INSTITUTE OF TECHNOLOGY OF CAMBODIA
GRADUATE SCHOOL

MASTER OF WATER AND ENVIRONMENTAL ENGINEERING (M-WEE)

CURRICULUM

2022

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1. Background

In 2012, ITC launched the master program of Water Resource Engineering which was under department of Rural Engineering (now become Faculty of Hydrology and Water Resources Engineering). In 2017, the graduate program in ITC is modified to comply with the five-research thematic. Among those five thematic, Water and Environment is the leading research field in ITC. Along with the need on human resource in this engineering field, the graduate school decided to develop the new master program which is called Master of Water and Environmental Engineering (MWEE). The master program has become a thematic-based engineering master degree at ITC. The existing Master program of Water Resource Engineering is modified to be a specialization and added the other two specializations which are Urban Water and Sanitation Engineering and Environmental Engineering and Management to be under this Master program. In 2018, the specialization of Urban Water and Sanitation Engineering has been supported and funded under European Union - Agence Française de Développement (EU-AFD) until 2023. From 2021-2023, the master program of MWEE has been supported under Higher Education Partnership Program of the Higher Education Improvement Project (HEIP) with the partnership of Chulalongkorn University to improve the program to modes program.

1.1. SWOT analysis of the current program

The SWOT analysis through a survey discussion with alumni and relevant stakeholders were conducted in 2021. The following table shows the SWOT analysis of the master program.

Table 1. SWOT analysis – Strengths and Weaknesses of existing M-WEE program.

Strength	
Financial support	• Financial support from AFD and HIEP project until 2023 for the master program of Urban and Sanitation Engineering.
Leadership	• Leadership team with great motivation to lead the program toward the international reputation.
Reputation	• The reputation of the ITC school is strong in the local and international context. One Myanmar and French students have graduated from the master program and many other foreigner students from Indonesia, Laos, Vietnam, Africa contacted us for scholarship study.
Flexible curriculum	• Flexible curriculum allows students to engage in different pathway program such as course and research-based program and research-based program. From 2021-2022 academic year, the program has launched the research-based pathway. This has great attraction for many students of ITC to join this. There are 7

	students join this academic year of 2020-2021. And one from the owner of a water supply company. That is a good sign of the program among the private industries.
Lecturers	• Highly qualified and dynamic teaching staffs. They provide sound scientific and technological knowledge for professional life to the master students. They have had grant to support students for research thesis.
Expertise	• The program is known as the leading academic and research experts in the field of water and environmental engineering.
Market need	• High market needs in the field of WASH sector both public and private sectors.
Graduation rate	• Successful 4-year graduation rates since 2018-2021.
Weakness	
Scholarship/Project grant	• Financial limitations and support. The current course-research based program depends heavily on the scholarship sponsor from AFD that will be end by 2023.
Instructors	• Some instructors' expertise is not fit to the courses designed.
Laboratory	• The laboratory activities of each course are still limited.
Study duration	• One-year system that request one semester for course and one semester for research is very limited the research period for course-research based study.
Research thesis qualification	• The research scope for qualified graduate is required to strengthen for ensuring the graduated student quality.
A mandatory internship or a field-implemented project	• A mandatory internship or a field-implemented project where students can demonstrate the knowledge, they are learning in the classroom would make their candidacy stronger. (Comments from companies and intentional organization)
Marketing	• Lack of awareness of the master program in the private sectors and public institutions. (Some provincial departments did not know about the program until we met them to show the program.). • Marketing strategy and skills are still limited to produce video for promoting the master program.
Teaching and learning methods	• It is heavily on lecturer-center study methods. The student center method should be enhanced.
Job Market	• Some master graduates commented having difficulty to find a job to match the field in a short time period. Limited industry linkage cooperation for being ready for the students to catch the

	job. No event/workshop to recruit the position of the fresh graduates. • Some lecturers advise also that to connect with market network, **industry internship** is important to let the students, lecturers and industry work together.
Competency	• Competency should be well defined for each course and align with the competency of the program.
Professional Management Skills	• Because the lecturers have less experience in the industries, therefore there are lacking on management part in their courses. Therefore, **Guest lectures/seminars** are important for the students to understand the experience from experts from potential industry. It will be more attractive for their future professionalism and job market network with industry.
Study space	• Limited study space for research-based students
Research sources	• Poor access to scientific literature
Quality assessment	• Internal quality assessments are not yet totally implemented.
Opportunities	
Partnerships and Grants	• There are great opportunities to extend more collaboration and partnerships both international and local stakeholders in the field of water and environmental engineering. GIZ, JICA, ADB are the potential partnerships for the further collaboration. Opportunities to collaborate with other donor stakeholders such as IRD.
Internship and industry linkage	• There should have an active collaborating with companies and public entities, namely through Projects/Internships as team work. This will create new opportunities for students, promoting multidisciplinary and multicultural teamwork.
Competency based pathway	• Competency or module-based pathway can be another study pathway that opens to different needs of the market need.
Solid waste management	• Solid waste management should be enhanced in the master program. • After a survey, the organizations mentioned in looking for expertise in the following area, e.g., fecal sludge management (on-site waste treatment) and solid waste management (trash disposal, recycling, and reuse) • They emphasized on other desired skills including computational analysis, critical thinking, ingenuity, presentation and writing skills, etc.
Threat	

Tuition fee	• Will we need to raise tuition or fees to support our growth after 2023 after reforming the program?
Pandemic impact	• Covid-19 continuity would limit the opportunities for many students

1.2. Analysis of Market Survey

The survey of the interest for the master program is conducted with participants joining the promotion of Master Program, MWEE. The graphics below show the correspondences from survey.

