPA. 3. Official website of the Central Environmental Authority of Sri Lanka - www.cea.lk.
Names of Lecturers	Prof. M. W. Jayaweera, Prof. J. M. A. Manatunge, Dr. (Ms.) W. B. Gunawardana

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1		L				M	H	H	M	H	L	M
LO-2						M	H	H	L	H	L	M
LO-3		L				H	M	H	H	H	L	M
LO-4		L				H	H	H		H		
LO-5						H			M	H	M	M
Module		**L**				**H**	**H**	**H**	**M**	**H**	**L**	**M**

Scale: H – High M – Medium L – Low

Module Code	CE4902	**Module Title**	Communication Skills for Projects			
Credits	2.0	**Hours/Week**	**Lectures**	1.0	**Pre – requisites**	EL1012
GPA/NGPA	NGPA		**Lab/Assignments**	3/1		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *demonstrate* skills to write professional project proposals, reports and literature reviews,

LO-2: *write* research reports, minutes of meetings, memos, emails and letters, and

LO-3: *conduct* oral presentations and meetings.

Module Outline	**LOs Covered**
Project Proposals [2 h] *Writing project proposals for various types of engineering or related projects*	LO-1
Literature Review [2 h] *Familiarize with standard methods of searching reputed literature using various keywords related to the subject, use of online methods for the literature search using reputed databases such as Scopus/ScienceDirect, performing literature review using standard techniques, use of reference management systems and plagiarism tools*	LO-1, LO-2
Project Reports [2 h] *Writing reports for various types of technical projects: preparation of project reports following standard formats for different types of projects, writing styles, etc.*	LO-1, LO-2
Research Papers [2 h] *Writing research papers targeting various reputed journals and conferences*	LO-1, LO-2
Minutes, Memos, Emails and Letters [2 h] *Writing minutes of meetings, memos, letters, and other relevant office communications*	LO-2
Presentation Techniques [2 h] *Presentation techniques and skills for effective oral presentation*	LO-3
Participation at meetings, Telephone conversations [2 h] *Effective techniques to conduct and participate in meetings, effective telephone skills and maintaining communication ethics*	LO-3
Practical Work	
1. Writing Project/ Research proposals	LO-1
2. Databases, Literature survey, Referencing and Plagiarism	LO-1, LO-2
3. Project reports	LO-1, LO-2
4. Writing research papers	LO-1, LO-2
5. Business letter writing and e-mails	LO-2
6. Participation at meetings, telephone conversations	LO-3
7. Preparing PowerPoint presentations	LO-3
Assignments	
1. Writing Business letters	LO-1
2. Writing a Project proposal	LO-1, LO-2
3. A detailed Literature review	LO-1, LO-2
4. Writing a Project report	LO-1, LO-2
5. Project presentation	LO-3

	Category	Type	Assessed LOs	Weightage
Assessments	CA	Business letter writing [10%]	LO-1	100%
		Project/ research proposal [10%]	LO-1, LO-2	
		Report on literature review [20%]	LO-1, LO-2	
		A detailed project report [20%]	LO-1, LO-2	
		Oral presentation [20%]	LO-3	
		Writing a project article [10%]	LO-2	
		Take home assignment [10%]	LO-2, LO-3	
	WE	End Semester Examination	N/A	0%
Recommended Textbooks		1. Collection of e-learning material available on Moodle at the Computer Resources Units of the Department.		
Names of Lecturers		Prof. (Mrs.) C. Jayasinghe, Dr. (Mrs.) A. S. Ranathunga, Dr. (Mrs.) M. T. P. Hettiarachchi		

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1								L		H		M
LO-2								M	L	H		M
LO-3								L	M	H		M
Module								**L**	**M**	**H**		**M**

Scale: H – High M – Medium L – Low

Module Code	CE4912	**Module Title**	Comprehensive Design Project			
Credits	5.0	**Hours/Week**	**Lectures**	-	**Pre-requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	-		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *propose* design alternatives and master plan for a given project brief and *analyse* feasibility of those alternatives,

LO-2: *apply* standard methods to carry out Environmental and social appraisal, Traffic Impact Assessments, Financial/Economic and Technical feasibility,

LO-3: *conduct* preliminary analyses using site investigation data,

LO-4: *perform* detailed analysis and designs for the selected solution using site related data,

LO-5: *estimate* the project cost by preparing the bills of quantities and necessary tender documents, and

LO-6: *demonstrate* necessary skills to undertake design projects, work in a team and complete the design phase and deliver the outcome in the form of reports and drawings to the satisfaction of all stakeholders.