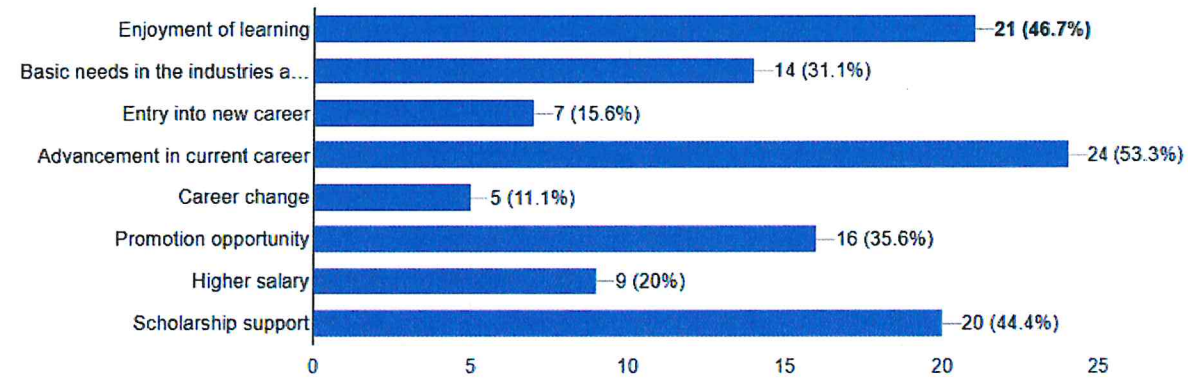

Figure 1 The reasons to choose the program

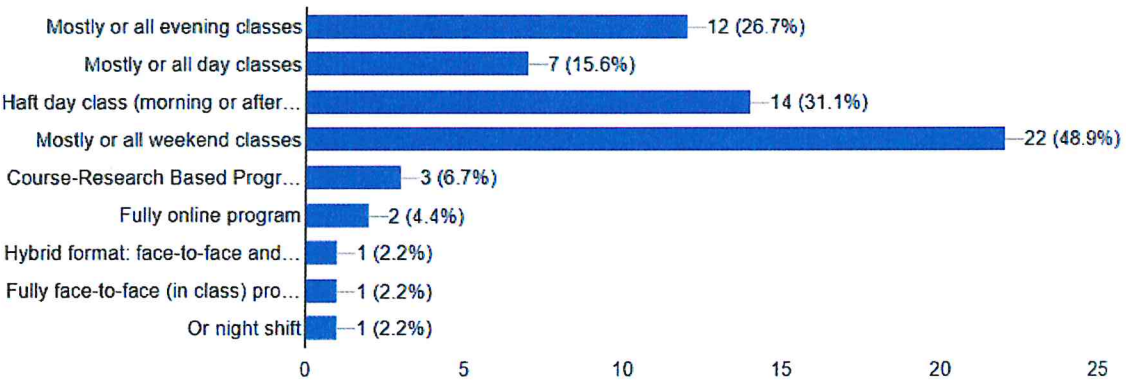

Figure 2 Preference of study time

1

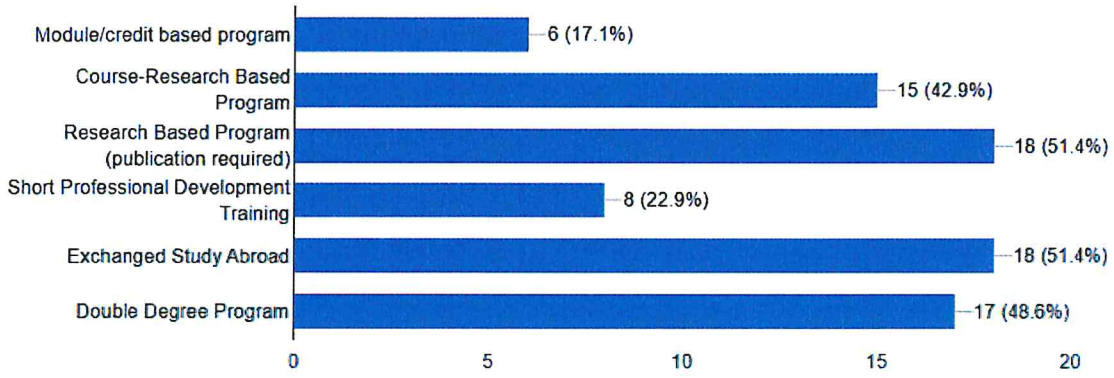

Figure 3 Preference of the pathway

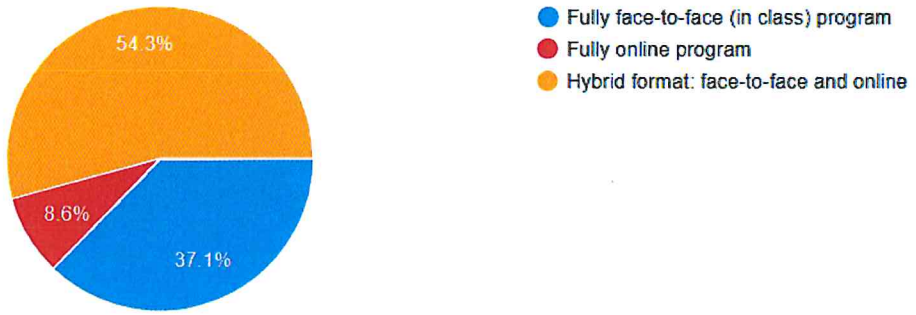

Figure 4 Preference of the teaching class method

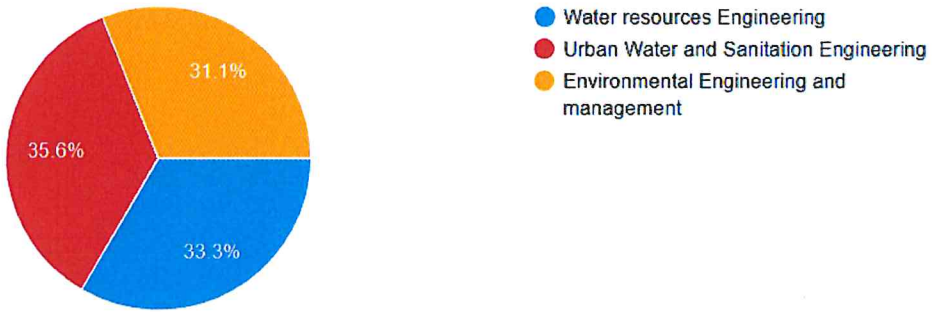

Figure 5 Preference of the 3 specializations of the MWEE

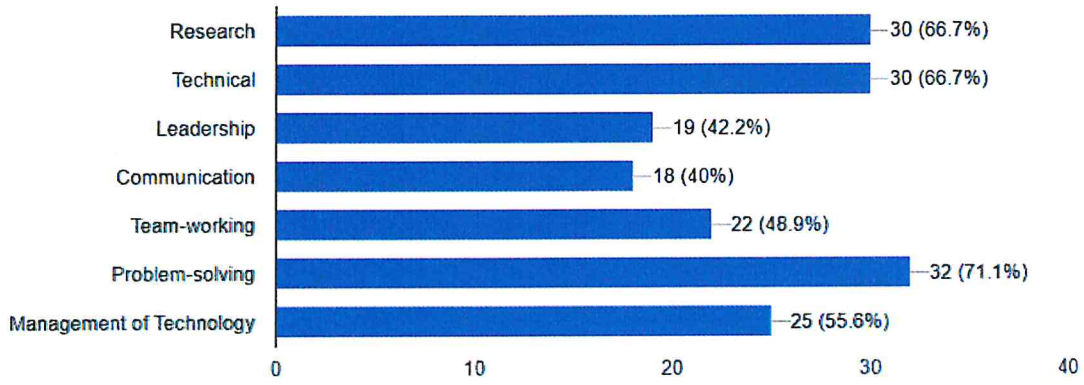

Figure 6 The most important skills for the career of the correspondents

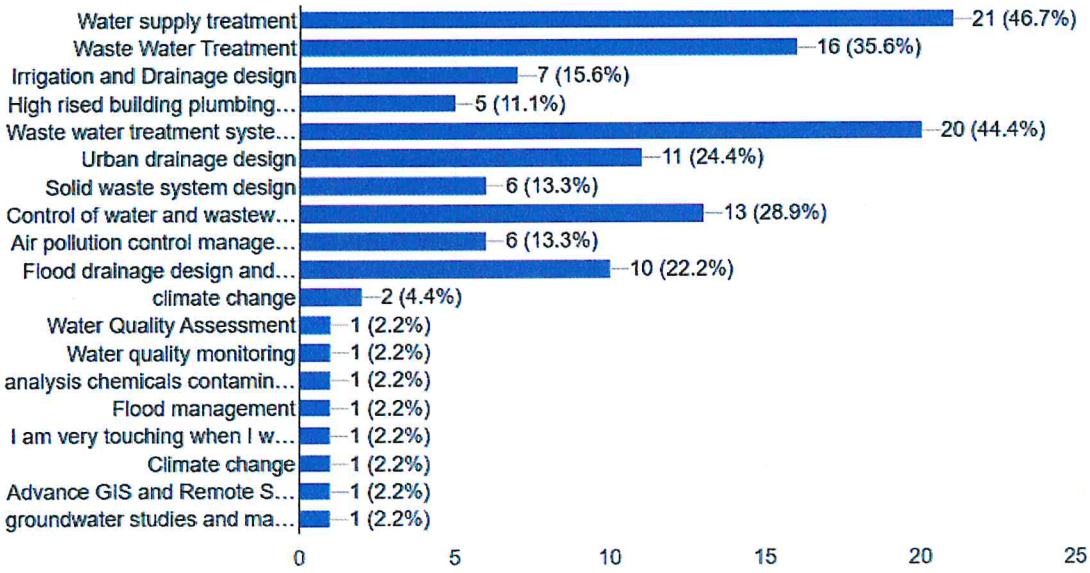

Figure 7 Preference of technical skills

2. Proposition to update current curriculum

2.1. Description of updated program

The global change puts pressure to the environment in which water always be the major problem. The overall program looks for solutions to environmental problems, such as global change impact, water crisis, water supply and sanitation, wastewater treatment and disposal systems, air pollution, solid and hazardous wastes, waste minimization, and environmental impact assessment and audit to promote sustainability in our business and in our community through the ongoing development of environmentally responsible practices.

The program is designed to train the master students learn not only technical skills but also management capacities with critical thinking following the requirement of educational quality framework of Cambodia for higher education in science and engineering.

The graduate program on Water and Environmental Engineering at Institute of Technology of Cambodia (ITC) shall be a leading international engineering program in the region to support higher education, research and technology innovation that serve the nation and improve the quality of life. The missions of the program are:

- To produce skillful and knowledgeable human resources with responsible stewardship and ethic that useful for the nation to address challenges in striking a balance between serving socio-economic and protecting the environment.
- To promote proactive, green and clean development that respond to environmental problems through enhancing interdisciplinary and multi-sectoral initiatives research collaboration and university industrial and societal linkage.
- To keep improving the teaching and learning environment and facility for internationalization and attraction to local and foreign students.

The Master Program of Water and Environmental Engineering (MWEE) offers three specializations:

1. Water Resources Engineering (WRE)
2. Urban water and Sanitation Engineering (USE)
3. Environmental Engineering and Management (EEM)

2.2. Program Educational Objectives (PEOs)

The objectives of the Master Program of Water and Environmental Engineering to provide the graduates of the program with the:

- **PEO1**: An advanced, scientific and technical knowledge, in-depth understanding and competent with strong capabilities to professionally work in the field of water and environmental engineering to address challenges with consideration of a balance between serving socio-economic and protecting the environment for sustainable development.

- **PEO2**: An ability to master, design conduct and publish their original research by applying critical and creative thinking skills and problem-solving strategies to address the key issues in a variety of situations in water and environmental context and engaging interdisciplinary and multi-sectoral research collaboration and university-industrial linkage.
- **PEO3:** Leadership, entrepreneurship innterpersonal development skills with morals values and ethical to fulfil social responsibility in their professionalism.

2.3. Program Learning Outcomes: PLOs

Program Learning Outcomes are the following:

a. Knowledge

PLO1: Demonstrate mastery of advanced scientific and technical knowledge and deep understanding of concepts, theories of mathematics, science, engineering fundamentals, and research required to find innovative engineering solutions to current and emerging water security and disaster challenges with covering the most important aspects of water resources engineering such as stormwater management, modeling of hydrological processes, advanced irrigation and drainage and hydropower development.
PLO2: Demonstrate mastery of the advanced scientific and technical knowledge required in the field of urban water and sanitation engineering with the key technologies of water supply, sanitation and solid waste management, wastewater treatment as well as urban storm water management in cities for addressing the critical current and future challenges of climate change, population growth and urbanization.
PLO3: Demonstrate mastery of an advanced scientific and technical knowledge required to solve a wide range of environmental engineering challenges including water supply, waste water treatment, hazardous waste management, air pollution control, agricultural waste management.

b. Cognitive skills

PLO4.: Apply the 21st century skills such as critical and creative thinking and problem-solving strategies in addressing key issues in a variety of situations in environmental context.
PLO5: To initiate, identify, plan and execute a substantial research-based engineering project and experiment using appropriate and feasible research methods and tools for critically analyzing and interpreting reaching substantiated conclusions on the relevant sustainability, innovation, change, planning, and reflecting critically on professional practice.
PLO6: Apply ethical principles and commit to integrity, empathy, professionalism ethics and fulfill their social responsibilities by following standards, regulations, procedures, norms, and practices related to environmental engineering practices.

c. Psychomotor skills

PLO7: Demonstrate awareness and understand of the role of professional engineering and the impact of professional engineering solutions in societal and environmental contexts for sustainable development.

d. Interpersonal skills and responsibilities

PLO8: Apply quantitative skills and create, select, apply and integrate appropriate modern engineering and IT tools, resources, and digital technologies for prediction and modeling, computations, simulations, analysis design and interpretation to complex engineering activities with understanding of the limitations in addressing issues related to water and environmental engineering context.
PLO9: Demonstrate managerial and entrepreneurial skills with effective work in teams in diverse environments.

e. Communication, Information technology, and numerical skills

PLO10: Demonstrate their ability to apply scientific written and oral communication skills at high level and convey and transfer their scientific ideas and original research results to a range of specialist and nonspecialist audiences, professional scientists and to the public and to publish their research in national and international scientific journals.

PLO11: Demonstrate their long-life learning through upskill and reskill to improve their professionalism in the context of changing world.

Table 1. Mapping of the relationship between PEOs and PLOs

PLO\PEO	PEO1	PEO2	PEO3
PLO1	F	F	
PLO2	F	F	
PLO3	F	F	
PLO4	F	F	F
PLO5	F	F	
PLO6			F
PLO7			F
PLO8	F	F	
PLO9			F
PLO10	F	F	F
PLO11	F		F

2.4. Program Structure

Based on the educational qualification framework of Cambodia, for master's degree program of engineering, the students are required to pass 45 to 57 credits. The credit requirement for the program needs to be complied with the qualification framework of ministry of education youth and sport of Cambodia.

This master's degree offers two years. It will accept the applicants from two categories which are ITC students and non-ITC students. ITC students referring to those who graduated Engineering degree from ITC with Faculty of Hydrology and Water Resources Engineering, Faculty of Chemical and Food Engineering, Faculty of Civil Engineering and Faculty of Geo-resources and Geotechnical Engineering. Non-ITC student refers to those who graduated bachelor's degree from other university/institute aside from ITC, but their background must be in the field of science and engineering related to water and environment, chemical engineering, agriculture engineering, and chemistry and biological Science and engineering. Figure 8 shows the structure of the two-year program for 1st year (M1) and 2nd year (M2).

2.5. Study pathway and credit principle

The new program of MWEE offers Coursework and research-based pathway and Research-based. Both pathway programs consist of core course, elective course, specialized course and research-oriented course. Number of credits requirement in each course categories is different between Course-Research Based and Research-Based pathways. However, the total minimum requirement for the number of credits is set to be 54 credits which is the same for both pathways.