Module Outline	**LOs Covered**
Terms of Reference [2 weeks] *Identification of objectives, requirements and nature of the project; Project organization and team building*	LO-1, LO-6
Alternative analysis [4 weeks] *Formulation of conceptual design alternatives and analysis of feasibility of these alternatives considering environmental, social, economic and financial aspects*	LO-1, LO-2, LO-6
Development of preliminary designs [2 weeks] *Development of preliminary design for the selected alternative using site investigation data and also with sufficient attention to principles of sustainability*	LO-2, LO-3, LO-6
Performing detailed designs [8 weeks] *Detailed designs including super structure, sub structure, building services, etc.*	LO-2, LO-4, LO-6
Cost Studies and Financial proposals [3 weeks] *Preparation of tender documents and other work associated with procurement/ implementation of the project*	LO-5, LO-6
Preparation of written communication of the project outputs [3 weeks] *Detailed drawings and reports*	All
Assignments	
1. Conceptual design with alternatives for the major development envisaged	LO-1
2. Feasibility study to indicate the environmental, social and financial viability of alternatives	LO-1, LO-2
3. Development of preliminary designs for the selected alternative (both concepts and layouts)	LO-2, LO-3
4. Detailed analyses of the super-structure using site specific data	LO-4
5. Detailed design of the super structure and building services (if applicable)	LO-4
6. Detailed load evaluation and structural analysis of sub-structure	LO-4
7. Detailed design of sub-structure	LO-4
8. Preparation of detailed drawings and writing a comprehensive report	LO-6
9. Detailed cost evaluation and preparation of tender documents	LO-5

	Category	Type	Assessed LOs	Weightage
Assessments	CA	Terms of Reference [5%]	LO-1	100%
		Progress reviews [10%]	LO-1, LO-2	
		Individual handwritten report [20%]	LO-1, LO-2, LO-3	
		Interim presentation [15%]	LO-1, LO-2 LO-3, LO-4	
		Viva [20%]	LO-1, LO-2 LO-3, LO-4	
		Final presentation [15%]	All	
		Final group report [15%]	All	
Recommended Textbooks		Relevant references will be recommended based on the selected project		
Names of Lecturers		Prof. (Mrs.) C. Jayasinghe, Prof. M. T. R. Jayasinghe, Other lecturers who supervise the projects		

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	L	M	M	H		M	L		H	H		M
LO-2	L	M		M		M	H	M	H	H	M	M
LO-3	H	H	H		M	M	H	M	H	H		M
LO-4	H	H	H	M	H	M	H	M	H	H	L	H
LO-5						M			H	H	H	M
LO-6									H	H		H
Module	**H**	**H**	**H**	**M**	**H**	**M**	**H**	**H**	**H**	**H**	**M**	**H**

Scale: H – High M – Medium L – Low

Module Code	CE4922	**Module Title**	Research Project			
Credits	4.0	**Hours/Week**	**Lectures**	-	**Pre-requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	-		
Module Type:	Core Module/Compulsory ☑		Elective ☐		Optional ☐	

Learning Outcomes (LOs)
After completing this module, students should be able to:

LO-1: *identify* the problem and research need, overall and specific objectives, and *prepare* the research proposal,

LO-2: *conduct* a comprehensive literature review,

LO-3: *investigate* using research-based knowledge and research methods

LO-4: *apply* the underlying engineering fundamentals related to the research and *analyse*, *verify* and *interpret* the results, and

LO-5: *derive* conclusions and *communicate* in oral and written form.

Module Outline	**LOs Covered**
Problem Identification and Project Formulation [4 weeks] *Identification of problem statement, overall objectives, specific objectives, contribution to the society, scope of work, outputs and outcomes, resource requirements*	LO-1, LO-2
Research Project Planning [4 weeks] *Preparation of work plans, progress monitoring, assessment techniques, timing of field data collection and other programmes*	LO-1, LO-2
Conducting Research [24 weeks] *Literature surveys, field surveys, data collection and checking methods and needs, analysis methods, parameter identification, calibration and verification, laboratory experiments, statistical techniques, use of software*	LO-2, LO-3, LO-4
Research Report Preparation and Defence [4 weeks] *Reporting formats, referencing methods, arrangement of contents page and sub sections, compilation of the research report, formatting of text, graphs, tables and figures, available tools, organisation of a presentation, presentation techniques, expressing and delivery of outputs*	LO-5

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Research Proposal Submission [0%]	LO-1	100%
		Literature Review Submission [0%]	LO-2	
		Proposal presentation [5%]	LO-1, LO-2, LO-5	
		Progress presentation [15%]	LO-3, LO-5	
		Submission of initial draft report & draft 4-page summary [0%]	LO-3, LO-4	
		Final 4-page summary submission [10%]	LO-3, LO-4, LO-5	
		Submission of presentation slides, presentation and viva [30%]	LO-3, LO-4 LO-5	
		Final Report evaluated by supervisor [40%]	All	
	WE	End Semester Examination	-	-

Recommended Textbooks	As directed by supervisor
Names of Lecturers	Prof. J. M. S. J. Bandara, Dr. H. L. K. Perera and all senior academic staff

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1	M	M		M	L	L	L	L		M	L	H
LO-2	L	H		H	L							H
LO-3	H	H		H	H			H			L	H
LO-4	H	H	M	H	H			M				H
LO-5	H	H	M					H		H		H
Module	**H**	**H**	**M**	**H**	**H**			**H**		**H**	**L**	**H**

Scale: H – High M – Medium L – Low

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4.4 DESCRIPTION OF HUMANITIES MODULES

Module Code	DE2230	**Module Title**	History and Development of Engineering			
Credits	2.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	-		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *appreciate* key historical events that led to a quantum shift in advancement of engineering and technological development,

LO-2: *discuss* how some engineering developments have been a direct result of social needs and how other engineering developments that have originated without the existence of a clear social need for them, but have had an immense impact on society, and

LO-3: *appreciate* the importance of innovations in engineering and its development.

Module Outline	**LOs Covered**
Ancient engineering practice [6 h] *Ancient engineering practice: invention of wheel, structures in ancient Greece and Egypt, Roman road network, Sri Lankan stupas and extensive irrigation network*	LO-1, LO-2
Industrial revolution [4 h] *Industrial revolution and influence of energy: invention of the steam engine, cotton spinning and advancement in iron making; Invention of internal combustion engine and electrical power generator*	LO-1, LO-2, LO-3
Effects of wars [4 h] *The effects of the First and Second World Wars; Development of aeroplanes, airships, submarines and automobiles; Invention of synthetic rubber, Radar, nuclear power and synthetic fuel*	LO-1, LO-2, LO-3
Space age [4 h] *Rapid advancements in rocketry, material science, electronics and computers, including light-weight materials, satellite radio and television, mobile phone technology, GPS navigation systems, solar energy*	LO-1, LO-2, LO-3
Influence of computer technology [4 h] *Automated control systems, rapid advancement in complex engineering designs, virtual prototype testing*	LO-1, LO-2, LO-3
Future scenario [4 h] *Artificial intelligence, renewable energy and future inventions; Need to appreciate sustainable development with new innovations for the existence of mankind*	LO-2, LO-3

Assignments	
1. Individual report and presentation on selected historical engineering achievements	LO-1, LO-2, LO-3