As principles for each course in the curriculum, the number of credits is divided as follows:

- 16 hours of Lectures equal to 1 credit
- 32 hours of Tutorial equal to 1 credit
- 32 hours of Laboratory work equal to 1 credit
- 48 hours of Self-study equal to 1 credit

A-Coursework and research-based pathway

The total credit requirement by the coursework and research-based pathway is 55 credits. It includes 43 credits of coursework (minimum requirement based on qualification framework is 33 credits) and 12 credits of thesis. ITC student is required to take 1 year (start from Year 2) and Non-ITC student is required to take 2 years (start from year 1). **Table 2 and Table 3** show the summary of credits required and the distributed credits for the 2 years.

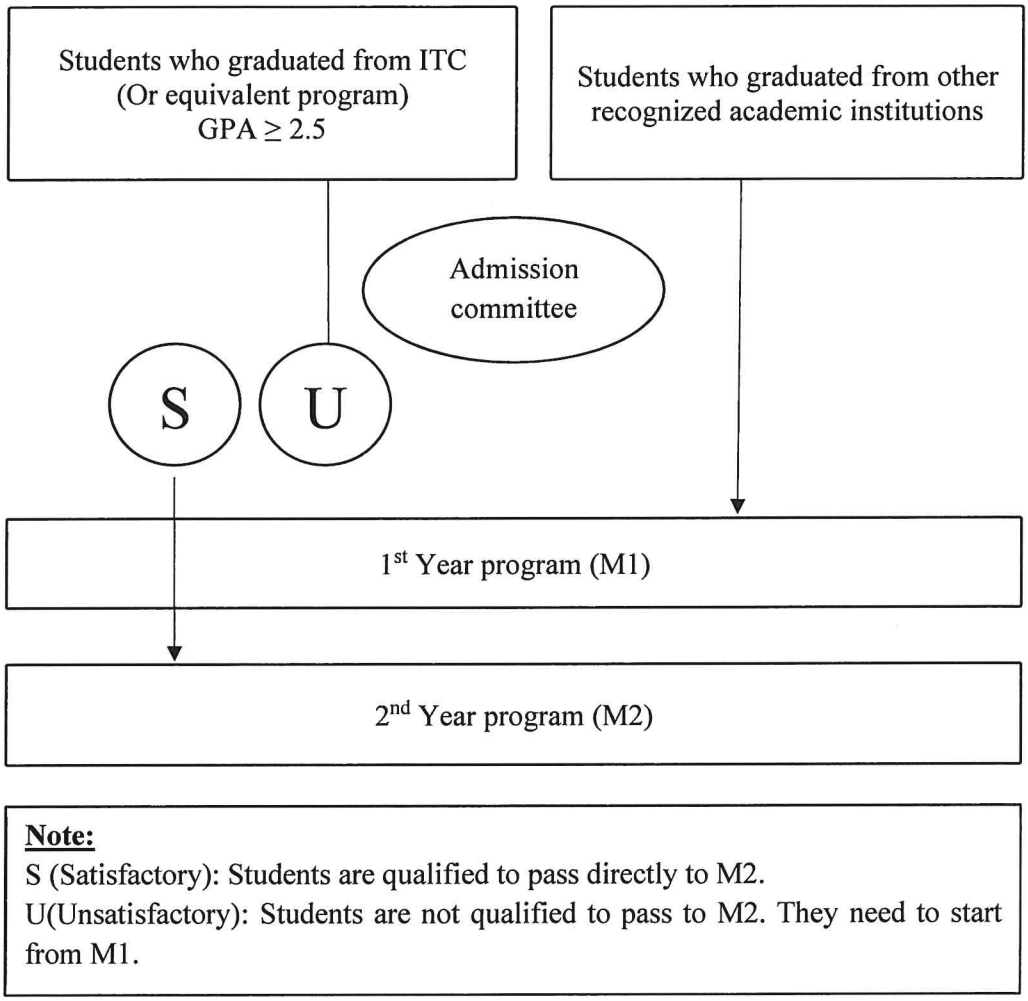

Figure 8 Structure of the master program

Table 2. Summary of credits requirement for coursework and research pathway

(Coursework + research pathway)	
Complete and pass a series of courses of 40 credits minimum	
Core Courses	13 credits
Research-oriented Courses	6 credits
Specialization courses	18 credits
Elective courses	8 credits (min)
Research activities 12 credits minimum:	
Presentation in scientific conference	Required
Research Thesis:	12 credits

Table 3. Distributed credit requirement for coursework and research-based pathway.

Description	Year 1 (M1)		Year 2 (M2)	
	Semester 1	Semester 2	Semester 1	Semester 2
Core course	7		4	
Elective Course	2	4	2	
Specialized Course		8	10	
Research Oriented Course	4		2	
Research Proposal				3
Scientific conference with presentation				3
Master Thesis and Defense				6
Total in each Semester	13	12	18	12
Total in each Year	25		30	
Total number of credits	55			

B-Research based pathway

The total credit requirement by the coursework and research-based pathway is 54 credits. It includes 12 credits of coursework and 33 credits of research activities. ITC student is required to take 1 year (start from Year 2) and Non-ITC student is required to take 2 years (start from year 1). **Table 4** and Table 5 show the summary of credits required and the distributed credits for the 2 years.

Table 4. Summary of credits requirement for research-based pathway requirement

Research-based pathway	
Complete and pass a series of courses of 12 credits minimum	
Major Course:	6 credits
Research-oriented Course:	6 credits
Research activities 42 credits minimum:	
Primary research report and defense:	9 credits
Detailed research proposal defense:	3 credits
Gradate Seminars:	3 credits
Presentation in scientific conference:	3 credits
Publication:	6 credits
Research Thesis:	18 credits

Table 5. Distributed credit requirement for coursework and research-based pathway.

Description	Year 1 (M1)		Year 2 (M2)	
	Semester 1	Semester 2	Semester 1	Semester 2
Major Course (6 credits min.)				
Elective Course	2			
Specialized Course	4			
Research Oriented Course (6 credits min.)				
Research methodology	2			
Applied Statistics			2	
Scientific Communication			2	
Research activity for Thesis (33 credits min.)				
Primary research report and defense		9		
Detailed research proposal defense			3	
Graduate Seminar I		1		
Graduate Seminar II			1	
Graduate Seminar III			1	
Presentation in scientific conference			3	
Publication				6
Thesis				18
Total in each Semester	8	10	12	24
Total in each Year	18		36	
Total number of credits	54			

2.6. Specializations

The Master Program of Water and Environmental Engineering (MWEE) offers three specializations

i) Water Resources Engineering (WRE)
ii) Urban water and Sanitation Engineering (USE), and
iii) Environmental Engineering and Management (EEM).

The following session describes the details of each specialization.

2.6.1. MWEE in Water Resources Engineering

2.6.1.1. Program Objective

Water Resources Engineering focuses on basin management, provide water resources planning, modeling and design, and construction management services for water resources projects. The specialized courses for Water resources engineering will provide the students with knowledge and skill to conduct investigations including water quality evaluations and basin management studies, and provided water resources planning, modeling and design, and construction management services for water resources projects.

2.6.1.2. Career Opportunity after Graduation

Students who graduated with the specialization in water resources engineering will become a potential with engineering related jobs that require knowledge of irrigation, hydrology, fluid mechanics or water related development projects. Experts in water resources engineering might also work as city planners, consultant.

2.6.1.3. Courses

The coursework in Water Resources Engineering (WRE) is classified into 4 main components: core, elective, specialized, and research-oriented courses (**Table 7**).

Table 6. Coursework and research pathway requirements in Water Resources Engineering

Core Courses	**Elective Courses**	**Specialized Courses**	**Research-oriented Courses**
1. Hydrology **2.** Applied Statistics **3.** GIS and Remote Sensing for WEE **4.** Entrepreneurship **5.** Project Management	1. Hydrologeology 2. Hydraulic Structure 3. Water Chemistry 4. Environmental Monitoring and Modelling 5. Water Policy and Planning 6. Earth Dam Design & Construction	1. IWRM and Watershed Management 2. Water Quality Assessment and Management 3. Processes Engineering 4. Irrigation and Drainage 5. Agricultural Water and Irrigation System Management	1. Research Methodology 2. Seminar on Water and Environmental Engineering 3. Water and Environmental Laboratory 4. Mini-Project 5. Internship 6. Professional Lecture

	7. Water Induced Disaster Risk Assessment 8. Urban Pollution Control 9. Climate Change Impacts and Adaptation 10. Sustainable Solid Waste and Hazardous Management	6. Urban Flood Management and Disaster Risk Mitigation 7. Water Resources System Engineering 8. Sustainable hydropower development	

2.6.1.4. Program structure

Table 7. Number of credits in each coursework in Water Resources Engineering

First Year			
Semester 1		**Semester 2**	
Course	**Credit**	**Course**	**Credit**
Hydrology	2	IWRM and Watershed Management	2
Project Management	2	Processes Engineering	2
GIS and Remote Sensing for WEE	3	Irrigation and Drainage	2
Research Methodology	1	Water Quality Assessment and Management	2
Seminar on Water and Environmental Engineering	1	Elective Course	4
Water and Environmental Laboratory	2	Internship	2
Elective Course	2		
Second Year			
Entrepreneurship	2	Research Proposal	3
Applied Statistics	2	Scientific conference with presentation	3
Agricultural Water and Irrigation System Management	3	Master Thesis and Defense	6
Urban Flood Management and Disaster Risk Mitigation	2		

Water Resources System Engineering	3		
Sustainable hydropower development	2		
Mini-project	2		
Professional Lecture	2		

2.6.1.5. Course description

Table 8. Description of each course in Water Resources Engineering

No	Code	Course	Description
1	GSCM11HDL	Hydrology [CHHUON Kong]	This course will provide the student with an understanding of the hydrologic components and hydrologic events and the routing of flows through systems. This course will introduce the practice of surface water hydrology as water plays a role in the development of most human activities. Various land phase hydrologic processes will be described. Methods of development of intensity-duration-frequency (IDF) curves for rainfall, estimation of rainfall at ungauged locations, stream flow measurement methods, and flood frequency analysis will be discussed. Student will also learn various hydrologic and hydraulic models used in the professional domain. Based calculations within various hydrologic procedures as required for addressing surface water hydrology issues will also be covered. This course is recommended for non-ITC student and ITC students who are not from Faculty of Hydrology and water Resources Engineering.
2	GSCM11PRM	Project Management [BUN Kimngun]	This course provides a systematic and thorough introduction to all aspects of project management. Therefore, the course underlines the importance of understanding the relation between projects and the strategic goals of the organization. The course also discusses the technical, cultural, and interpersonal skills necessary to successfully manage projects from start to finish. It emphasizes that project management is a professional discipline with its own tools, body of knowledge, and skills. Concepts are reinforced by case studies covering a wide variety of project types and industries.
3	GSCM11GIR	GIS and Remote Sensing [Ann Vannak]	This course provides students with the principles of geographic information systems (GIS) and remote sensing, and the application of these techniques to the water resources and environmental engineering. The first part of the course focuses on GIS, where the structure and format of GIS data, data input and transformation, database compilation, and the use of search criteria and spatial modelling to carry out suitability mapping are examined. In remote sensing, it would be a introduction which capture and processing of satellite images, and how data from various satellite platforms are used in the environmental and life sciences. The course is strongly computer-based, and students will gain experience in the use of ArcGIS and remote sensing software. On successful completion of the course students will be able to:

			- Understand more on impotency and know the application of GIS and RS for Water and Environmental Engineering - Understand the principles of remote sensing and digital image processing; - Gain experience in the applications of remote sensing and GIS to solving problems in the environmental and life sciences; - Gain experience in the use of image processing and GIS software. Use ArcGIS and Spatial Analyst tool for environmental mapping such as map of water quality
4	GSCM11REM	Research Methodology Research Methodology [PENG Chanthol & MASSUEL Sylvain]	The primary objective of this course is to develop a research orientation to the students and to acquaint them with fundamentals of research methods. Specifically, the course aims at introducing them to the basic concepts used in research and to scientific social research methods and their approach. It includes discussions on sampling techniques, research designs and techniques of analysis. Some other objectives of the course are: - To demonstrate knowledge of research processes (reading, evaluating, and developing); - To identify various sources of information for literature review and data collection. - To develop an understanding of the ethical dimensions of conducting applied research. Appreciate the components of scholarly writing and evaluate its quality.
5	GSCM11SWE	Seminar on Water and Environmental Engineering [KET Pinnara & HANG Leakhena]	The seminar arms to make the student to understand more on the thematic of Water and Environment and make the student to feel more curious for research on the related topics. The seminar will: - Discussion of special topics related to environment and water resources engineering; analysis of data and conclusion; presentation of reports Invited speakers from government industry and various professionals will present these seminars. Every student is expected to present a paper on his own research interest.
6	GSCM11WEL	Water and Environmental Laboratory [TY Boreborey & PENG Chanthol]	Water and Environmental Laboratory to develop sampling and analytical skills of the students which are required in environmental monitoring. Through this course, the students will be able to perform quantitative analysis of various physical, chemical and biological parameters involved in water, soil and microbiology research. The course will also be giving an opportunity to the students to learn how to use and calibrate measurement devices, how to conduct experiment, and how to write a report that justify the theory and to develop their practical skills.
7	GSCM12IWM	IWRM and Watershed Management [KET Pinnara & HANG Leakhena]	Upon completion, the participant should be able to: - describe the main natural and anthropogenic interactions at a watershed scale; and how they can be aggregated to river basin scale - understand the watershed planning and management approaches, specifically in terms of soil and water management

			- characterize the fundamental economic issues in watersheds and river basins and the role of economic valuation of acquatic ecosystem services in watershed and river basin management - understand the concept of sustainable hydropower structural design and low impact development Feasibility study on hydropower development and monitoring system to prevent hazard.
8	GSCM12PRE	Processes Engineering [TY Boreyborey & EANG Khyeam]	This course will cover the theory of molecular diffusion and mass transfer; fundamental of phase equilibrium; mass transfer operation and separation process; interface mass transfer; absorption and desorption; adsorption and ion exchange; distillation; physical separation process; membrane separation process; finishing process. It is essential for urban water and sanitation engineering specialization.
9	GSCM12IRD	Irrigation and Drainage [Ket Pinnara]	This course offers students a comprehensive introduction to the water balance of cropped fields and the technology to manage this balance. In the irrigation part, the student gains insights and skills necessary for calculating the irrigation water needs of crops and the amount of water in function of different irrigation methods. For the part of the drainage plans for subsurface drainage equations are derived and the drainage criteria determined. Also the choice and installation of drainage systems is explained. During the practicum, students receive training in the use of the software packages that are useful for designing irrigation schemes and to examine how efficient irrigation methods are in the field. The drainage part learns the students to estimate drainage criteria and distance between the drains.
10	GSCM12WAM	Water Quality Analysis and Management [HEU Rina]	The course is designed to provide an understanding of water quality parameters (with a focus on toxic pollutants), their properties, measurement techniques, and control technologies. Risk assessment and fate and transport of pollutants in relation with their physicochemical properties will also be covered.
11	GSCM21ETP	Entrepreneurship [IN Sokneang]	This is Entrepreneurship for engineer. This course arms to help the student to think about the entrepreneurial opportunities of new technology. Therefore, the student will learn to explore the entrepreneurial mindset and culture that has been developing in companies of all sizes and industries; Examine the entrepreneurial process from the generation of creative ideas to exploring feasibility to creation of an enterprise for implementation of the ideas; Experience the dynamics of participating on a business team and the power inherent in a team relative to individual effort; Create and present a business plan for a technology idea; Provide the background, tools, and life skills to participate in the entrepreneurial process within a large company, in a new venture, or as an investor. Upon the completion of the course, the students will: - be able to function on multidisciplinary teams; - understand of professional and ethical responsibility; - have ability to communicate effectively;

			have a broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
12	GSCM21APS Revised	Applied Statistics [PHAUK Sokkhey]	The purpose of this course is to help students develop statistical reasoning skills through investigating and understanding advanced statistical analysis methods beyond that of the introductory course. The course content includes basic descriptive statistics, linear correlation and regression, sampling, probability, random variables, discrete probability distributions, the Normal distribution, sampling distributions, sample size calculations, parameter estimation including confidence intervals, hypothesis testing. However, the topic will be depended on instructor's appropriate selection. Statistical Software shall be introduced in the course. After finishing the course, the students should be about to: - Demonstrate an understanding of how statistics is used in the process of asking research questions, gathering data to address these questions, analyzing the data, and making decisions based upon that analysis. - Use descriptive statistics and graphical methods to summarize data accurately.
13	GSCM21AIM	Agricultural Water and Irrigation System Management [Ket Pinnara & Sok Ty]	Upon completion, the participant should be able to: - Determine crop water requirements, drainage requirements and understand their mutual relationship - Formulate objectives for irrigation development, modernisation and management and understand the consequences for irrigation management and users - Comprehend various forms and levels of irrigation management organisations and different levels of water delivery service and associated costs - Have gained insights into the laws, legislations, and traditions pertaining to the development and use of water resources for agriculture - Identify the relation between water rights arrangements such Farmer Water User Group (FWUG) and water delivery, allocation and decision-making Design water management plans including justifiable decisions on agreements between stakeholders, water delivery and distribution between different users, division of tasks and responsibilities including payments among stakeholders, and monitoring and evaluation for assessing system performance
14	GSCM21UMD	Urban Flood Management and Disaster Risk Mitigation [DOUNG Ratha & PEN Sothytharith]	Upon completion, the participant should be able to: - Develop enhanced understanding of the effects of climate variability on the hydrology that affects urban areas - Learn how to build safe and reliable urban drainage models and how to evaluate system performance against different standards (engineering, environmental, public health, etc.), and develop understanding of novel techniques for modelling the complex geometry and interaction between surface water (including floodplains),

			- Learn how to produce different flood risk maps in a GIS or other flood modelling environment and how to calculate different types of flood damages, and Develop understanding of structural and non-structural flood resilience measures such as, conventional and innovative structures, early warning systems, etc., and understand how to develop effective flood disaster management plans
15	GSCM21WSE	Water Resources System Engineering [Sok Ty]	Water Resources System Engineering shall provide the application of system analysis in water resources planning, design and operation; simulation modelling; reservoir design and operation; optimization for multipurpose water resources system. Determination of optimal operating rules and planning strategies. Current and proposed methods for feasibility studies of water resources development projects.
16	GSCM21SHD	Sustainable hydropower development [Lun Sambo&Chhoun Kong]	This course examines the principles of sustainability and renewable energy conversion with emphasis on wind and hydro energy resources. Concentration is placed on the relationships between the renewable resources, conversion technology and economic feasibility along with consideration of the associated risks and environmental impacts. Students will understand both the principles of operation and the application of wind and hydropower technologies in an evolving energy economy. It will complement existing courses on fossil fuel and solar energy conversion.
17	**GSCM12INT** (New)	Internship [Ket Pinnara]	A three-credit internship program is designed to enrich the students with career-related work experiences to gain confidence and skills to become more mature professionally in any private company, government agency, or non-profit organization. Students who successfully complete an internship will be able to i) Apply knowledge obtained from class to real-world challenges in an internship place, ii) improved skills and maturity in performing within professional work environments, iii) achieved specific learning objectives agreed upon between the student, academic adviser, and hosting internship place.
18	**GSCM21CHK** **(New)**	Professional Lecture Lecture [Hak Danet]	This course is a series of guest lectures. Using guest lectures can provide graduate students with the great opportunity to link theories with practice in the real world and networking. A wide variety of guest lecturers from different industries and organizations will be invited to give lecture once per week. The guest lecturers can share their knowledge, expertise and especially an important professional experience for students based on their real-world life experiences that can reinforce the teachings of the instructor and the students' capacity. Students benefit greatly from being exposed to new pedagogies to get quality education. They can have the opportunity to meet passionate, committed and critical people and to learn from them in various ways. Guest lecturers can act as role models and bring an authentic, vivid picture of the real world to students, thereby enabling transdisciplinary learning. Experiences and perspectives from local actors and entrepreneurs inspire students in their own (entrepreneurial) projects, creating motivation and an action-

			orientation. They bring in special expertise and experiences that teachers cannot provide. The students present an opportunity to utilize alternative technologies and teaching techniques into the course (flexibility). They increase the access to the experts. The experts can be from local and international agencies. They get to see the insight and perspective of the guest lecturers' specific field. The format can enable students to interact and engage with professionals to ask questions during and after class. Through discussions, interpersonal competence and communicative skills are fostered. Guest lecturers can contribute to have a single lecture, a lecture series over a specific topics and period.