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	Individual Assignment [50 %]	LO-1, LO-2, LO-3	100%
		Class Presentation [50%]	LO-1, LO-2, LO-3	
	WE	End Semester Examination	-	-

Recommended Textbooks	Sivasegaram, P. S. (2006).History of Engineering in Sri Lanka – A Brief Overview, Centenary Commemoration Publications 1906 – 2006. Institution of Engineers Sri Lanka.
Names of Lecturers	Dr. L. L. Ekanayake, Prof. W. P. S. Dias, Dr. U. P. Nawagamuwa

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1						L	L	M	L	M		L
LO-2						L	L		M	M		
LO-3								L	M	M		L
Module						**L**	**L**	**L**	**M**	**M**		**L**

Scale: H – High M – Medium L – Low

Module Code	DE2480	Module Title	Human Rights			
Credits	2.0	Hours/Week	Lectures	2.0	Pre-requisites	None
GPA/NGPA	GPA		Lab/Assignments	-		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *explain* the basic concepts and theories of human rights,

LO-2: *discuss* the relevance and theories in the application of human rights concepts in the field of engineering, and

LO-3: *apply* concepts of human rights law in relation to engineering/ infrastructure development projects and evaluate those activities from a human rights perspective.

Module Outline	LOs Covered
Introduction [4 h] *Introduction to Human Rights (HR), international human rights instruments, international and HR mechanism, engineering ethics and Human Rights*	LO-1
Legal system in Sri Lanka [4 h] *Introduction to the legal system, the constitution and Fundamental Rights, Right to Remedy and Remedial Mechanism*	LO-1
Human Rights and Engineering [6 h] *Human rights aspect of engineering, engineering for human rights*	LO-2
Human Rights, Engineering and Sustainable Development [6 h] *Rights based approach, Gender and Engineering, HR and Disaster Management, HR and Sustainable Development Goals*	LO-2, LO-3
Rights Based Approach [4 h] *Introduction to Right Based Approach (RBA), RBA as mitigation strategy*	LO-3
Application of Human Rights in Engineering [HRE] [4 h] *HRE in Disaster Management, HRE in Post conflict Era, HRE in Sustainable Development*	LO-3

Assignments

1. Group project on identifying Human Rights related issues in infrastructure development projects	LO-1, LO-2, LO-3

Assessments	Category	Type	Assessed LOs	Weightage
	CA	Group project report	All	100%
	WE	End Semester Examination	-	-

Recommended Textbooks	Selected UN Human Rights Conventions.
Names of Lecturers	Dr. S. D. B. Dissanayake, Dr. H.R.Pasindu

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1						M						
LO-2						M						
LO-3						H	H		M	H		H
Module						**H**	**M**		**L**	**H**		**H**

Scale: H – High M – Medium L – Low

Module Code	DE2510	**Module Title**	Responsible Citizenship			
Credits	2.0	**Hours/Week**	**Lectures**	2.0	**Pre-requisites**	None
GPA/NGPA	GPA		**Lab/Assignments**	-		
Module Type:	Core Module/Compulsory ☐		Elective ☑		Optional ☐	

Learning Outcomes (LOs)

After completing this module, students should be able to:

LO-1: *express* themselves, their surrounding and their connection to the society at large,

LO-2: *acknowledge*, *respect* and *engage* with communities and their culture for long term wellbeing,

LO-3: *appreciate* local actions of an individual which can have a big impact on the lives of people,

LO-4: *demonstrate* awareness of the consequences of the actions of an individual, and

LO-5: *accept* interdependencies and be socially responsible.

Module Outline	**LOs Covered**
Me: Identity and community in the Cultural Space [4 h] *Self-confidence, self-awareness, understand how identities and cultures are formed/ expressed/changed and connected, value different perspectives*	LO-1, LO-2
Me and You: Community conversations [6 h] *Understand different components of the conversation, how and when it can be used, ability to support, learn and share through dialogue, intercultural communication and tolerance, ability to support, learn and share*	LO-1, LO-2, LO-3
We: Local and global commitments [6 h] *Understand the concept of community and connections between local and global communities, ability to identify key stakeholders in the community, ability to identify a social development issue to address in the community, motivation to act towards sustainable development*	LO-2, LO-3, LO-4
Planning social action [6 h] *Skills in project planning and management*	LO-3, LO-4
Delivering social action [6 h] *Experience implementing social action*	LO-4, LO-5
Application of Human Rights in Engineering [HRE] [4 h] *HRE in Disaster Management, HRE in Post conflict Era, HRE in Sustainable Development*	LO-3

Assignments

1. My Identity – A graphical illustration	LO-1
2. Community Project – Proposal Presentation	All
3. Debate on a topic related to a current issue faced by the youth	All

	Category	**Type**	**Assessed LOs**	**Weightage**
Assessments	CA	My Identity – A graphical illustration [10%]	LO-1	100%
		Community Project – Proposal Presentation [10%]	All	
		Debate [20%]		
		Community Project – Progress Evaluation [10%]		
		Community Project – Final Evaluation and Viva [20%]		
		Attendance and active participation in class activities [30%]	LO-1, LO-4, LO-5	
	WE	End Semester Examination	-	-

Recommended Textbooks	1. Whetten, D. A., & Cameron, K. S. (2020). *Developing management skills*. Hoboken, NJ: Pearson Education. 2. British Council. (2017). *Active Citizens facilitator's toolkit*.
Names of Lecturers	Dr. C. S. A. Siriwardana

Mapping of Module Learning Outcomes (MLO) to the Programme Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
LO-1						L	L	L	M	M		L
LO-2						L	M	L	M	M		M
LO-3				L		M	M	M	H	M	L	M
LO-4			L	L		M	M	L	H	H	M	M
LO-5			L	L		M	M	M	H	H	M	M
Module			**L**	**L**		**M**	**M**	**M**	**H**	**M**	**M**	**M**

Scale: H – High M – Medium L – Low

5 OTHER USEFUL INFORMATION

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5. OTHER USEFUL INFORMATION

5.1 GETTING HELP AND ADVICE

Students are expected to discuss any issues or problems they have regarding the academic programme with their Academic Advisors or the Level Coordinators. In addition, they can seek assistance from the lecturers and the Head of Department. Problems or issues common to many students may be best resolved through the Batch Representatives at the Student Liaison Committee Meetings chaired by the Dean, Faculty of Engineering. All students are encouraged to talk about any problems encountered during the stay in the Department with the relevant staff members early, before the problems become complicated and difficult to handle.

The University has a Chief Student Counsellor and a group of Student Counsellors who are available to help in matters other than those directly related to your studies. Student Counsellors who are in the Department of Civil Engineering are listed below.

5.1.1 STUDENT COUNSELLORS IN THE DEPARTMENT OF CIVIL ENGINEERING

Dr K. Baskaran	Room CE 128
Prof. J. M. A. Manatunge	Room CERC F1/B/D9
Prof. R. L. H. L. Rajapakse	Room UMCSAWM Ground Floor

The University has a Professional Counselling Service for students having problems of a serious nature. Please seek help from the Academic Adviser, Level Coordinator, a Student Counsellor or any staff member in the Department, who would direct you to the relevant person. Any matters that remain unresolved can be discussed with the Dean, Faculty of Engineering or the Vice-Chancellor.

5.2 SAFETY IN THE DEPARTMENT

The Department of Civil Engineering is committed to provide a safe environment within the Department and is continually improving the safety standards within Laboratories and other areas. All Technical Staff have been trained in Fire Safety and First Aid, and Fire Exits are clearly marked in the building. All Laboratories are expected to practise safety precautions in handling equipment, chemicals and other hazardous materials. All students working in the laboratories are required to be aware of the safety practices needed to be followed within the laboratory. First Aid Boxes are available at each Level of the Civil Engineering Building.