2.6.1.6. Program Learning Outcomes (PLOs)

Table 9. Program Learning Outcomes (PLOs) and course mapping

Courses	Program Learning Outcomes (PLO)										
	PLO 1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PLO 10**	**PLO 11**
Hydrology	F	M	M	M	F	P	F	M	M	P	M
Project Management	P	M	F	P	P	P	P	F	F	M	F
GIS and Remote Sensing	F	F	F	M	F	M	M	P	M	M	M
Research Methodology	F	F	M	F	M	M	P	M	M	M	F
Seminar on Water and Environmental Engineering	F	F	F	M	F	M	M	M	P	F	F
Water and Environmental Laboratory	F	M	M	M	M	P	P	P	M	P	P
IWRM and Watershed Management	F	F	M	M	M	F	F	F	M	F	F
Processes Engineering	F	M	F	M	M	P	P	M	M	P	P
Irrigation and Drainage	F	F	F	M	F	F	F	M	M	M	F
Water Quality Analysis and Management	F	F	F	M	F	F	F	M	M	P	M
Entrepreneurship	M	F	F	F	M	F	F	F	F	F	F
Applied Statistics	F	F	F	M	M	M	F	M	M	M	M

Agricultural Water and Irrigation System Management	F	F	F	M	F	F	F	M	M	M	F
Urban Flood Management and Disaster Risk Mitigation	F	F	F	M	F	F	F	M	M	M	F
Water Resources System Engineering	F	F	F	M	F	F	F	M	M	M	F
Sustainable hydropower development	F	F	F	M	F	F	F	M	M	M	F
Internship	F	F	F	F	F	F	F	F	F	F	F
Professional Lecture	F	F	F	F	F	F	F	F	F	F	F

Note: CLOs and PLOs
P: Partially Fulfilled
M: Moderately Fulfilled

2.6.2. MWEE in Urban water and Sanitation Engineering

2.6.2.1. Program Objective

In Cambodia, there is urgent need of water and sanitation engineering specialist to address the problems of providing adequate water supplies, and design and management of urban drainage with water and wastewater treatment facilities. The Master Program of Urban water and Sanitation Engineering aims to produce highly capable human resources to operate and manage water supply and wastewater treatment and sewage system. The program will provide students with an in-depth knowledge of how to deliver effective modern water supply and sanitation engineering. The students will learn to deal with technical aspects of drinking water treatment and distribution, as well as sewage collection and treatment (on- and off-site), in an integrated way, design the treatment plant and pay attention to the choice of technologies and services. They will be able to manage the utility function of a supply and treatment plant. The program will also train the practitioners, technical persons and decision makers who have limited capacity to become experts with strong management and responsible leadership of a development project. Once students have successfully completed this program, they will obtain a position in the wider social, economic and environmental contexts of urbanization and municipal water and infrastructure services provision. This program aims also to provide students with the tools and knowledge to contribute to the development of innovative approaches to the provision of sustainable and equitable municipal water, sanitation, environmental and infrastructure services in developing and transition countries.

2.6.2.2. Career Opportunity after Graduation

After graduation the student will become civil water supply and sanitary engineers working in water supply and waste-water companies, municipal assemblies, government ministries and consulting companies dealing with water supply, sanitation and municipal infrastructure.

2.6.2.3. Courses

Table 10. Coursework and research pathway requirements in Urban Water and Sanitation Engineering

Urban Water and Sanitation Engineering (USE)			
Core Courses	**Elective Courses**	**Specialized Courses**	**Research-oriented Courses**
1. Applied Statistics 2. Chemical Kinetics 3. GIS and Remote Sensing for WEE 4. Entrepreneurship 5. Project Management	1. Hydrology 2. Water Chemistry 3. Sustainable Solid Waste and Hazardous Management 4. Environmental Monitoring and Modelling 5. Water Policy and Planning 6. Water Induced Disaster Risk Assessment 7. Sustainable Energy Management and Conservation 8. Urban Pollution Control 9. Environmental Impact Assessment 10. Climate Change Impacts and Adaptation	1. IWRM and Watershed Management 2. Water Quality Assessment and Management 3. Processes Engineering 4. Micro-biology and Toxicology 5. Water Treatment and Distribution System Design 6. Urban Drainage and Sewerage System Design 7. Wastewater and Sludge Treatment Process 8. Management of Water Supply and Sanitation	1. Research Methodology 2. Seminar on Water and Environmental Engineering 3. Water and Environmental Laboratory 4. Mini-Project 5. Professional Lecture 6. Internship

	11. Resource Recovery (New) 12. Water economy and entrepreneurship (New)		

2.6.2.4. Program structure

Table 11. Number of credits in each coursework in Urban Water and Sanitation Engineering

First Year			
Semester 1		**Semester 2**	
Course	**Credit**	**Course**	**Credit**
Chemical Kinetics	2	IWRM and Watershed Management	2
Project Management	2	Processes Engineering	2
GIS and Remote Sensing for WEE	3	Micro-biology and Toxicology	2
Research Methodology	1	Water Quality Assessment and Management	2
Seminar on Water and Environmental Engineering	1	Elective Course	4
Water and Environmental Laboratory	2	Internship	2
Elective Course	2		
Second Year			
Entrepreneurship	2	Research Proposal	3
Applied Statistics	2	Scientific conference with presentation	3
Water Treatment and Distribution System Design	2	Master Thesis and Defense	6
Urban Drainage and Sewerage System Design	3		

Wastewater and Sludge Treatment Process	3		
Management of Water Supply and Sanitation	2		
Mini-project	2		
Professional Lecture	2		

2.6.2.5. Urban water and Sanitation Engineering

Table 12. Description of each course in Urban water and Sanitation Engineering

No	Code	Course and Lecturer	Description
1	**GSCM12INT** (New)	Internship [Ket Pinnara]	A three-credit internship program is designed to enrich the students with career-related work experiences to gain confidence and skills to become more mature professionally in any private company, government agency, or non-profit organization. Students who successfully complete an internship will be able to i) Apply knowledge obtained from class to real-world challenges in an internship place, ii) improved skills and maturity in performing within professional work environments, iii) achieved specific learning objectives agreed upon between the student, academic adviser, and hosting internship place.
2	**GSCM22CHK (New)**	Professional Lecture Lecture [Hak Danet]	This course is a series of guest lectures. Using guest lectures can provide graduate students with the great opportunity to link theories with practice in the real world and networking. A wide variety of guest lecturers from different industries and organizations will be invited to give lecture once per week. The guest lecturers can share their knowledge, expertise and especially an important professional experience for students based on their real-world life experiences that can reinforce the teachings of the instructor and the students' capacity. Students benefit greatly from being exposed to new pedagogies to get quality education. They can have the opportunity to meet passionate, committed and critical people and to learn from them in various ways. Guest lecturers can act as role models and bring an authentic, vivid picture of the real world to students, thereby enabling transdisciplinary learning. Experiences and perspectives from local actors and entrepreneurs inspire students in their own (entrepreneurial) projects, creating motivation and an action-orientation. They bring in special expertise and experiences that teachers cannot provide. The students present an opportunity to utilize alternative technologies and teaching techniques into the course (flexibility). They increase the access to the experts. The experts can be from local and international agencies. They get to see the insight and perspective of the guest lecturers' specific field. The format can enable students to interact and engage with professionals to ask

			questions during and after class. Through discussions, interpersonal competence and communicative skills are fostered. Guest lecturers can contribute to have a single lecture, a lecture series over a specific topics and period.
3	GSCM11CHK (Revised)	Chemical Kinetics [Bun Saret & KHOEURN Kimleang]	The chemical kinetics is strongly needed for wastewater treatment processes. This course covers the principles of chemical kinetics, including differential rate laws, derivation of exact and approximate integral rate laws for common elementary and composite reactions, fundamentals of collision and transition state theories, and applications such as enzymatic catalysis. By the end of the course, the student must be able to: - Express differential rate laws for elementary and composite chemical reactions. - Derive and apply integral rate laws for the most common elementary and composite reactions. - Apply correctly the steady-state approximation for the rate constant. - Derive and apply the rate law for the mechanism of enzymatic catalysis. Use the transition state theory to compute rate constants of elementary reactions.
4	GSCM11PRM	Project Management [BUN Kimngun]	This course provides a systematic and thorough introduction to all aspects of project management. Therefore, the course underlines the importance of understanding the relation between projects and the strategic goals of the organisation. The course also discusses the technical, cultural, and interpersonal skills necessary to successfully manage projects from start to finish. It emphasises that project management is a professional discipline with its own tools, body of knowledge, and skills. Concepts are reinforced by case studies covering a wide variety of project types and industries.
5	GSCM11GIR	GIS and Remote Sensing [Ann Vannak]	This course provides students with the principles of geographic information systems (GIS) and remote sensing, and the application of these techniques to the water resources and environmental engineering. The first part of the course focuses on GIS, where the structure and format of GIS data, data input and transformation, database compilation, and the use of search criteria and spatial modelling to carry out suitability mapping are examined. In remote sensing, it would be a introduction which capture and processing of satellite images, and how data from various satellite platforms are used in the environmental and life sciences. The course is strongly computer-based, and students will gain experience in the use of ArcGIS and remote sensing software. On successful completion of the course students will be able to: - Understand more on impotency and know the application of GIS and RS for Water and Environmental Engineering - Understand the principles of remote sensing and digital image processing; - Gain experience in the applications of remote sensing and GIS to solving problems in the environmental and life sciences; - Gain experience in the use of image processing and GIS software.

			Use ArcGIS and Spatial Analyst tool for environmental mapping such as map of water quality
6	GSCM11REM	Research Methodology [PENG Chanthol & MASSUEL Sylvain]	The primary objective of this course is to develop a research orientation to the students and to acquaint them with fundamentals of research methods. Specifically, the course aims at introducing them to the basic concepts used in research and to scientific social research methods and their approach. It includes discussions on sampling techniques, research designs and techniques of analysis. Some other objectives of the course are: - To demonstrate knowledge of research processes (reading, evaluating, and developing); - To identify various sources of information for literature review and data collection. - To develop an understanding of the ethical dimensions of conducting applied research. Appreciate the components of scholarly writing and evaluate its quality.
7	GSCM11SMN (Revised)	Seminar on Water and Environmental Engineering [KET Pinnara & HANG Leakhena]	The seminar arms to make the student to understand more on the thematic of Water and Environment and make the student to feel more curious for research on the related topics. The seminar will: - Discussion of special topics related to environment and water resources engineering; analysis of data and conclusion; presentation of reports. - Invited speakers from government industry and various professionals will present these seminars. Every student is expected to present a paper on his own research interest.
8	GSCM11SCC	Water and Environmental Laboratory [TY Boreborey & PENG Chanthol]	Water and Environmental Laboratory to develop sampling and analytical skills of the students which are required in environmental monitoring. Through this course, the students will be able to perform quantitative analysis of various physical, chemical and biological parameters involved in water, soil and microbiology research. The course will also be giving an opportunity to the students to learn how to use and calibrate measurement devices, how to conduct experiment, and how to write a report that justify the theory and to develop their practical skills.
9	GSCM12IWM	IWRM and Watershed Management [KET Pinnara & HANG Leakhena]	Upon completion, the participant should be able to: - describe the main natural and anthropogenic interactions at a watershed scale; and how they can be aggregated to river basin scale - understand the watershed planning and management approaches, specifically in terms of soil and water management - characterize the fundamental economic issues in watersheds and river basins and the role of economic valuation of acquatic ecosystem services in watershed and river basin management - understand the concept of sustainable hydropower structural design and low impact development - Feasibility study on hydropower development and monitoring system to prevent hazard.

10	GSCM12PRE (Revised)	Processes Engineering [TY Boreyborey & EANG Khyeam]	This course will cover the theory of molecular diffusion and mass transfer; fundamental of phase equilibrium; mass transfer operation and separation process; interface mass transfer; absorption and desorption; adsorption and ion exchange; distillation; physical separation process; membrane separation process; finishing process. It is essential for urban water and sanitation engineering specialization.
11	GSCM12MBT	Micro-biology and Toxicology [TAN Reasmey&CHAN Rathborey]	The objective of this course is to introduce the students to some of the unifying concepts of biology, microbiology and toxicology relating to water, the most common and significant source of infectious diseases caused by microbial contamination. The course will explore the types of toxicants present in aquatic systems, their routes of exposure and modes of action, as well as their effects on human health and the environment.
12	GSCM12MBT (Revised)	Water Quality Analysis and Management [BUN Saret& HAM Phaly]	The course is designed to provide an understanding of water quality parameters (with a focus on toxic pollutants), their properties, measurement techniques, and control technologies. Risk assessment and fate and transport of pollutants in relation with their physicochemical properties will also be covered.
13	GSCM21ETP	Entrepreneurship [IN Sokneang]	This is Entrepreneurship for engineer. This course arms to help the student to think about the entrepreneurial opportunities of new technology. Therefore, the student will learn to explore the entrepreneurial mindset and culture that has been developing in companies of all sizes and industries; Examine the entrepreneurial process from the generation of creative ideas to exploring feasibility to creation of an enterprise for implementation of the ideas; Experience the dynamics of participating on a business team and the power inherent in a team relative to individual effort; Create and present a business plan for a technology idea; Provide the background, tools, and life skills to participate in the entrepreneurial process within a large company, in a new venture, or as an investor. Upon the completion of the course, the students will: - be able to function on multidisciplinary teams; - understand of professional and ethical responsibility; - have ability to communicate effectively; - have a broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
14	GSCM21APS (Revised)	Applied Statistics [PHAUK Sokkhey]	The purpose of this course is to help students develop statistical reasoning skills through investigating and understanding advanced statistical analysis methods beyond that of the introductory course. The course content includes basic descriptive statistics, linear correlation and regression, sampling, probability, random variables, discrete probability distributions, the Normal distribution, sampling distributions, sample size calculations, parameter estimation including confidence intervals, hypothesis testing. However, the topic will be depended on instructor's appropriate selection. Statistical Software shall be introduced in the course. After finishing the course, the students should be about to:

			- Demonstrate an understanding of how statistics is used in the process of asking research questions, gathering data to address these questions, analyzing the data, and making decisions based upon that analysis. - Use descriptive statistics and graphical methods to summarize data accurately.
15	GSCM21WTD (Revised)	Water Treatment and Distribution System Design [KHOEURN Kimleang & BUN Saret]	Upon completion, the participant should be able to: - to operate and maintenance and rehabilitation of conventional water treatment processes and plants for urban water supply; - to design and engineer a conventional water treatment plant; - to execute plant performance studies and to evaluate results, as well as to propose improvements in order to rehabilitate a malfunctioning plant; - to propose preliminary hydraulic design that will integrate economic aspects, choose adequate components, and judge technical solutions dealing with the network maintenance, rehabilitation, and expansion
16	GSCM21USD	Urban Drainage and Sewerage System Design [DOUNG Ratha & PEN Sothytharith]	The general objective of the course is to provide the students with an understanding of the basic principles and knowledge for the planning, design and construction of urban drainage and sewerage systems. Upon completion of the course, students shall be able to: - describe the inputs, outputs and functioning of urban drainage/sewerage systems; - appraise urban drainage and sewerage management problems in urban areas; - describe the standard practice in designing urban drainage systems and develop simple drainage system designs; - describe the elementary hydraulic/hydrological processes involved in the urban drainage systems and recommend their appropriate applications; - construct a simple model for analysis of hydraulics of a drainage system;
17	GSCM21WST (Revised)	Wastewater and Sludge Treatment Process [TAN Reasmey & HEU Rina]	This course will focus on basic technologies for the treatment of urban sewage. The technology for remaining sludge treatment will introduced. Unit processes involved in the treatment chain will be described as well as the physical, chemical and biological processes involved. There will be an emphasis on water quality and the functionality of each unit process within the treatment chain. After the course, the students should be able to recognize the process units, describe their function and make simple design calculations on urban sewage treatment plants. The course will cover: - Sewage treatment plant overview: In this module you will learn what major pollutants are present in the sewage and why we need to treat sewage prior to discharge to surface waters. The functional units will be briefly discussed - Primary treatment: In this module you learn how coarse material, sand & grit are removed from the sewage and how to design primary clarification tanks - Biological treatment. In this module you learn the basics of the carbon, nitrogen and phosphorous cycle and how biological processes are used to treat the main pollutants of concern. - Sludge treatment: In this module you will the design principles of sludge thickeners, digesters and dewatering facilities for the concentration and stabilization of excess sewage sludge.

			Potentials for energy recovery via the produced biogas will be discussed.
18	GSCM21MWS	Management of Water Supply and Sanitation [LUN Sambo & HEU Rina]	This course is provided for the learner to be able to make utility planning, financial management: how does a water supply or sanitation utility function, what are the costs, the revenues, how do you plan maintenance / asset renewal. Upon the completion of the course, students will be able to: - Identify and estimate the construction, operational and maintenance costs of a wastewater treatment plant and the investments required to secure its satisfactory operation throughout the expected life-span of the system. - Describe the main elements and components involved in the project planning, project management, and project administration for the design, engineering, construction, start-up and operation of a wastewater treatment plant. - Explain the position and strategy of a water organization in relation to its institutional environment. Assess the processes of human resources, health and safety, management for integrity and sustainability, asset management and customer management.
19	GSEM22RER (New)	Resources Recovery [Theng Vouchlay & HEU Rina]	The course focuses on research and trends in Resource Recovery where the focus is on new material recycling processes for e.g. biomaterials and textiles. The course also focuses on how to make technology and society work together, different incentives that can be used to create the changes required and how knowledge and financial resources are best used to reach a circular society. In connection with recycling and circular society, ethical, social, legal and economic issues are also addressed.
20	GSEM22WET (New)	Water economy and entrepreneurship [In Sokneang]	This course provides an introduction to economic theory and approach as applied to water management. It is for professionals in water-related fields with no prior economic background. The course focuses on both the entrepreneurial mindset and the process of launching and growing a new business in the context of water economic. Reviews opportunities, innovation, new value creation, business context, existing firms and any area of business or life that pertains to entrepreneurship.

2.6.2.6. Program Learning Outcomes (PLOs)

Table 13. Program Learning Outcomes (PLOs) and course mapping

Courses	Program Learning Outcomes (PLOs)										
	PLO1	**PLO 2**	**PLO 3**	**PLO 4**	**PLO 5**	**PLO 6**	**PLO 7**	**PLO 8**	**PLO 9**	**PLO 10**	**PLO 11**
Chemical Kinetics	F	M	M	M	F	P	F	M	M	M	M
Project Management	P	M	F	P	P	P	P	F	F	M	F
GIS and Remote Sensing	F	F	F	M	F	M	M	P	M	M	M
Research Methodology	F	F	M	F	M	M	P	M	M	M	F
Seminar on Water and Environmental Engineering	F	F	F	M	F	M	M	M	P	F	F
Water and Environmental Laboratory	F	M	M	M	M	P	P	P	M	P	P
IWRM and Watershed Management	F	F	M	M	M	F	F	F	M	F	F
Processes Engineering	F	M	F	M	M	P	P	M	M	P	P
Micro-biology and Toxicology	F	F	F	M	F	F	F	M	M	M	F
Water Quality Analysis and Management	F	F	F	M	F	F	F	M	M	P	M
Entrepreneurship	M	F	F	F	M	F	F	F	F	F	F
Applied Statistics	F	F	F	M	M	M	F	M	M	M	M
Water Treatment and Distribution System Design	F	F	F	M	F	F	F	M	M	M	F
Urban Drainage and Sewerage System Design	F	F	F	M	F	F	F	M	M	M	F
Wastewater and Sludge Treatment Process	F	F	F	M	F	F	F	M	M	M	F
Management of Water Supply and Sanitation	F	F	F	M	F	F	F	M	M	M	F
Internship	F	F	F	F	F	F	F	F	F	F	F
Professional Lecture	F	F	F	F	F	F	F	F	F	F	F

Note: CLOs and PLOs
P: Partially Fulfilled
M: Moderately Fulfilled

2.6.3. MWEE in Environmental Engineering and Management

2.6.3.1. Program Objective

The rapid development, natural resources extraction and industrial production side-effects cause enormous impact on rural and urban environment, and society's awareness of such effects is constantly growing. The specialization of Environmental Engineering and Management offers an integrated approach towards current and long term strategic environmental issues, focusing on technologies and concepts in environmental planning and management for green and clean industrial production systems. Particularly, this specialization looks for solutions to environmental problems including air pollution engineering and management; solid and hazardous wastes; waste minimization and life cycle assessment; environmental impact assessment and audit; and environmental control planning.

2.6.3.2. Career Opportunity after Graduation

Career opportunities for this level of specialization will be managerial and policy positions in companies, consulting firms and government as an environmental manager, engineer, auditor or policy analyst. The graduates work in industrial and trade enterprises, municipalities, environmental agencies as environmental engineers. Moreover, this course is designed to provide consultants, operators, regulators and managers with the professional skills and training to contribute to the provision of environmentally sound and economically sustainable systems.