5.2.1 SAFETY OFFICERS OF THE DEPARTMENT

Dr K. Baskaran	- Lecturer in-charge
Mr E. K. Zoysa	- Analytical Chemist- Environmental Eng. Laboratory
Mr H. W. Kumarasinghe	- Senior Staff Technical Officer - Hydraulic Eng. Laboratory
Mr T. P. G. D. I. Yohan	- Technical Officer – Structural Dynamics and Health Monitoring Laboratory
Mr D. M. N. L. Dissanayaka	- Tech Officer – Structural Testing Laboratory
Mr U. K. Padmaperuma	- Tech Officer - Highway Eng. Laboratory

5.3 CIVIL ENGINEERING SOCIETY

Civil Engineering Society is the main official body looking after the welfare of students in the Department of Civil Engineering.

Civil Engineering Society (CES) was inaugurated in 1986 and has been an active contributor to the Department ever since. CES is an integral part of the Civil Engineering Department, always exploring the possibilities of upgrading the students' life in the department.

Civil Engineering Society, University of Moratuwa is the main society in the Department of Civil Engineering. Up to now Civil Engineering Society has done many things for the betterment of both students and the department. One of the main purposes of the society is to enhance the image of the Department of Civil Engineering among society at large and to assist in continually improving the quality of the courses in Civil Engineering. Society assists students having particular needs to succesfully complete their studies in Civil Engineering. Besides academic activities, annually Civil Engineering Society is organizing several students events and community service projects in order to give the students an opportunity for the personality development. "Civil Padura", "Civil Ape Awrudu", "Suhastha", "Meth Mihira", "Piyaman" are some of the events organized by the society. By those events, capabilities of students can be identified and it gives the opportunity to promote their leadership skills and professionalism. Further, in order to keep the Department of Civil Engineering at top of the field, Civil Engineering Society organizes both "Spaghetti Bridge Competition" and "INSEE Concrete Mix Design Competition" aiming the Techno exhibition. And there are technical

and soft skill development programs such as “Skill-up with CES”, “Inflexion” organized by the Civil Engineering society to improve the skills of undergraduates. The society is led by the Patron (Head of the Department), Senior Treasurer and Staff Advisor from the staff and from students, President, Secretary, Junior Treasurer, Vice President, Assistant Secretary and chairman of each committee. Currently, there are eight committees under the society which are Executive Committee, Internal Affairs Committee, External Affairs Committee, Public Relations Committee, Panel Discussion Committee, Editors, Coordinators and Media Crew. Civil Engineering Society promotes, explores and assists in the development of new career opportunities for civil engineering graduates and also society promotes professional interest with regards to Civil Engineering among its members. Further, society raises and mobilizes resources for the development of Civil Engineering specially at the University of Moratuwa.

5.3.1 ACTIVITIES OF CES

- CES holds an AGM annually, where the new office bearers are elected for a tenure of 12 months
- Organize industrial workshops in collaboration with professional bodies having presentations and interactive sessions with students
- Organize guest lectures by inviting key personalities from the industry
- Carrying out charity projects to encourage students serve society
- Organize fundraising activities such as Film Festivals

5.3.2 SERVICES PROVIDED BY THE CES

- Running the CES bookshop and the photocopy centre
- Running the department canteens
- Provide newspapers at final year lecture room and in common reading stand
- Providing loans for students in need

In addition to above services and activities, CES works in close collaboration with the industry in developing the skills of students, giving career guidance and help in addition to organizing many activities that will help familiarize students with society in Sri Lanka.

5.3.3 COMPETITIONS, STUDENTS ACTIVITIES AND COMMUNITY PROJECTS

Competitions

Civil Engineering students compete in the annual "Spaghetti Bridge Competition" organized by IESL and the "Concrete Mix Design Competition" organized by Siam City Cement. Initially both intra university competitions are organized in the department by the Civil Engineering Society and the winners will get the opportunity to participate in the inter university competition of both Spaghetti Bridge Competition and Concrete Mix Design competition in National Engineering and Technology Exhibition (Techno), organized by the Institution of Engineers, Sri Lanka (IESL). As the department of Civil Engineering we have won both of these competitions in the past. In 2017, our department achieved both 1st place (13th Batch) and 4th place (16th Batch) in the Spaghetti Bridge Competition after competing with other university teams. Also, in the same year we won the 1st place (13th Batch) in Concrete Mix Design competition as well. So, in 2017, department of Civil Engineering was capable to conquer both major competition in the field of Civil Engineering. Also, students are participating in the "Emerging Civil Engineer Award Competition" which is organized by

Sri Lanka Association of the Institution of Civil Engineers Student Chapter (SLAice). In 2018, five students from our department were capable to reach the finals by competing with around 10 universities and T.M.P. Malshan (15th Batch) won the 2nd place for his innovative project related to traffic engineering.

Spaghetti Bridge Competition 2022

INSEE Concrete Mix Design Competition 2018

Student Activities

The students are not only capable in technical activities but also in many other extracurricular activities linked with creativity, teamwork, and leadership. To optimize those activities there are several activities in the Civil Engineering department for the student for their personality development. Some events such as; "Civil Ape Awrudu", "Civil Padura", "Civil Nite", "Civil Cric Fiesta" and Welcome for a new batch are organized by the Civil Engineering Society. In addition, several community service projects are being organized by each batch while doing their academic work.

Civil Cric Fiesta 2022

Civil Night 2018

Welcome Batch 18

Civil Padura 2022

Civil Ape Awrudu 2017

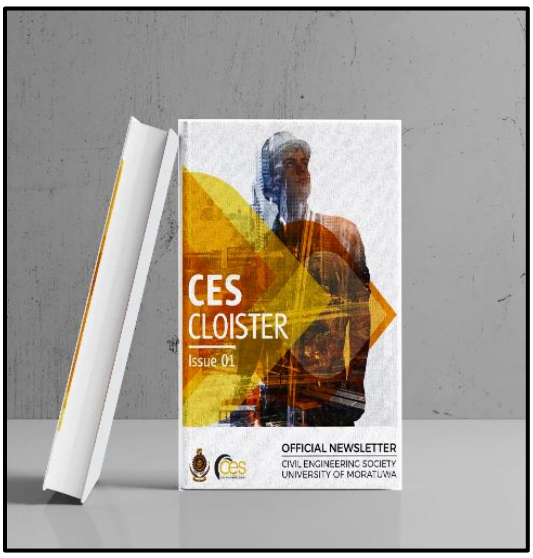
Undergraduates' Skills Development Projects

To improve the skills of the undergraduates, there are technical and soft skill development programs such as Skill-up with CES, Inflexion. In those programs industry experts from the civil engineering industry and other verticals will share their experiences with our undergraduates. This helps to develop the subject understanding, communication skills and other needed skills. Apart from that, these seminars help to identify the opportunities in the job market and the skills needed to be developed to perform certain tasks successfully.

Furthermore in the past year, the Civil Engineering Society of the University of Moratuwa published the first ever Newsletter of CES reaching another milestone that they were planning for years. In the newsletter a brief overview about the projects that are carried out through the CES, the articles, poems, puzzles other creative works done by department undergraduates are published.

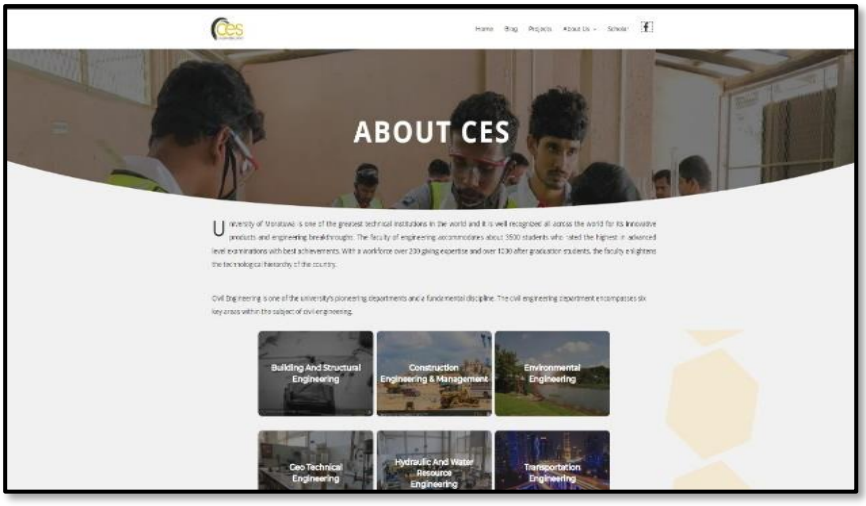
At the same time, we launched our new website to provide society, staff and students with a more intuitive and user-friendly experience that clearly states who we are, what we stand for, and what we can achieve for the entire society.