2.6.3.3. Courses

Table 14. Coursework and research pathway requirements in Environmental Engineering and Management

Environmental Engineering and Management (EEM)			
Core Courses	**Elective Courses**	**Specialized Courses**	**Research-oriented Courses**
1. Hydrology 2. Applied Statistic 3. GIS and Remote Sensing for WEE 4. Entrepreneurship	1. Water Chemistry 2. Environmental Chemistry 3. Water Policy and Planning	1. IWRM and Watershed Management 2. Water Quality Assessment and Management	1. Research Methodology 2. Seminar on Water and Environmental Engineering

5. Project Management	4. Micro-biology and Toxicology 5. Environmental Monitoring and Modelling 6. Water Induced Disaster Risk Assessment 7. Urban Pollution Control 8. Climate Change Impacts and Adaptation 9. Environmental and Ecological System Modeling 10. Environmental Impact Assessment	3.Sustainable Solid Waste and Hazardous Management 4.Processes Engineering 5.Engineering Environmental Sustainability 6.Sustainable Energy Management and Conservation 7.Industrial Resource Management and Cleaner Production 8.Air pollution control and monitoring	3. Water and Environmental Laboratory 4. Mini-Project 5. Professional course 6. Internship

2.6.3.4. Program structure

Table 15. Number of credits in each coursework in Environmental Engineering and Management

First Year			
Semester 1		**Semester 2**	
Course	**Credit**	**Course**	**Credit**
Hydrology	2	IWRM and Watershed Management	2
Project Management	2	Processes Engineering	2
GIS and Remote Sensing for WEE	3	Irrigation and Drainage	2
Research Methodology	1	Water Quality Assessment and Management	2
Seminar on Water and Environmental Engineering	1	Elective Course	4
Water and Environmental Laboratory	2	Internship	2
Elective Course	2		

Second Year			
Hydrology	2	IWRM and Watershed Management	2
Project Management	2	Processes Engineering	2
GIS and Remote Sensing for WEE	3	Irrigation and Drainage	2
Research Methodology	1	Water Quality Assessment and Management	2
Seminar on Water and Environmental Engineering	1	Elective Course	4
Water and Environmental Laboratory	2		
Professional course	2		

2.6.3.5. Course Description

Table 16. Description of each course in Environmental Engineering and Management

No	Code	Course and Lecturers	Description
1	GSCM11HYD	Hydrology [Dr. Chhoun Kong]	This course will provide the student with an understanding of the hydrologic components and hydrologic events and the routing of flows through systems. This course will introduce the practice of surface water hydrology as water plays a role in the development of most human activities. Various land phase hydrologic processes will be described. Methods of development of intensity-duration-frequency (IDF) curves for rainfall, estimation of rainfall at ungauged locations, stream flow measurement methods, and flood frequency analysis will be discussed. Student will also learn various hydrologic and hydraulic models used in the professional domain. Based calculations within various hydrologic procedures as required for addressing surface water hydrology issues will also be covered. This course is recommended for non-ITC student and ITC students who are not from Faculty of Hydrology and water Resources Engineering.
2	GSCM11PRM	Project Management [Bun Kimngoun]	This course provides a systematic and thorough introduction to all aspects of project management. Therefore, the course underlines the importance of understanding the relation between projects and the strategic goals of the organisation. The course also discusses the technical, cultural, and interpersonal skills necessary to successfully manage projects from start to finish. It emphasises that project management is a professional discipline with its own tools, body of knowledge, and skills. Concepts are reinforced by case studies covering a wide variety of project types and industries.

3	GSCM11GIR	GIS and Remote Sensing [Ann Vannak]	This course provides students with the principles of geographic information systems (GIS) and remote sensing, and the application of these techniques to the water resources and environmental engineering. The first part of the course focuses on GIS, where the structure and format of GIS data, data input and transformation, database compilation, and the use of search criteria and spatial modelling to carry out suitability mapping are examined. In remote sensing, it would be a introduction which capture and processing of satellite images, and how data from various satellite platforms are used in the environmental and life sciences. The course is strongly computer-based, and students will gain experience in the use of ArcGIS and remote sensing software. On successful completion of the course students will be able to: - Understand more on impotency and know the application of GIS and RS for Water and Environmental Engineering - Understand the principles of remote sensing and digital image processing; - Gain experience in the applications of remote sensing and GIS to solving problems in the environmental and life sciences; - Gain experience in the use of image processing and GIS software. - Use ArcGIS and Spatial Analyst tool for environmental mapping such as map of water quality
4	GSCM11REM	Research Methodology [PENG Chanthol & MASSUEL Sylvain]	The primary objective of this course is to develop a research orientation to the students and to acquaint them with fundamentals of research methods. Specifically, the course aims at introducing them to the basic concepts used in research and to scientific social research methods and their approach. It includes discussions on sampling techniques, research designs and techniques of analysis. Some other objectives of the course are: - To demonstrate knowledge of research processes (reading, evaluating, and developing); - To identify various sources of information for literature review and data collection. - To develop an understanding of the ethical dimensions of conducting applied research. Appreciate the components of scholarly writing and evaluate its quality.
5	GSCM11SMN (Revised)	Seminar on Water and Environmental Engineering [KET Pinnara & HANG Leakhena]	The seminar arms to make the student to understand more on the thematic of Water and Environment and make the student to feel more curious for research on the related topics. The seminar will: - Discussion of special topics related to environment and water resources engineering, analysis of data and conclusion, presentation of reports. - Invited speakers from government industry and various professionals will present these seminars. - Every student is expected to present a paper on his own research interest.
6	GSCM11WEL	Water and Environmental Laboratory	Water and Environmental Laboratory to develop sampling and analytical skills of the students which are required in environmental monitoring. Through this course, the students will be able to perform quantitative analysis of various physical, chemical and biological parameters involved in water, soil and

		[TY Boreborey & PENG Chanthol]	microbiology research. The course will also be giving an opportunity to the students to learn how to use and calibrate measurement devices, how to conduct experiment, and how to write a report that justify the theory and to develop their practical skills.
7	GSCM12IWM	IWRM and Watershed Management [KET Pinnara & HANG Leakhena]	Upon completion, the participant should be able to: - describe the main natural and anthropogenic interactions at a watershed scale; and how they can be aggregated to river basin scale - understand the watershed planning and management approaches, specifically in terms of soil and water management - characterize the fundamental economic issues in watersheds and river basins and the role of economic valuation of acquatic ecosystem services in watershed and river basin management - understand the concept of sustainable hydropower structural design and low impact development Feasibility study on hydropower development and monitoring system to prevent hazard.
8	GSCM12PRE (Revised)	Processes Engineering [TY Boreyborey & EANG Khyeam]	This course will cover the theory of molecular diffusion and mass transfer; fundamental of phase equilibrium; mass transfer operation and separation process; interface mass transfer; absorption and desorption; adsorption and ion exchange; distillation; physical separation process; membrane separation process; finishing process. It is essential for urban water and sanitation engineering specialization.
9	GSCM12IRD	Irrigation and Drainage [Ket Pinnara]	This course offers students a comprehensive introduction to the water balance of cropped fields and the technology to manage this balance. In the irrigation part, the student gains insights and skills necessary for calculating the irrigation water needs of crops and the amount of water in function of different irrigation methods. For the part of the drainage plans for subsurface drainage equations are derived and the drainage criteria determined. Also the choice and installation of drainage systems is explained. During the practicum, students receive training in the use of the software packages that are useful for designing irrigation schemes and to examine how efficient irrigation methods are in the field. The drainage part learns the students to estimate drainage criteria and distance between the drains.
10	GSCM12WAM	Water Quality Analysis and Management [Heu Rina]	The course is designed to provide an understanding of water quality parameters (with a focus on toxic pollutants), their properties, measurement techniques, and control technologies. Risk assessment and fate and transport of pollutants in relation with their physicochemical properties will also be covered.
11	GSCM21WEL	Entrepreneurship [IN Sokneang]	This is Entrepreneurship for engineer. This course arms to help the student to think about the entrepreneurial opportunities of new technology. Therefore the student will learn to explore the entrepreneurial mindset and culture that has been developing in companies of all sizes and industries; Examine the entrepreneurial process from the generation of creative ideas to exploring feasibility to creation of an enterprise for implementation of the

			ideas; Experience the dynamics of participating on a business team and the power inherent in a team relative to individual effort; Create and present a business plan for a technology idea; Provide the background, tools, and life skills to participate in the entrepreneurial process within a large company, in a new venture, or as an investor. Upon the completion of the course, the students will: - be able to function on multidisciplinary teams; - understand of professional and ethical responsibility; - have ability to communicate effectively; - have a broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
12	GSCM21AST (Revised)	Applied Statistics [PHAUK Sokkhey]	The purpose of this course is to help students develop statistical reasoning skills through investigating and understanding advanced statistical analysis methods beyond that of the introductory course. The course content includes basic descriptive statistics, linear correlation and regression, sampling, probability, random variables, discrete probability distributions, the Normal distribution, sampling distributions, sample size calculations, parameter estimation including confidence intervals, hypothesis testing. However, the topic will be depended on instructor's appropriate selection. Statistical Software shall be introduced in the course. After finishing the course, the students should be about to: - Demonstrate an understanding of how statistics is used in the process of asking research questions, gathering data to address these questions, analyzing the data, and making decisions based upon that analysis. - Use descriptive statistics and graphical methods to summarize data accurately.
13	GSCM21SGE	Sustainable and Green Energy Systems [Theng Vouchlay]	The Renewable and Sustainable Energy Systems course provides a graduate-level understanding of the conversion principles and technology behind various renewable energy sources. It also examines the issues involved in the integration of various renewable energy sources and their economics for heat, power, and transportation needs. Based on the technical and sustainability challenges, the future outlook for each of the sources and systems is discussed.
14	GSCM21IMC	Industrial Resource Management and Cleaner Production [Bun Saret]	The course introduces the concept of Cleaner Production in the context of the water cycle in general and water management in particular. The course focuses on the careful use of the resource water and brings in various tools that can aid in saving water.
15	GSCM21SWH	Sustainable Solid Waste and Hazardous Management [Ham Phaly]	This course covers the principles of integrated solid waste management. Provides an overview of municipal solid waste (MSW), industrial waste and hazardous waste management, including design and economic analysis. Covers the planning and engineering principles needed to address the growing and increasingly intricate problem of controlling and processing the refuse (solid waste) created by urban societies. Discusses options

			such as landfilling, composting and incineration from engineering, social, and regulatory perspectives. Reviews physical, chemical, and biological treatment of hazardous waste. Federal regulations, permitting and public participation processes and innovative management practices associated with solid and hazardous waste are also covered. Situations dealing with real world settings are covered through worked examples and field trips to solid waste management facilities.
16	GSCM11ACM	Air pollution control and monitoring [KET Pinnara & HANG Leakhena	This course provides students with the philosophy and procedures for the design of air pollution control system. In addition to design work, the responsibility of air pollution engineers can include monitoring, permitting, performance testing, maintenance scheduling, and operational troubleshooting. The two main objectives of this course are: - to present essential basic information about air pollution and its control and to provide formal design training of engineering students. - to provides detailed knowledge of theoretical and practical aspects of industrial air pollution control and monitoring. It covers main processes and devices widely used in the area air pollution control, particularly filtration and separation, chemical and mechanical methods of air purification, absorption, adsorption, precipitation, etc. The subject also covers main technologies and protocols used for air pollution monitoring.
17	**GSCM12INT** (New)	Internship [Ket Pinnara]	A three-credit internship program is designed to enrich the students with career-related work experiences to gain confidence and skills to become more mature professionally in any private company, government agency, or non-profit organization. Students who successfully complete an internship will be able to i) Apply knowledge obtained from class to real-world challenges in an internship place, ii) improved skills and maturity in performing within professional work environments, iii) achieved specific learning objectives agreed upon between the student, academic adviser, and hosting internship place.
18	**GSCM21CHK** **(New)**	Professional Lecture Lecture [Hak Danet]	This course is a series of guest lectures. Using guest lectures can provide graduate students with the great opportunity to link theories with practice in the real world and networking. A wide variety of guest lecturers from different industries and organizations will be invited to give lecture once per week. The guest lecturers can share their knowledge, expertise and especially an important professional experience for students based on their real-world life experiences that can reinforce the teachings of the instructor and the students' capacity. Students benefit greatly from being exposed to new pedagogies to get quality education. They can have the opportunity to meet passionate, committed and critical people and to learn from them in various ways. Guest lecturers can act as role models and bring an authentic, vivid picture of the real world to students, thereby enabling transdisciplinary learning. Experiences and perspectives from local actors and entrepreneurs inspire students in their own (entrepreneurial) projects, creating motivation and an action-

			orientation. They bring in special expertise and experiences that teachers cannot provide. The students present an opportunity to utilize alternative technologies and teaching techniques into the course (flexibility). They increase the access to the experts. The experts can be from local and international agencies. They get to see the insight and perspective of the guest lecturers' specific field. The format can enable students to interact and engage with professionals to ask questions during and after class. Through discussions, interpersonal competence and communicative skills are fostered. Guest lecturers can contribute to have a single lecture, a lecture series over a specific topics and period.