Skill- up with CES



Official Newsletter

Inflexion 2021



CES website

Community Service Projects

As community service projects Department of Civil Engineering organizes several events with the collaboration of Civil Engineering Society. Piyaman, Suhastha, Methmihira are some of the community service projects.

Meth Mihira 2018

Piyaman 2018

Suhastha 2021

Activity list of the Department and the respective batch responsible for organizing,

- Civil Padura - Level 03 (Semester 7)
- Civil Nite - Level 04 (Semester 8)
- Civil Cric Fiesta - All Batches
- Civil Ape Awrudu - Level 02 (Semester 3)
- Welcome of the new batch - Level 02 (Semester 4)
- Meth Mihira - Level 03 (Semester 5)
- Piyaman - All Batches
- Suhastha - Level 02 (Semester 4)
- Pirith Ceremony - All Batches
- Carol service - All Batches
- Skill- Up with CES - All Batches
- Inflexion - Level 03 (Semester 6)
- Official newsletter - All Batches
- The Spaghetti Bridge Challenge - Level 03 (Semester 5)

5.3.4 OFFICE BEARERS OF CES IN 2022/23

Patron

Prof. (Mrs) Chintha Jayasinghe	Room : CE 108 Ext: 2001

Senior Treasurer

Dr. H.L.K Perera	Room : Road Safety and ITS Lab Ext: 2219

Staff Advisor

Dr. Pasindu Weerasinghe	Room : CE031 Ext: 2015

Office Bearers

President	
Mr. Malith Pahasara	Contact: 0719287840
Secretary	
Mr. Dhyan Chandeepa	Contact: 0714890902
Junior Treasurer	
Mr. Sasith Anupama	Contact: 0776290045
Vice President	
Mr. Dilshan Sanitu	Contact: 0717042093
Assistant Secretary	
Ms. Paboda Jayawardane	Contact: 0761890347

Civil Engineers:

plan, design, construct, operate, and maintain facilities and systems that serve the basic needs of society. Engineering, in general, is a problem-solving profession, and Civil Engineers focus their problem-solving capabilities on making our surroundings better places to live. Civil Engineers are frequently involved in city planning and in managing the use of natural resources. They face the challenges of meeting society's needs while protecting the environment thus ensuring sustainable development. Civil Engineering is a people-serving profession that provides a great deal of pride and achievement...!

Building & Structural Engineering

Buildings and bridges, structural forms, concrete technology, construction materials, structural dynamics and health monitoring, deployable structures, structural retrofitting, computational mechanics

Hydraulic and Water Resources Engineering

Hydrology and water resources, coastal engineering, design of water supply schemes, river and canal modelling & flow analyses, pump & turbine operations, dam & spillway designs

Geotechnical Engineering

Foundation of structures, earth retaining systems, environmental geotechnics, landslide studies, Soil-structure interaction, rock mechanics, ground improvement, unsaturated soils, energy geotechnics

Construction Engineering & Management

Project Management, construction materials and methods, disaster management, building services, IT applications in construction, building performance and occupant comfort, sustainable design

Environmental Engineering

Water & wastewater treatment, environmental impact assessment, environmental sustainability & law, air & noise pollution & their control, solid & hazardous waste management

Transportation Engineering

Traffic engineering & management, pavement design, road safety, highway construction & maintenance, transport systems planning & operations, advanced computer simulations