2.6.3.6. Program Learning Outcomes

Table 17. Program learning outcomes of Master program of Environmental Engineering and Management

Courses	Program Learning Outcomes (PLO)										
	PLO1	PLO2	PLO 3	PLO4	PLO5	PLO6	PLO7	PLO8	PLO9	PLO1 0	PLO1 1
Hydrology	F	M	M	M	F	P	F	M	M		M
Project Management	P	M	F	P	P	P	P	F	F	M	F
GIS and Remote Sensing	F	F	F	M	F	M	M	P	M	M	M
Research Methodology	F	F	M	F	M	M	P	M	M	M	F
Seminar on Water and Environmental Engineering	F	F	F	M	F	M	M	M	P	F	F
Water and Environmental Laboratory	F	M	M	M	M	P	P	P	M	P	P
IWRM and Watershed Management	F	F	M	M	M	F	F	F	M	F	F
Processes Engineering	F	M	F	M	M	P	P	M	M	P	P
Irrigation and Drainage	F	F	F	M	F	F	F	M	M	M	F
Water Quality Analysis and Management	F	F	F	M	F	F	F	M	M	P	M
Entrepreneurship	M	F	F	F	M	F	F	F	F	F	F

Applied Statistics	F	F	F	M	M	M	F	M	M	M	M
Sustainable and Green Energy Systems	F	F	F	M	F	F	F	M	M	M	F
Industrial Resource Management and Cleaner Production	F	F	F	M	F	F	F	M	M	M	F
Sustainable Solid Waste and Hazardous Management	F	F	F	M	F	F	F	M	M	M	F
Air pollution control and monitoring	F	F	F	M	F	F	F	M	M	M	F
Internship	F	F	F	F	F	F	F	F	F	F	F
Professional Lecture	F	F	F	F	F	F	F	F	F	F	F

Note: CLOs and PLOs

P: Partially Fulfilled

M: Moderately Fulfilled

3. Human Resources

Table 18. List of Human Resources

Lecturers	Degree	Graduated from	Specialization
Tan Reasmey	Ph.D.	Tokyo Institute of Technology	Bio-engineering
Ket Pinnara	Ph.D.	University of Liège-Gembloux Agro-Bio Tech	Agricultural Science and Biological Engineering
Oeurng Chantha	Ph.D.	INP- Toulouse	Water Resources
Soy Ty	MSc.	Université de Liège	Soil Mechanics
Ann Vannak	Ph.D.	University of Girona	Water Science and Technology
Veng Huor	MSc.	Université de Liège	Fluid mechanics
Lun Sambo	MSc.	University of Tokyo	Environmental Engineering
Ouch Rithy	Ph.D.	Chulalongkorn University	GeoEnvironment
Hak Danet	Ph.D.	Tokyo Institute of Technology	Environmental Engineering
Heng Sokchay	Ph.D.	University of Yamanashi	Water Resources
Doung Ratha	Ph.D.	University of the Philippines	Environmental Engineering
TY Boreborey	Ph.D.	University of the Philippines	Environmental Engineering
Song Layheang	Ph.D	University Montpellier 2	Water Resources
Sok Ty	Ph.D	Kasetsart University	Environmental Engineering
Chhuon Kong	Ph.D.	University of the Philippines	Environmental Engineering
Pen Sytharith	Ph.D.	Hokkaido University	Environmental Engineering

IN Sokneang	Ph.D.	AgroParisTech	Agriculture Biology Environment Health
SIM Tepmony	Ph.D.	Télécom ParisTech	Applied Mathematics and Statistics
Kinnaleth VONGCHANH	Ph.D.	Institute of Technology of Bandung	Engineering in Mechanical Engineering
Theng Vouchlay	D.Eng	Tokyo Institute of Technology	Environmental Engineering
Sang Davin	M.Eng	Kasetsart University	Environmental Engineering
Heu Rina	PhD	Tokyo Institute of Technology	Tokyo Institute of Technology
Bun Saret	PhD	The University of Tokyo	Environmental Engineering

4. Laboratory and Research Equipment

Table 19. List of laboratory and research equipment

Water Chemistry Laboratory	
▪ Spectrophotometer ▪ Total dissolved solid meter ▪ Viscosi-Meter ▪ Titronic-SCHOTT ▪ Turbidity meter (2100 Q Portable Turbidity, HACH) ▪ Dissolved Oxygen meter (HI 9146, HANNA) ▪ Conductivity meter (HI 8663, HANNA) ▪ Total dissolved solid (TDS meter) ▪ High Performance Liquid Chromatography: HPLC-Fluorescence Detector, SHIMAZU ▪ Kjeldahl system ▪ Lab scale bio-reactor	▪ Soxtherm extraction system (GERH 13-005, Germany Product) ▪ Rotary evaporator (RV-10, IKA Germany Product) ▪ Oxi 1970i Oxy-Meter ▪ Colorimeter ▪ Viscosimeter (MORMALAB, France) ▪ GC-MS (GSMS- QP2010 Ultral, Shimadzu) ▪ Freeze Dryer (Alpha 1-4 LD plus) ▪ Chroma meter (CR-400/410) ▪ ELISA machine ▪ Gerhardt Fiber determination machine ▪ Satorius Humidity Equipment ▪ Furnace for ash content analysis
Water Supply and Hydrology Laboratory	
Laboratory ▪ Water Supply, Plumbing & Sanitation ▪ Soil, Water and Irrigation ▪ GIS-Remote Sensing and Surveying ▪ Hydrology and Hydraulic	Equipment ▪ Acoustic Doppler Current Profiler (ADCP): River Surveyor SonTek M9 ▪ Current meter ▪ Water level sensor: HOBO ▪ Hydrometer

	▪ Weather station ▪ Total Station (Topcon, Leica) ▪ GNSS RTK systems (Leica) ▪ Sounding devices with acoustic and light signal (Eijkelkamp) ▪ Ceramic plates (Eijkelkamp) ▪ Double rings (Eijkelkamp) ▪ Hand augers ▪ Sieves ▪ Direct shear test
Environmental Laboratory	
▪ Gas chromatography–mass spectrometry (GCMS) ▪ Total Organic Carbon (TOC) Analyzer	▪ Ion chromatography (IC) ▪ SALD-2300 Laser Diffraction Particle Size Analyzer

5. Name of Degree

Successful students will receive a:

"Master of Engineering degree in Water and Environmental Engineering".

6. Conclusion and Implementation of the updated program

Curriculum improvement was completed in 2022 after the fruitful discussions and supports from the graduate school and faculty of Hydrology and Water Resources Engineering staffs. In addition, this updated curriculum was endorsed by the consortium members, and the approval of Board of Trustees of the Institute of Technology of Cambodia (CA – Conseils d'administration of ITC) during the annual CA board meeting on 16th June 2022. This updated program will be implemented in the academic year of 2022-2023.

Prepared by
Phnom Penh, October 2022
Head of Master Program

Dr. Ket Pinnara

Verified by
Phnom Penh, October 2022
Director of Graduate School of ITC

Dr. Sim Tepmony

Seen and Approved
Phnom Penh, October 2022
Deputy Director General of ITC

Mr. Soy Ty

Appendix A: Comparison of the updated and old curriculum

No.	Description	Old curriculum)	Updated curriculum
1	Number of subjects Year M1 and M2 in MWEE-USE	27	31
2	New subjects in all specializations		4
3	Revised Subject in MWEE-USE	7	
4	Pathway of the all specializations	1 Pathway: Course-Research Based	2 Pathway: Research based Course-Research Based

Appendix B: Details of course syllabus

Appendix B

INSTITUTE OF TECHNOLOGY OF CAMBODIA

GRADUATE SCHOOL

MASTER OF AGRO-INDUSTRIAL ENGINEERING – M-WEE
RESEARCH – BASED PATHWAY

DETAILED COURSE SYLLABUS

APPLIED STATISTICS

Course Syllabus

Subject: Applied Statistics **Course's Code:**

Year: 1 (Semester 1) **Number of Credits:** 2 (32h)

Instructors:

1. **Name:** PHAUK Sokkhey **Sex**: Male **Title**: Dr.
   Qualification: Ph.D. in Interdisciplinary Intelligent Systems (Data Science)
   Office: F104, Building F **Affiliation**: Department of Applied Mathematics and Statistics (AMS)
   Telephone/Telegram: 012 939 310 **Email:** phauk.sokkhey@itc.edu.kh
2. **Name:** EK Pichmony **Sex**: Female **Title**: Dr.
   Qualification: Ph.D. in Food Science
   Office: Room B-110 **Affiliation**: Graduate School of ITC
   Telephone/Telegram: 092 882 055 **Email:** pichmony@itc.edu.kh

1. Course Description

Applied statistic is designed to analyzing data has become common practice in virtually all scientific and engineering discipline. This course provides a comprehensive introduction to those model and methods most likely to be encountered and used by students in their career in engineering and data analytic. The examples and exercises have been designed with scientists and engineers in mind, most of the methods covered are basic to statistical analyses in many other discipline, so that students of engineering, computer science, and data science will profit from this course.

Keywords and description

1. **Credit:** a unit of measurement of the study duration in each course contributed by an educational course to a college degree.
2. **Thesis:** a document submitted in support of candidature for an academic degree or professional qualification presenting the author's research and findings.
3. **Academic staff:** professional personnel directly involved in teaching students, research, or public service, holding an academic rank with such titles as professor, associate professor, assistant professor, instructor, supervisor, etc. who work in the academic field.
4. **Proportion of lecturer per student:** the total number of lecturers (including professor, associate professor, assistant professor, instructor, supervisor, etc.) divided by the total number of graduate students.
5. **Core course**: mandatory courses that students must study to meet the requirements of a study program.
6. **Elective course:** courses that students can choose, allowing to study topics that the students interest. Electives, when added to the core courses, make up the total number of units needed to complete the degree requirement.
7. **Specialized course:** a course of study or major at an academic institution or may refer to the field in which a specialist practices.
8. **Research-oriented Course:** a course that requires students to study the method and strategy to do research and write thesis, proposal, and report.
9. **Research report:** research finding report of students to be submitted to the university to meet the requirement of a study program.
10. **Supervisor:** a lecturer who supervises students to do research and write thesis.